DEPARTMENT OF INDUSTRY, SCIENCE AND RESOURCES

MS22-001858

To: Minister for Industry and Science (For Information only)

INTERNATIONAL COOPERATION UPDATE – QUANTUM

Recommendation: That you,

1. **Note** the current international cooperation activities on quantum, and the role they play in supporting our domestic industry and furthering Australia's strategic interests.

Noted / Please Discuss

2. **Note** that we will brief you separately on progressing new cooperation opportunities such as joint statements of cooperation on quantum.

Noted / Please Discuss

Minister: Date:

Comments:

Clearing Officer: Sent: 31/10/22	Camille de Burgh	General Manager, Technology Policy and Engagement Branch	s22
Contact Officer:	s22	A/g Manager, Quantum Engagement and International, Technology and National Security	s22

Key Points:

Quantum is a global endeavour

1. Developing quantum technologies is complex, expensive and slow, requiring significant, long term commitment to create sovereign capability. As a result, countries that have been early movers on quantum, such as Australia, are increasingly working together to bring quantum use cases to life and manage national security risks. There are significant benefits for Australia to collaborate internationally on quantum as outlined below.

Strengthening supply chains and gaining access to international markets for Australian quantum technology exporters.

2. The customer base for many Australian quantum companies is located overseas, mainly in Europe and North America. As a result, Australian quantum companies are seeking to have a global footprint and proximity to their export market – with Quantum Brilliance, Q-CTRL and Nomad Atomics setting up offices in Germany, and QuintessenceLabs and Q-

CTRL expanding to the United States (US). Integrating Australia into the global supply chain will be important for the continued growth of our domestic industry.

Deepening research and development opportunities, and leveraging complementary capabilities of international partners.

3. Working with other advanced international quantum economies, Australia can access global experts and industry partners, and stay at the forefront of technological advances. For example, the UTS Centre for Quantum Software and Information is partnering with the US Defense Advanced Research Projects Agency on a quantum benchmarking program. This project provides Australian researchers access to global companies such as HRL Laboratories, Boeing and General Motors while deepening collaboration with multinational quantum companies such as Zapata, Rigetti, and IonQ.

Helping attract and retain talent and investment.

4. International collaboration opportunities not only provide access to global talent, they also send an important signal to our domestic sector that the Australian Government is an active player in the global quantum ecosystem. In a global market where countries are competing for talent, it is important Australia is considered a reliable and desirable international partner. This will help prevent the risk of losing opportunities, investments and talent to our competitors s33

Managing national security risks, and shaping norms and standards to reflect Australian values and interests.

5. s33

For example, between 2019 and 2021 China invested as much as $15 billion, Europe $7.2 billion, the US $1.3 billion, the United Kingdom (UK) around $1.2 billion, and Japan $1 billion in quantum technologies. Furthermore, given the potential defence applications of quantum technologies, leveraging existing partnerships such as the Quad (Australia, India, Japan and the US) and AUKUS will be important to ensure Australia's values and interests are reflected internationally.

There is growing interest to work with Australia on quantum

6. Increasingly we are seeing countries leveraging existing treaties and agreements, including a range of Joint Science and Technology treaties (managed by Science and Commercialisation Division in the department) to progress discussions on quantum (see Attachment A for more background information). With a national program, deep technical capability and a soon to be released strategy, there is increasing interest to speak to Australia on quantum under these treaties (most recently from New Zealand, Japan, Brazil and the US).

7. To date discussions under these treaties have been high level as agendas cover the full breadth of science and technology. As a result, there is a role for quantum specific agreements with countries with whom we share strategic values and interests in order to steer the dialogue towards deeper collaboration and concrete outcomes.

8. Australia (led by the department) has an existing Statement of Intent with the US, and the opportunity to progress a draft MOU with the UK, and has the opportunity to consider

a number of other quantum specific international collaborations, as outlined below. We will continue to work with existing partners, and will work with you and your office as we become aware of new opportunities for you to consider.

Multilateral fora

9. s33 multilateral group (the group) to discuss quantum and to identify areas of common interest and concern. The current members include: Australia, Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland, UK and the US. s33

10. s33 For example, an outcome of the second meeting in November 2022 was to publish an "Entanglement Exchange" – a new website highlighting international exchange opportunities for students, postdocs and researchers in quantum (see Attachment B for more information about this initiative).

11. There is interest from member nations within this group to engage bilaterally with Australia on quantum and there is an opportunity to deepen ties with countries we have existing strategic relationships (e.g. via the Quad or AUKUS). This has informed the countries we have sought to engage bilaterally with as outlined in more detail below.

Bilateral opportunities

United States

12. As the global leader in quantum and as a long defence partner of Australia's, the US is an obvious bilateral partner. It is also the only country we have a joint statement of cooperation on quantum with, which was signed in November 2021 (see Attachment C for the joint statement).

13. The purpose of this joint statement is to improve market access in both directions and increase knowledge sharing. s47G Australian quantum companies have also expanded into the US, including QuintessenceLabs and Q-CTRL.

14. This joint statement has been an important public reaffirming of our countries' commitment to work more closely on quantum and is often referenced by other countries as a signal of Australia's long-term commitment to quantum. s33

15. We are continuing discussions on cooperation ahead of the US delegation's visit to Australia in February 2023 as part of the Australia-US Joint Commission Meeting on Science and Technology, as well as the upcoming visit from the Director of the National Science Foundation, Dr Sethuraman Panchanathan, at the end of February 2023. We will brief you separately closer to the US delegation's visit.

United Kingdom

16. Australia has a long standing and deep defence and technology relationship with the UK. Given the AUKUS agreement, discussions can be had on a more sensitive level than with other countries with quantum capabilities. There are also significant benefits to Australia pursuing deeper quantum collaboration with the UK.

17. With one of the longest standing national quantum programs, the UK has a vibrant domestic quantum ecosystem comprising four hubs, a National Quantum Computing Centre and approximately 40 quantum start-ups. As a result, there is increased collaboration between Australian and UK quantum companies (Quantum Brilliance and Element Six, Q-CTRL and Oxford Quantum Computing). A quantum specific agreement with the UK would help Australia leverage the UK's well-developed research system and provide more access for Australian companies to enter the UK market.

18. The Department has been in discussion with the UK for most of 2022 on a joint statement of collaboration in quantum (see Attachment D for the draft joint statement). However due to election cycles, discussion have stalled. Should you wish to progress with establishing this Statement of Collaboration, we will work with your office to progress and provide a range of collaboration opportunities with the UK on quantum.

Japan

19. As a member of the Quad, and a leading quantum economy within Asia Pacific, Japan is an important strategic partner for Australia on quantum. Japan is also an important digital technology market for Australia, and is Australia's number two trading partner.

20. There is a long research history between Australia and Japan on physics and quantum. The Australian National Beamline Facility at the KEK Photon Factory in Tsukuba is a real success in quantum physics and collaboration between researchers in Australia and Japan. Most recently through this research collaboration, the team developed the world's first quantum thermometer to measure the minute changes in temperature in the fabric of space-time. Japan is also home to one of the first supercomputers, Fugaku, and has a national program supporting five quantum innovation centres. Deepening our relationship with Japan will help ensure Australia has access to Japan's market, our researchers can access the complimentary expertise of the Japanese and that we have a strategic ally in the region.

21. s33 . Japan already has similar agreements with the US (signed in 2019), and an Joint Committee on Science and Technology with the UK (signed in 1994) which has enabled the close collaboration between Japan and the UK on quantum. Japanese companies also have a range of MOUs with international partners including Canadian company D-Wave Systems, global quantum leader Quantinuum, and IBM.

Furthering bilateral joint statements of cooperation on quantum

22. Being a member of the informal quantum group and associated Entanglement Exchange will continue to increase Australia's desirability as a collaboration partner. s33 . As countries continue to seek to form international quantum partnerships with Australia, we will brief you on new opportunities that are of strategic importance that you may wish to consider.

Consultation: YES

Digital Technology Taskforce, Critical Technologies Hub, Office of the Chief Scientist, Science and Commercialisation Division, National Measurement Institute.

Attachments

A: Background
B: Quantum Entanglement Exchange
C: Signed Joint Statement of Cooperation between AU-US
D: Draft Joint Statement of Cooperation between AU-UK

ATTACHMENT A

Background

Treaties and other arrangements relevant to Science, Technology, Innovation and Research

The Department of Industry, Science and Resources has oversight of 109 bilateral treaty-level agreements relevant to science, research, technology and innovation collaboration with 55 partners, and 25 other less-than-treaty status arrangements (such as MOUs) with 19 of those same partners plus 3 others. Some of those treaties and other arrangements are restricted to specific areas of science.

The Department leads a program of biennial senior officials' meetings with many of these partners, which provide an opportunity to discuss collaboration opportunities. Quantum is increasingly identified as a key agenda item for discussion at these meetings, highlighting the international appetite to collaborate with Australia on quantum.

As part of this program, the Department leverages a range of Joint Science and technology treaties and their implementing Committees (JSTCs).For example, at the 17th JSTC meeting between Australia and Japan in Melbourne on 29 November 2022, quantum technologies was discussed as a mutual interest of both countries. This was the first high-level visit to Australia by a Japanese delegation of science officials in over five years. Similarly, staff from the department attended an officials' level workshop on the trans-Tasman Innovation Ecosystem in Wellington, New Zealand from 20 to 24 November 2022. Quantum technologies was discussed as it was highlighted as a key joint collaboration priority by New Zealand Minister Verrall. To date, discussions in these forums has been high level, and primarily used as an opportunity to share information about one another's national programs.

Quad

The Quad is dedicated to bringing tangible benefits to the region and making it more resilient for the 21st century. It has a focus on harnessing critical and emerging technologies to enhance the prosperity and security of the region. For example, it has been undertaking work on ways to support a diverse and competitive market for semiconductors. The Quad has agreed that it will have a future focus on quantum technologies including through a business and investment forum for networking with industry partners to expand capital for critical and emerging technologies.

a. s33

AUKUS

The AUKUS Quantum Arrangement (AQuA) is led by the Department of Defence and is a core component of AUKUS' work. AQuA will work to accelerate investments to deliver generation-after-next quantum military capabilities. There will be an initial focus on quantum technologies for positioning, navigation and timing. It is intended that the AQuA work will integrate emerging quantum technologies in trials and experimentation over 2022, 2023 and 2024. While AUKUS's primary focus is on enhancing defence capabilities going forward there will potentially be opportunities for Australia's broader quantum ecosystem to contribute to and support Defence's research efforts occurring through AUKUS.

ATTACHMENT B

JOINT PRESS RELEASE

Webpage

Entanglement Exchange Links Quantum Researchers Across Twelve Nations

New website is a portal for international exchange opportunities in quantum information science

Posted November 29, 2022

Australia, Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States are proud to launch the Entanglement Exchange, a portal for highlighting international exchange opportunities for students, postdocs, and researchers in quantum information science (QIS).

QIS is an emerging field that harnesses quantum physics for information processing, and it promises technological breakthroughs such as quantum computers, quantum networks, and quantum sensors, each of which offer capabilities beyond traditional devices. The field has been developing for decades, but in recent years, the pace of discovery has accelerated through programs and initiatives to invest in QIS research and development.

In May 2022, a roundtable meeting on Pursuing Quantum Information Together was held in Washington between the twelve countries. This meeting highlighted the importance of international cooperation in QIS to accelerate discovery, share resources, and jointly address global challenges. Recognizing the benefits of international partnerships and the global nature of science, the idea for the Entanglement Exchange was proposed as a follow-up action.

Working together, the countries identified exchange opportunities in QIS and developed the Entanglement Exchange to help distribute information about those opportunities. In November 2022, the countries held a roundtable in London on Progressing Multilateral Dialogue on Quantum. There, plans for the Entanglement Exchange were finalized, with entanglementexchange.org being launched later that month.

On the Entanglement Exchange website, visitors will find links to webpages created and hosted by each of the represented countries. Those pages contain opportunities for studying and conducting research in QIS. The listed opportunities are varied, with some specifically focused between identified countries and others open to researchers from around the world.

Given the importance of developing the next generation of QIS scientists and engineers, and the profound effect that international collaborations can have on advancing the field, the countries participating in the launch of the Entanglement Exchange hope this information advances the field and helps ensure QIS technologies are realized for the benefit of humanity.

entanglementexchange.org

Text

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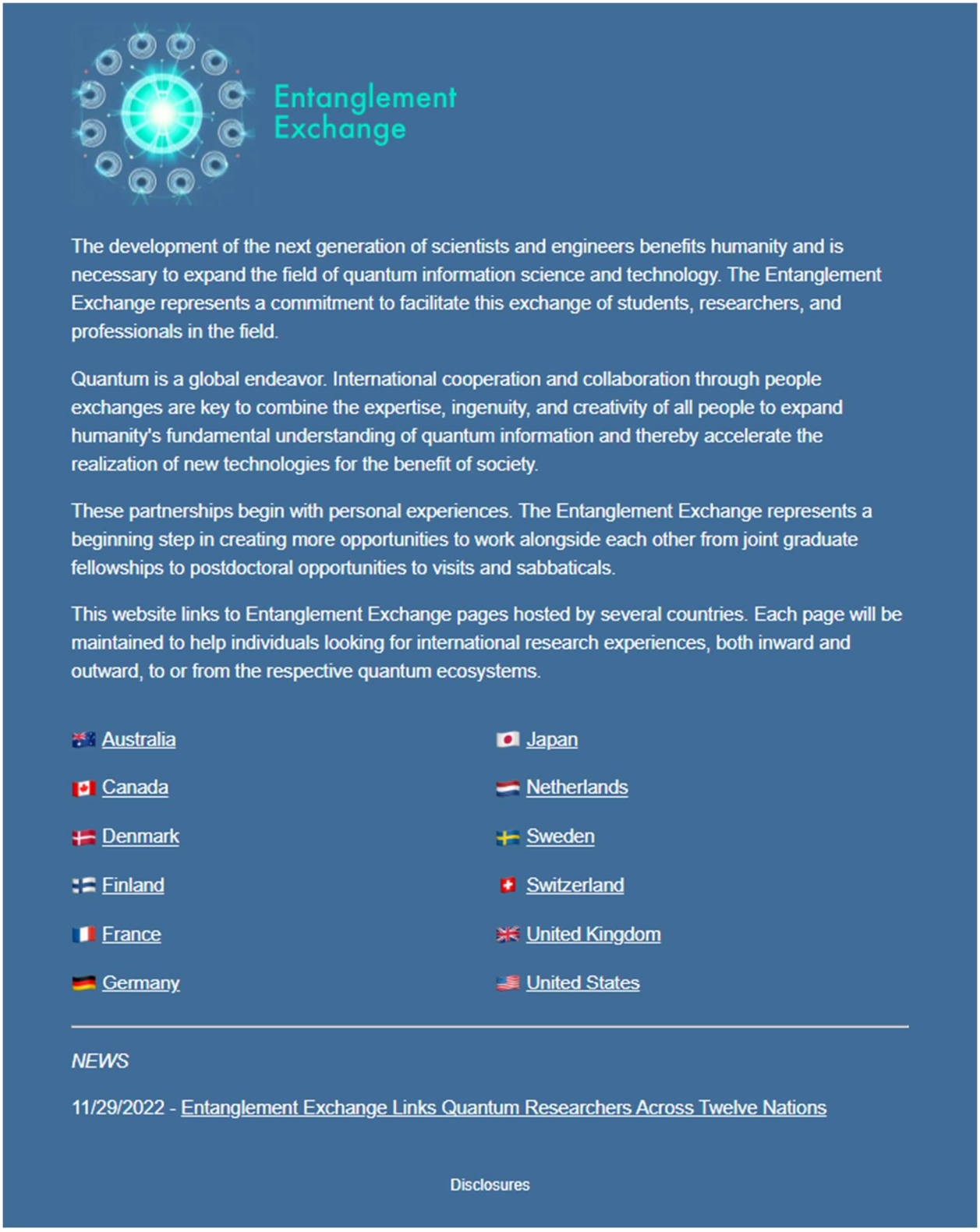
HOME PAGE

Webpage



Text

The development of the next generation of scientists and engineers benefits humanity and is necessary to expand the field of quantum information science and technology. The Entanglement Exchange represents a commitment to support this exchange of students, researchers, and professionals in the field.

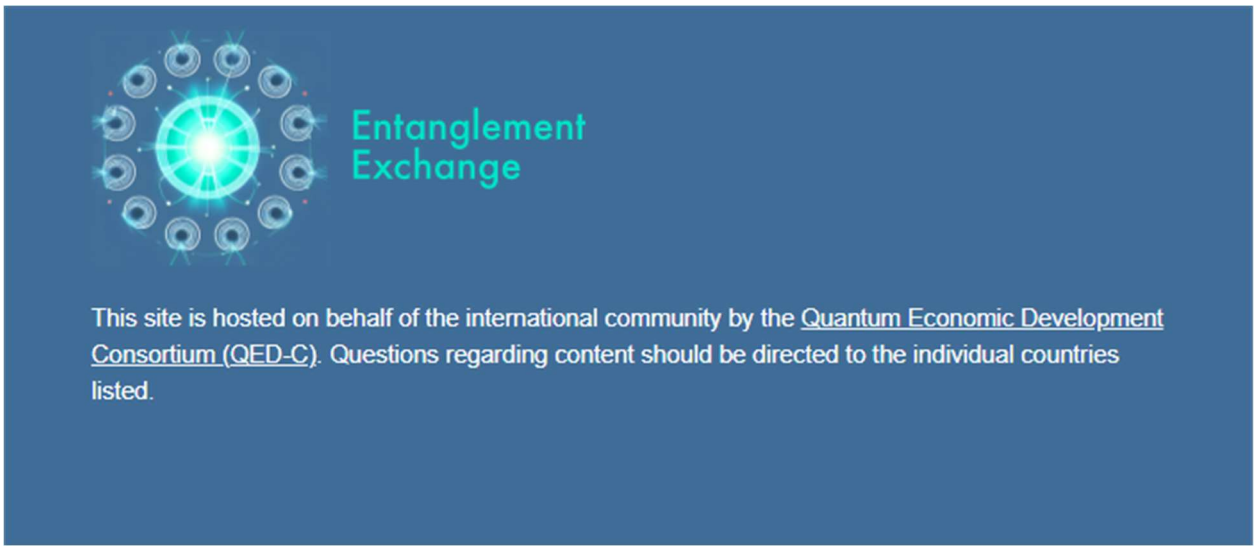
Quantum is a global endeavor. International cooperation and collaboration through people exchanges are key to combine the expertise, ingenuity, and creativity of all people to expand humanity's fundamental understanding of quantum information and thereby accelerate the realization of new technologies for the benefit of society.

These partnerships begin with personal experiences. The Entanglement Exchange represents a beginning step in creating more opportunities to work alongside each other from joint graduate fellowships to postdoctoral opportunities to visits and sabbaticals.

This website links to Entanglement Exchange pages hosted by several countries. Each page will be maintained to help individuals looking for international research experiences, both inward and outward, to or from the respective quantum ecosystems.

DISCLOSURES PAGE

Webpage



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This site is hosted on behalf of the international community by the Quantum Economic Development Consortium (QED-C). Questions regarding content should be directed to the individual countries listed.

ATTACHMENT C

Signed Australia- US Joint Statement of Collaboration

Joint Statement of Australia and the United States of America on Cooperation in Quantum Science and Technology

The Government of the United States of America and the Government of Australia, (hereinafter referred to collectively as "the Participants" and singularly as "the Participant"):

We recognise the depth and strength of the economic and strategic relationship between Australia and the United States of America and note both nations' shared commitment to our democratic institutions and to an open, inclusive and resilient Indo-Pacific region, underpinned by rules, norms and respect for sovereignty.

We recall the commitments in the *Agreement Relating to Scientific and Technical Cooperation between the Government of the United States of America and the Government of Australia* which set out a framework for the conduct of the overall science and technology relationship between our countries.

We acknowledge that science and technology (S&T) is the engine that enables transformative capabilities. At its core, S&T research are collaborative, transnational efforts. Accordingly, working together is essential to scientific discovery and societal benefit.

We recognise that quantum technologies – broadly based on the study and application of quantum mechanics to explore new ways to acquire, transmit and process information – is a critical emerging technology that could enable more powerful computers, more capable communication networks and more precise and accurate sensors.

We understand that the quantum ecosystem is global, interconnected and includes stakeholders from many different sectors including academia, government and the private sector. This allows the movement and synergy of ideas, expertise and creativity to advance scientific discovery, develop new quantum-enabled technologies and apply them to the shared challenges of our time.

We affirm our responsibility to steward a quantum ecosystem, which entails fostering broad and inclusive participation in the field and public awareness of quantum; collectively, these are essential to broadly realise the benefits of this field and achieve the future of quantum-enabled economies.

Together, we intend to advance our shared vision of a vibrant, secure, trusted and interconnected quantum ecosystem.

We have reached the following understandings:

Section 1: Purpose and Areas of Cooperation

The purpose of this Joint Statement on Cooperation in Quantum Science and Technology is to promote partnerships and enable cooperation between the Participants. This Joint Statement underscores the intent to:

- **Explore** new theoretical and practical applications of quantum technologies and collaborate to translate quantum technology research into meaningful practical applications that would be of mutual benefit to both of our nations.
- **Promote** joint research, development and exchange of quantum technologies, underpinned by shared principles of research integrity, including freedom of inquiry, merit-based competition, openness and transparency, accountability and reciprocity.
- **Build** a trusted global quantum marketplace and the necessary secure supply chain through the engagement of the private sector and industry consortia.
- **Open** opportunities to expand quantum industries and encourage participation in the quantum value chain.
- **Foster** shared economic prosperity and security by shaping the design, development, commercialisation, and use of quantum technologies.
- **Protect** sensitive technologies for which there are national security implications through shared arrangements between the two nations.
- **Support** the collaborative, mutually beneficial exchange of skills and development of a future quantum workforce.
- **Develop** collaborative quantum technology standards in ways that foster interoperability, innovation, transparency, diverse markets and security by design.
- **Leverage** existing bilateral and multilateral science and technology cooperation frameworks and pursue new agreements and engagements, as appropriate, to support joint research and development efforts, promote protection of intellectual property and build safe and inclusive research environments.

Section 2: Manner of Cooperation

We intend to advance this cooperative agenda by the following means:

1) Elevating quantum in existing bilateral engagements between the Participants;
2) Convening regular meetings of senior government officials involved in quantum technologies (i.e., the Quantum Policy Dialogue – hereafter the “Dialogue”), co-chaired by representatives of the Participants, to exchange information, identify practical initiatives and review cooperation under this Joint Statement.
    a. Including participants in the Dialogue from relevant government departments and agencies, as determined by mutual consent of the Government of the United States and the Government of Australia; and
    b. Determining the agenda, timing, location and other relevant elements of the Dialogue through mutual consultation
3) Convening additional working-level meetings to advance specific topics under this Joint Statement, by mutual consent.

We confirm our mutual understanding that cooperation informed and enabled by this Statement will be pursuant to the Agreement between the Government of the United

States of America and the Government of Australia on Cooperation in Science and that the terms of the S&T Agreement and related agreements govern this cooperation, including with regard to issues relating to financial arrangements, confidentiality, and the protection and allocation of intellectual property created or furnished in the course of cooperative activities.

Elevating this cooperation across quantum scientific research, technology and innovation promises to deepen our bonds of friendship and understanding, strengthen our economies and contribute to global science and technology knowledge.
Signed at Washington and Canberra, in two originals, in the English language.

ATTACHMENT D

DRAFT – Joint Statement of the United Kingdom and Australia on Cooperation in Quantum Technologies

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We recognise the depth and strength of the economic and strategic relationship between Australia and the United Kingdom, and note both nations' shared commitment to our democratic institutions and to an open, inclusive and resilient global quantum ecosystem, underpinned by rules, norms and respect for sovereignty.

We recall our nations' shared commitment to advancing the development and application of science and technologies in ways that are in line with shared values. Just recently, our nations have agreed a Cyber and Critical Technology Partnership that will help shape a positive technology environment and maintain an Internet that is open, free, peaceful and secure.

We acknowledge that science and technology (S&T) is the engine that enables transformative capabilities. At its core, S&T research are collaborative, transnational efforts. Accordingly, working together is essential to scientific discovery and societal benefit.

We recognise that quantum technologies – broadly based on the study and application of quantum mechanics to explore new ways to acquire, transmit and process information – is a critical emerging technology that could enable more powerful computers, more capable communication networks and more precise and accurate sensors.

We understand that the quantum ecosystem is global, interconnected and includes stakeholders from many different sectors including academia, government and the private sector. This allows the movement and synergy of ideas, expertise and creativity to advance scientific discovery, develop new quantum-enabled technologies and apply them to the shared challenges of our time.

We affirm our responsibility to steward a quantum ecosystem, which entails fostering broad and inclusive participation in the field and public awareness of quantum; collectively, these are essential to broadly realise the benefits of this field and achieve the future of quantum-enabled economies.

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Elevating this cooperation across quantum scientific research, technology and innovation promises to deepen our bonds of friendship and understanding, strengthen our economies and contribute to global science and technology knowledge.

Signed in LOCATION on DATE in two originals, in the English language.