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The Quad's quantum leap: how Quad countries can boost cooperation on quantum computing

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Key points

- Quantum computing is a powerful dual-use technology that carries the potential to transform traditional understandings of national and economic security.
- The race to build, scale, and commercialise quantum computers is already under way and the Quad cannot afford to cede the lead to competitors.
- The Quad must take collective action to establish global leadership in quantum computing and foster the development of a technology ecosystem that upholds its values and interests.

Policy recommendations

- The Quad should expand its STEM Fellowship program to secure access to the talent required to advance state-of-the-art quantum systems.
- The Quad Center of Excellence in Quantum Information Science should develop a strategy to ensure that the Quad partners maintain competitiveness across all leading quantum computing modalities.
- The Fall 2023 convening of the Quad Technology Business and Investment Forum should feature roundtable discussions on standard-setting and export controls for quantum technologies.

Introduction

Cooperation on emerging technologies ranks among the highest priorities of the Quad.[1] While the Quad partners – Australia, India, Japan, and the United States – have made significant progress in advancing shared interests in biotechnology, semiconductors, cybersecurity, and telecommunications, they have missed opportunities for collaboration in quantum computing.[2] Increased Quad cooperation is critical to the development of a quantum technology ecosystem that supports an open, inclusive, and resilient Indo-Pacific.

The significance of quantum computing

The possible strategic advantages of quantum computing, a subfield of quantum information science that leverages quantum mechanics to solve complex problems at unprecedented speeds, are numerous and significant.[3] Several technical bottlenecks still prevent quantum computers from delivering impactful real-world effects, but quantum technology is maturing rapidly, with implications for the Quad partners' civilian and military sectors.[4]

Quantum computers could optimise efficiency and catalyse new discoveries in industries such as drug design, fertiliser production, and supply chain management. They could also be used to model new battery and energy storage systems, expedite financial fraud detection, or simulate

complex weather systems.[5] Some estimates project that quantum computing will produce a global market value of US$1 trillion by 2035.[6]

Militaries may leverage quantum computers as well, including for weapons development, mission planning, predictive maintenance, targeting, or data analysis.[7] Quantum computing could unlock the next generation of defence technologies, affording militaries a new toolkit of capabilities to threaten previously unreachable parts of adversaries' corporate, military, and government infrastructure.[8]

Given its transformative potential, quantum computing carries consequential first-mover advantages. The first country to scale and commercialise quantum computers will gain an upper hand in securing a favourable market position, setting standards, implementing regulations, and exploring profitable new use cases. To ensure the development of a quantum technology network that aligns with its values and interests, the Quad must dominate the global race to build functional quantum systems.

Opportunities for Quad Cooperation

To date, Quad cooperation on quantum technology has been limited to broad joint statements conveying a desire to 'focus on quantum technologies' in the future. But the quantum race is under way now. To avoid ceding the lead to competitors, the Quad must move beyond generic statements to coordinated and collective action.[9]

First, the Quad should expand its science, technology, engineering, and mathematics (STEM) Fellowship program to ensure access to quantum-relevant talent.[10] Talent is necessary to invent, develop, and scale quantum systems and maintain global competitiveness.[11] But increased investment in quantum technology has created a landscape in which quantum-relevant expertise is globally dispersed and a commodity in short supply.[12] No country has exclusive access to the people required to advance state-of-the-art quantum technologies, and the talent shortage is only expected to worsen as demand for expertise increases over the next decade.[13]

The Quad can use the STEM Fellowship program – which aims to develop a network of STEM talent by sponsoring 100 American, Japanese, Australian, and Indian master's and doctoral students to study in the US – to collectively increase access to talent.[14] Opening the fellowship to more students – particularly students in quantum-relevant disciplines such as physics, electrical engineering, and computer and information science – will enable the Quad to stay at the cutting edge of research and discovery and counteract competitors' efforts to train, recruit, and retain the best talent.[15] The Quad should also create opportunities for STEM fellows to study in Japan, Australia, and India. Geographically diverse fellowship placement options will help ensure that all Quad partners benefit from the exchange of STEM talent and could help broaden the pool of potential talent from which to draw.

Second, the Quad Investors Network should direct the co-chairs of its recently launched Quad Center of Excellence in Quantum Information Sciences to develop a Quad quantum technology strategy that funnels research and investment towards various scientific approaches to quantum computing.[16] Though two quantum computing modalities – superconducting qubits and trapped ions – have progressed most rapidly, other emerging approaches – like neutral atoms and photonics – could emerge as 'dark horse' candidates for future breakthroughs.[17]

The Quad must maintain an edge across all leading modalities to ensure superiority in the one that ultimately produces the first scalable quantum computing system. Because each scientific approach to quantum computing requires a different combination of globally dispersed components and materials, balanced research and investment also supports the development of a resilient quantum supply chain.[18] Exploring every modality equips the Quad to coordinate

supply chains, identify key vulnerabilities early, and gain influence over critical nodes as they emerge.

Finally, the Fall 2023 convening of the Quad Technology Business and Investment Forum should feature roundtable discussions on standard-setting and export controls for quantum technologies.[19] Most quantum technologies are still too immature for significant standardisation, but Quad leaders must plan ahead to prevent competitors from gaining an unfair advantage over the eventual standardisation process.[20] Open discussions about potential technical requirements for quantum computers will help the Quad partners reach consensus early, establish leadership in quantum standard-setting bodies, and build interoperable quantum systems that align with democratic values.

The number of promising quantum computing modalities under development also likely means that it is too soon for the Quad to introduce export controls on quantum technologies.[21] However, the challenges associated with leading techno-democracies' recent efforts to organise multilateral export controls on semiconductors highlights the importance of forethought and proactive coordination on technology regulations.[22]

The Quad should develop metrics to assess when export controls on quantum computing technology may be appropriate and begin discussing how such controls may be structured and implemented. The Quad partners could consider implementing export controls on quantum technologies once they identify a leading quantum computing modality and secure a definitive advantage over foreign competitors, for example. The Quad should also consider whether changes to certain export control regimes, such as the International Traffic in Arms Regulations, could help foster desirable outcomes in quantum technology by facilitating technology transfers and collaboration.

Conclusion

The Quad stands at an important inflection point. Though quantum computing is maturing rapidly, actual applications remain limited, and no single country has a commanding lead in the race to build a scalable quantum system. Now is an ideal time to create policies that uphold democratic values and advance the Quad's vision for a resilient and open Indo-Pacific. Quantum computers carry the potential for tremendous economic, political, and military disruption. The Quad partners must work together to harness their positive potential while mitigating their risks.

Notes

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About this paper

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About the Quad Tech Network

The Quad Tech Network (QTN) is an initiative of the NSC, delivered with support from the Australian Government. It aims to establish and deepen academic and official networks linking the Quad nations – Australia, India, Japan, and the United States – in relation to the most pressing technology issues affecting the future security and prosperity of the Indo-Pacific.

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