Written Testimony
Standing Committee on Industry and Technology
Study of Quantum Computing

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On behalf of D-Wave Systems Inc., thank you for the opportunity to appear before the committee.

As background, D-Wave is a leader in the development and delivery of quantum computing systems, software, and services and is the world's first commercial supplier of quantum computers. With our headquarters and our Quantum Engineering Center of Excellence based near Vancouver, D-Wave is passionate about preserving Canada's global leadership in quantum computing.

The quantum computing industry is an important one and, for this emerging technology, the Canadian ecosystem is impressive. We appreciate the attention this technology is receiving from the Government of Canada and look forward to supporting the work of this Committee as it examines how to frame activities and programs within the National Quantum Strategy to best foster and protect Canadian innovation.

D-Wave is a full stack provider, which means our technology, products and services include hardware, software, cloud platform, professional services, developer tools and more. D-Wave is the only company building both annealing quantum computers and gate-model quantum computers, so our platform-agnostic approach can provide broad industry perspective.

Recommendation 1: Inclusivity of Academic Disciplines

D-Wave integrates new discoveries in physics, engineering, manufacturing, and computer science into breakthrough products that enable quantum computation to help solve some of the world's most complex challenges. Quantum computing is inherently interwoven across a variety of academic disciplines and touches upon a variety of different technologies. This depth and breadth requirement guides our first recommendation: inclusivity. Inclusivity of academic disciplines and access, as well as integration with different technologies.

We recommend the Canadian research community's engagement on quantum be multi-disciplinary: one that goes beyond physics. The quantum ecosystem requires a workforce with skills encompassing everything from engineering, cryogenics and software to IP and business strategy. What is often forgotten is that to be successful, users must bring existing skills in data science, materials science, optimization, computer science, and yes, even physics, to ensure the business value of quantum computing is unlocked. Canada should support broad inclusive policy initiatives that incorporate expertise in physics, engineering, computer science, mathematics, algorithm development, and more.

Inclusive policy initiatives require federal programs to focus beyond broad curriculum development and engagement in theory. Canada's opportunity is to focus on quantum access in addition to inclusivity. Cloud access to quantum computing technology is another key tool to promote diverse use of the technology.

Recommendation 2: Quantum User Access and Training Program

A federal program should be created to facilitate broad quantum user access via the cloud. A similar idea is currently being discussed in the United States. The U.S. Congress is working to create a quantum user access program, called QUEST, aimed at expanding access to quantum hardware through a government funded program. QUEST is focused on enhancing quantum research, educating the future quantum computing workforce, and accelerating advancement of quantum computing capabilities. A similar program should be considered in Canada, but we recommend going one step further and incorporate a National Quantum Training program within a user access program. This could serve as a beacon for quantum workforce talent development globally. This kind of program would

engage Canadian quantum computing companies, like D-Wave and others, to provide skills training for their individual technologies, allowing for upskilling and re-skilling for a quantum-ready workforce. This program could be open to students, researchers, government officials, as well as industry, to accelerate quantum fluency. A training program could easily be stood up quickly as a pilot in 2022 through existing organizations that have an understanding of quantum computing such as the Digital Supercluster, the Quantum Algorithm Institute (QAI) and/or the Creative Destruction Lab (CDL). All of these have a quantum focus and existing relationships with industry, governments, end users and academia.

Recommendation 3: Supporting Quantum-Hybrid Technologies

Government must also support quantum-hybrid technologies. This was highlighted in the recent quantum consultation report released by Minister Champagne. The report stated, "Roundtable and survey participants expressed the need to bridge classical and quantum computing with hybrid technology while society transitions toward quantum computing."[1] Supporting quantum-hybrid technologies was also highlighted in TechUK's call for evidence in the United Kingdom. Their response states, "near- and medium-term quantum systems that can be delivered commercially in a hybrid HPC model will provide early-stage access to quantum and facilitate adoption and applied R&D by industry."[2]

Quantum computing is being integrated with a variety of other technologies. For example, the quantum hybrid solvers in D-Wave's Leap™ quantum cloud service combine the best of both classical and quantum computing technologies, helping businesses and governments build quantum-hybrid applications to address their current problems. There will likely always be a need for classical computation as a part of the solution for many problems, but the most complex parts of those problems are often best suited for quantum computers. Government should think of quantum computing in a holistic manner and note that quantum computing technology will likely be integrated with, and work alongside, a variety of other technologies, including through cloud platforms and integrated data centers with both high performance and supercomputing systems combined with quantum computers. One project could be to build a domestic high performance computing data center that is integrated with quantum computing. This complete environment, providing access to resources in an integrated fashion, will be critical to building near-term quantum hybrid applications, ensuring domestic access to systems, while also creating a pipeline for talent development.

Recommendation 4: Near-Term Application Development Through a National Quantum Sandbox Program

Lastly, there is a real need for broad education to showcase the capabilities of today's quantum systems. As a leader in this industry, D-Wave's mission is to unlock the power of quantum computing to benefit business and society, starting today. We do this by delivering customer value with practical quantum applications for problems as diverse as logistics, artificial intelligence, materials sciences, drug discovery, scheduling, cybersecurity, fault detection, and financial modeling for organizations like Volkswagen, Lockheed Martin and even Save-On-Foods, right here in Canada, for grocery optimization. In September 2020, we brought our next-generation Advantage™ quantum system to market via Leap, our quantum cloud service. In the service, we offer access to the quantum computer which includes more than 5,000 qubits and 15-way qubit connectivity, as well as an expanded hybrid solver service capable of running problems with up to one million variables. The combination of Advantage's computing power and scale with the hybrid solver service gives businesses and

[1] https://www.ic.gc.ca/eic/site/154.nsf/eng/h_00002.html
[2] https://www.techuk.org/resource/techuk-s-response-to-the-quantum-strategy-call-for-evidence.html

governments the ability to run in-production quantum applications, tackling complex, real-world problems. Yet with all of this, the first question we hear most often is “what can the technology do today?”

D-Wave is consistently consulting with governments and businesses on applications which can be developed using today’s technology. Our annealing quantum computers are best suited to tackle optimization problems while gate-model systems are expected to able to solve problems in quantum chemistry and materials design. We are but one voice trying to showcase the art of the possible with today’s quantum computing technology. A dedicated government program that supports rapid quantum and quantum-hybrid application development would not only be a strong educational tool, but also a needed program to showcase Canadian innovation for use of the technology today, speeding up innovation, adoption, and commercialization.

Creating a “quantum sandbox” to develop proof-of-concepts and test near-term quantum applications would be a unique way to educate on the use cases for today’s technology. A sandbox can serve as a living lab program, run through a public-private partnership. It would develop and deploy near-term quantum and quantum-hybrid applications for a variety of purposes in a rapid timeframe. As an emerging technology, a quantum sandbox can be used by government to focus on public sector use cases. For example, posing challenges on a variety of pressing public sector priorities such as CO2 reduction or other sustainability efforts, emergency and/or pandemic response and tracking, and transportation and logistics management. Quantum and quantum-hybrid applications can be built to address these key public sector needs. Near-term application development and a quantum sandbox are being considered by other governments. The President’s National Security Telecommunications Advisory Committee in the United States recommended a sandbox for communications resiliency. The Australian Army is looking at quantum applications for optimizing autonomous vehicle resupply, and the Australian government is looking at quantum applications to optimize their transportation system. In Japan, there has been an application piloted that optimized waste collection while also reducing CO2 emissions by nearly 60 percent. The Information Technology & Innovation Foundation released a report in 2021 highlighting near-term quantum applications and showcased many global use cases across a variety of industries.

A dedicated quantum sandbox program for proof-of-concept development would be a useful tool for not only educating on today’s technology capabilities, but also with each application developed, it provides a feedback loop for additional innovation. As heard during the ISED roundtable discussions, there is a “need to nurture a quantum ecosystem in Canada; and scale-up of quantum commercial activity”[3] and a quantum sandbox would directly address that recommendation. Such a program could be run through existing organizations such as the Digital Supercluster, QAI and CDL.

In conclusion, there is a need to act swiftly in a multi-prong fashion focused on action, research, talent, and commercialization. Federal efforts in Canada should be inclusive of all technologies, incorporate many academic disciplines, support cloud-based system access and on-line training to break down barriers to access and understanding of the technology, and create a quantum sandbox focused on near-term application development and deployment. All of these efforts should be in addition to the continued promotion of the longer-term quantum computing R&D advancements.

I appreciate your time today and look forward to helping with your efforts. Your study can be an important tool in showcasing, preserving, and promoting Canadian quantum innovation and sustaining Canada's world-leading position in the quantum ecosystem.

Thank you.