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**Written Submission to the Standing Committee on Science &
Research:**

Study on Support for the Commercialization of Intellectual Property



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Executive Summary – Support for the Commercialization of Canadian Intellectual Property:

Over the past decade, government investments in fundamental research have positioned Canada as a global leader in quantum research. Today, Canada is at a critical juncture, and it is time to translate such research and IP into commercialization successes. Sector specific initiatives are needed to support and truly realise the commercialisation of Canadian IP.

We believe it remains vital for Canada to take deliberate and focused action now to ensure quantum innovations remain in Canada to be commercialised and its highly sought-after talent is not pulled away to other centres around the world.

It is also vital for Canada's government and private cyber security that we develop a domestic quantum industry that keeps pace in the global race to crack existing encryption systems and develop new secure quantum-based encryption solutions.

We have outlined below two targeted strategic initiatives that align with the specific goals of the National Quantum Strategy and would directly support the commercialisation of Canada's IP in the quantum sector.

- **Recommendation 1:** In support of the commercialization of Canada's quantum IP, direct Innovation, Science & Economic Development Canada (ISED) to engage with key stakeholders to formalise a Public/Private Partnership to establish a Canada Quantum Data Centre. This centre would enable ongoing collaboration and cooperation between Canadian academics, startups, large enterprises, and government users all focused on innovation in quantum computing. It would directly facilitate greater collaboration and training in support of quantum innovation, critical components to realising the commercialization potential of Canadian quantum IP.
- **Recommendation 2:** To help facilitate the commercialisation success of Canadian innovation and research, establish a nationally-coordinated funded program for quantum computing software education to prepare talent for work-integrated-learning opportunities and fuel the adoption of quantum computing across Canada. By establishing such a program, the government would be helping to accelerate and incubate a strong talent pipeline for Canadian businesses and institutions to help facilitate the commercialisation of Canadian quantum IP. Canada has a strong academic base of quantum researchers but the quantum industry's demand for employees far outstrips the supply, forcing quantum companies to constantly source talent from outside the country. Consequently, as the quantum computing industry grows, domestic firms will eventually have to grow and locate overseas in order to be able to hire sufficient talent, without a stronger domestic training pipeline.

Introduction:

Xanadu Quantum Technologies is pleased to provide comments in response to the Standing Committee on Science & Research (SRSR) study on how the Government of Canada can better support the commercialisation of intellectual property.

Our recommendations are focused on Canada's quantum computing sector and the corresponding opportunities to help protect current investments and realise the commercialisation potential of leading Canadian quantum R&D.

Who we are:

Xanadu is a leading Canadian quantum computing company, whose mission is to build quantum computers that are useful and available to people everywhere. Our approach to quantum computing is based on photonics whose advantages include room temperature computation, modular and networkable systems, and compatibility with existing telecom networks. Our company, founded in 2016, has grown into one of Canada's largest quantum technology companies and over the past five years we have rapidly expanded to include over 180 scientists and engineers. Our growth has been fuelled by more than \$245M USD of private capital investment to date. We plan to continue growing our team in 2023 and beyond. Our growth as a company was also bolstered this past January by a \$40M investment by the Government of Canada, through the Strategic Innovation Fund, to help build the world's first photonic-based, fault-tolerant quantum computer.

The Government of Canada's investment follows other recent notable achievements for our company. For example, in June 2022, the prestigious science journal *Nature* published peer-reviewed research from Xanadu demonstrating that we have built the world's most powerful quantum computer. This achievement is a major milestone for both Xanadu and Canada's quantum community. This new quantum computer, which Xanadu has called Borealis, accomplishes a specific task in a fraction of a second that would take the world's best supercomputer 9,000 years to complete. This achievement has truly placed Canada on the global stage amongst other leading quantum countries. Previously, only the US and China had demonstrated quantum computational advantage but now we have surpassed these achievements with Canada's Borealis quantum computer.

Commercialising IP and the Quantum Sector – Investment & Talent:

For Xanadu, the commercialisation of our IP is the bedrock of our growth and success as a company. Our company was founded by quantum experts who were trained at some of Canada's best known research universities, but did not rely on any university IP. Much of Canada's quantum sector is being built off IP innovation funded by both public and private sources. Over the years, we have been fortunate to have had supporting Canadian partners and investors to help realise our goals; however, to truly realise our growth and potential, we have had to look out of the country to raise sufficient capital and now to expand and grow our operations. This is a common reality for many Canadian companies operating in the high-tech sector.

We also work very closely with Canada's academic community supporting the growth of quantum talent and the development of quantum technologies in Canada. Xanadu has been building educational partnerships with several Canadian universities that are expanding quantum computing teaching and training tools and programs to equip students for careers in the field while pushing the boundaries of existing quantum technologies with research and development initiatives. Giving students access to world-class quantum education provides an incredible launching platform to set them up for success in quantum roles. Through these efforts we believe we are building a foundation for a robust quantum talent pipeline in Canada, a vital ingredient to truly realise commercialization

success of Canadian innovation and research. Our engagement with Canadian university research projects may lead to exciting technological opportunities for us in years to come, and we trust that our university partners will manage any new IP professionally, thoroughly and fairly.

Targeted Government Action Needed:

Over the past decade, government investments in fundamental research have positioned Canada as a global leader in quantum research. Today, Canada is at a critical juncture, and it is time to translate such research and IP into commercialisation successes.

In the 2021 budget, the Federal Government committed \$360MM over seven years in support of its National Quantum Strategy (NQS). Xanadu welcomes the release of the NQS. We also appreciate the government's commitment to develop new investments and program initiatives that will help realise the broad policy objectives detailed under the NQS. Although the NQS is a helpful and promising outline to guide the government's approach, clear and focused commitments are needed. Against a rapidly expanding quantum sector and increasing global competition, any delayed action by the Canadian government will make it easier for entrepreneurs, SMEs and other innovative companies to be lured out of the country, undermining the government's investment in R&D, thereby losing out on the commercialization potential of these efforts.

To mitigate this threat, sector specific initiatives are needed to support the commercialisation of IP. It is for this reason we respectfully request the Standing Committee on Science and Research to detail recommendations that will directly support the commercialisation of quantum IP in Canada. We have outlined below two targeted strategic initiatives that align with the specific goals of the NQS that would directly support the commercialisation of Canada's IP in the quantum sector. We believe it remains vital for Canada to take deliberate and focused action now to ensure quantum innovations can be commercialised by Canadian firms and our highly sought-after talent is not pulled away to other centres around the world.

Priority Recommendations:

Xanadu respectfully requests consideration of the following recommendations which will help drive Canada's quantum sector, directly supporting the broad principles to commercialising Canadian IP, while creating jobs and strengthening our economy.

- **Recommendation 1: In support of the commercialisation of Canada's quantum IP, we strongly recommend that Innovation, Science & Economic Development Canada (ISED) engage with key stakeholders to formalise a Public/Private Partnership to establish a Canada Quantum Data Centre, as the House Finance recommended in 2021.**
 - **Issue:** Canada needs to put building blocks in place to properly commercialise its IP. Those building blocks include, among other things, investments, research, superior quantum talent and a forum to create inventive synergies among those elements.
 - To fully realise Canada's quantum potential and ability to commercialise its IP, it is critical that the Federal Government provides focused smart investments that protect and build on its earlier commitments while supporting the expansion of a Canadian quantum sector for decades to come.
 - By investing in a Canada Quantum Data Centre, the Federal Government would be creating and securing hundreds of new jobs and strengthening a talent pipeline for future generations. The Centre – the first major hub of its kind in the world – will be

- ideal for high tech quantum computing training for quantum data centre research, operation, and maintenance.
- As Canada's reputation in quantum technology expertise grows Canadian companies will more easily attract private sector investments that are critical to commercialisation of their IP.
 - Building this centre in Canada will secure access to the world's most powerful quantum computer for Canadian academics, startups, large enterprises, and government users.
 - The centre would directly facilitate greater education, training and collaboration in support of quantum innovation, critical components to realising the commercialization potential of Canadian quantum IP.
 - This investment will build on other major commitments from the Federal Government and should be positioned as a key component to Canada's National Quantum Strategy announced in January 2023.

 - **Background:** A Canada Quantum Data Centre would be a ground-breaking partnership between industry, academia, government, and talent aimed to promote and support Canada's standing in the rapidly developing field of quantum computing. It would be a truly made-in-Canada approach to building Canada's quantum future and greatly assist with future commercialisation and domestic adoption of quantum computing.
 - The initiative follows closely with the House Finance Committee's 2021 Pre-Budget recommendation to dedicate financial support to the establishment of a quantum computing research institute in the Toronto area to build upon quantum research expertise in the city.
 - With the Centre's strategic position in Toronto, it will be perfectly suited to develop the Canadian quantum ecosystem in partnership with academia from across Canada, Canadian industry leaders and Federal and Provincial Governments. Toronto has become one of the global centres for leading edge research, investment and commercialisation of quantum computing and a growing attractor for global talent and high-tech job creation and is an ideal location for the quantum computing centre research, operations, and maintenance. Talent will be attracted from across Canada and around the world and help achieve a critical mass as a global destination for quantum training and a key location for hiring highly qualified quantum experts to operate quantum computers to address company challenges.
 - The Canada Quantum Data Centre will embrace partners from the entire innovation ecosystem to offer access to the full Canadian quantum community and ensure the best chance for success. The Centre will be available to university and college students and researchers right across Canada and other academic organisations, including the Quantum Algorithms Institute, the Institute for Quantum Computing (IQC), Mila, and the Perimeter Institute. Potential Government-focused partners include ISED, the National Research Council of Canada (NRC), all Departments and Agencies concerned with cyber security, the Canadian Space Agency (CSA), Bank of Canada, SOSCIP, Creative Destruction Labs (CDL), MaRS, Mitacs, and Venture Lab. As the technology matures and begins to demonstrate commercial benefits, major Canadian industries like banking, telecoms, advanced manufacturing and biotechnology will become key partners in developing new use cases for quantum computing.

- **Recommendation:** In support of the commercialisation of Canada's quantum IP, we recommend that ISED engage key stakeholders to formalise a Public-Private Partnership to establish a Canada Quantum Data Centre – the first major hub of its kind in the world. The Centre will secure hundreds of new jobs, affirm a talent pipeline, and create jobs through research, operation, and maintenance. Industry and academic partners are already committed to realise a Canada Quantum Data Centre; however, we need the Federal Government to join this initiative and dedicate funds to help realise this public-private-partnership.
- **Recommendation 2: To help facilitate the commercialisation success of Canadian innovation and research, establish a nationally coordinated, funded program for quantum computing software education to prepare talent for work-integrated-learning opportunities and fuel the adoption of quantum computing across Canada.**
 - **Issue:** In support of ongoing investments in research, talent and commercialisation of quantum technologies, we recommend funding be directed to ISED to establish a funding program for Canadian universities across the country that would deliver specialised courses and work-integrated learning opportunities with Canadian companies to advance industry-academia partnerships. Specifically, programming can be applied nationally through the established open access Canadian platforms, such as Xanadu's PennyLane Cloud, the leading hardware-agnostic software toolkit for quantum computers.
 - This funding program would ensure the creation of a strong talent pipeline across Canada and grow science and technology literacy amongst Canadians, including under-represented groups like women and Indigenous communities.
 - **Background:** Over the past several years, ISED and partner organisations have developed several government-based initiatives to help Canadians become more involved with STEM fields, providing important resources and materials.
 - Under a nationally-coordinated initiative geared to support quantum computing education and research, the government would be helping to accelerate and incubate the potential across Canadian universities, while building the talent pipeline to help facilitate the commercialisation and domestic adoption of Canadian quantum IP.
 - Support is needed for the costs of a small number of dedicated staff at each institution to help develop and deliver iterations of the courses in the first 2-3 years, until the courses are established, and standard educational resources can be used to maintain them. Dedicated training and curriculum development resources could be delivered through federal programs like NSERC or Mitacs, and provincial programs like OCI TalentEdge, or a combination of programs from both levels of government.
 - Several Canadian universities are already working to coordinate a similar approach to quantum computing education and are looking for additional funding from governments to help execute this important initiative. To date, the University of Ottawa, McMaster University, Queen's University and Universite de Sherbrooke, are all working to deliver specialised courses in Quantum Computing programming using Xanadu's PennyLane to ensure a strong talent pipeline for Canadian businesses and institutions and to accelerate quantum application development and general adoption.
 - Xanadu has already signed MOUs for educational cooperation with the above-mentioned universities, and is cooperating on educational efforts with another 9 universities across the country. We believe the current cooperative efforts could be greatly accelerated, and expanded to include more schools and students, with the application of a modest amount of funding and national coordination by ISED.

- **Recommendation:** We recommend the federal government dedicate funding to establish a nationally-coordinated program for quantum computing software education to to prepare talent for work-integrated-learning opportunities and fuel the adoption of quantum computing across Canada. The training will create a talented workforce for generations of Canadians to come that will help facilitate the commercialisation success of Canadian quantum IP.