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Good morning, Chairman Cantwell and Ranking Member Wicker, and distinguished Members of the Committee. Thank you, Senator Cantwell, my Senator, for the opportunity to testify about the value and continued importance of our nation investing in emerging computing technologies. I am the Dean of the University of Washington (UW) College of Engineering, and the three technologies the committee is focusing on today — artificial intelligence (AI), quantum information science (QIS), and distributed ledger technologies (DLT) — are areas where the University of Washington is making significant contributions and leading nationally and internationally to develop and discover the potential of these fields while training the next generation of workers and innovators.

Earlier this year Congress took a bold step to ensure that the United States is equipped to be a global leader in science and innovation with the passing of the CHIPS and Science Act. As you know, this legislation is designed to revitalize American science and innovation, build a strong and diverse STEM workforce, create solutions for the climate crisis, and support American manufacturing. As a leader in academia, I am encouraged by this critical federal funding, and I am here today to urge you to continue to invest in our federal science agencies and initiatives empowered by CHIPS. Sustained federal investment in these programs are essential for our nation to remain a leader in a fierce global landscape, to leverage opportunities for collaboration between government, academic, and business sectors, and to build a workforce that reflects the rich diversity of our nation.

The University of Washington has significant expertise in the three areas that the committee is focusing on today. UW faculty serve as PIs on multiple large, multi-institution NSF awards in artificial intelligence, machine learning, and data science, including the Institute for Foundations in Data Science, the Institute for Foundations in Machine Learning, and the AI Institute for Dynamic Systems. However, this morning I will focus my comments on the impact of investing in quantum information science and I'll start with an example of its promise. As I write, Hurricane Ian is strengthening before making landfall in our southern states and coastlines, with the potential to shatter communities. As a native of Louisiana, I keenly understand the toll that a destructive hurricane can have on a community and the hardship of rebuilding. Thankfully, forecasting models help us predict the path and intensity of hurricanes. Large supercomputers and artificial intelligence already aid forecasting, such as models developed by NOAA, NASA and the Pacific Northwest National Laboratory (PNNL) that can predict when hurricanes will rapidly intensify. It is a tremendous improvement from when I was growing up, but we can and should do more. However, to achieve greater accuracy in weather forecasting, more computational power is needed.

Theoretically, a full-scale quantum computer can improve weather forecasting methods by handling huge amounts of data (terabytes per second) containing many variables and optimizing complex algorithms, and can do so in seconds. With quantum computing, we will be able to prepare for these storms with a much higher level of certainty, potentially saving lives and reducing property damage.

Our society stands on the brink of a major revolution driven by quantum information science with boundless potential to fundamentally change the way we live and work. Quantum information science uses quantum effects to acquire, transmit, and process information. Quantum science has already enabled us to better understand nature and advance groundbreaking technologies like GPS, MRI scans, and lasers for healthcare applications such as eye surgery and joint surgery.

Like the 1980s when classical computing and the personal computer changed the world, recent advances in quantum information science promise major breakthroughs in communications, computing, and simulation. Industry and governments around the world are investing heavily in quantum information science, recognizing its potential and poising to capitalize on it. As the U.S. aims to be a scientific leader of the coming quantum information age, now is the time to accelerate federal investment, as outlined by CHIPS, so our nation is a global leader in this field.

Currently, there are growing numbers of universities with established major quantum information programs in the world, and the University of Washington is proud to be one such program with robust partnerships with industry including Microsoft, Boeing, Google, and Amazon, and with the Pacific Northwest National Laboratory (PNNL). Internationally, quantum information programs are underway in Sweden (WACQT), the Netherlands (Quantum Delta), Japan (Moonshot), Israel (Israel National Quantum Initiative), and the U.K. (UKNQTP).

Germany, France, Austria, and Canada are also substantially investing in this area. China is making massive investments in quantum computing, and quantum technology more broadly, making it certain that they will emerge as a leader in this area in the next decade. Worldwide, the competition for top students, researchers, faculty, and funding is fierce, as is hiring by companies. The new quantum information initiatives in the U.S. and around the world have the same goal: not to miss the window to lead in this area. No country is better positioned to emerge in the top cohort than the U.S. in partnership with academia, government, and industry.

Investment in America's leading research universities will allow talented faculty and students to further innovative science that will elevate the U.S. as a global destination for knowledge and discovery in quantum information sciences. These foundational investments will influence economic and national security, prepare U.S. students for jobs with quantum information technology, enhance STEM education at all levels, and accelerate exploration of quantum information frontiers, all while expanding and diversifying the talent pool for the industries of the future in Washington state and across the nation.

For example, the Washington Quantum Technologies, Teaching and Testbed Laboratory (QT3) provides a regional resource for hands-on quantum technology training to the next generation of quantum scientists and engineers and state-of-the art quantum device characterization research tools in a publicly accessible user facility.

In this second quantum revolution, society will leverage the quantum-mechanical properties of light and matter to enable new technologies in computation, communication, and sensing. Federal funding to enable universities to train the next generation of scientists and engineers is needed to enable this revolution. To realize practical quantum technologies, quantum expertise is needed through the full quantum stack -- from materials, devices and hardware to software and algorithms. DOE NQI centers have been established to drive forward the research and training in select laboratories. These centers, however, do not address the need for shared quantum infrastructure for training and testbeds where federal funding would serve a critical need.

At the University of Washington, the lack of critical capabilities, primarily originating from the large cost of implementing and maintaining them, hampers our impact. While we have targeted systems that work at room temperature, the leading quantum computing platforms work at ultra-low temperatures, just a fraction of a degree above absolute zero. Our researchers and students need access to this capability. We are able to provide our current capabilities by focusing on a single qubit platform which can function at room temperature at one particular energy. This particular platform at room temperature cannot scale to the many qubits required for meaningful quantum computation. We also need to seek to expand to enable the excitation and detection capabilities to discover new qubits which have the potential to scale even further.

The Boston Consulting Group estimates that quantum computing alone could create a value of $450 billion to $850 billion in the next 15 to 30 years if the technology scales as fast as predicted[1]. Quantum information science presents a tremendous economic opportunity and a substantial hurdle. One of the biggest issues impeding the growth of this industry is the shortage of an equipped quantum information science workforce. This shortage has a significant impact on the future growth of industry. In Washington state workforce development will impact the recruitment to existing Washington companies who have expanding footprints in quantum computing including Microsoft, Boeing, Amazon and Google as well as to new start-ups. It is increasingly difficult to fill skilled STEM job openings, which is further compounded for companies where advanced degrees in physics, chemistry, materials science, engineering and computer science are needed. As the investment and interest in quantum computing grows, competition for skilled workers is intensifying and creating an unsustainable demand. This demand cannot be addressed without an accelerated and unrelenting investment in training and development.

According to a recent report from the Washington Roundtable, a nonprofit organization comprised of executives of major private sector employers in Washington state, in the next five years "Washington state's anticipated annual job growth rate of 2.3% will far outpace the national rate of 1.3%. Seventy percent of these jobs will require a post-high school credential. Washington employers want to hire local talent to fill these positions whenever possible and it's essential that our young people are ready."[2] At the University of Washington alone, student demand far exceeds capacity in the UW's engineering and natural sciences (including computer

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[1] Jean-François Bobier, Matt Langione, Edward Tao, and Antoine Gourevitch, "What Happens When 'If' Turns to When in Quantum Computing," Boston Consulting Group, 2021, https://web-assets.bcg.com/89/00/d2d074424a6ca820b1238e24ccc0/bcg-what-happens-when-if-turns-to-when-in-quantum-computing-jul-2021-r.pdf.
[2] Washington Roundtable, January 2022, https://www.waroundtable.com/wp-content/uploads/2022/02/WRT_PostsecondaryEnrollmentCrisis_Report_1.2022.pdf.

science and engineering, mathematical, physical and life sciences) programs. We are forced to turn away excellent students while our nation demands a skilled workforce.

Failing to prepare our citizens for the innovation economy compromises our nation's long-term competitiveness and economic stability and disadvantages our citizens and communities. Industry, government and universities must step up and invest in the quantum workforce. As we enter an increasingly specialized economy, America's leading research universities, including the University of Washington, are uniquely poised to provide leadership, research, and workforce education to meet this need, but we need federal investment.

To be competitive we need to educate the workforce of the future and we know diverse teams lead to better results, so we are investing in programs to expand access to more Washington students, as well as asking for investment from the state. Students from low-income backgrounds, underserved public high schools, as well as first-generation college students, are particularly likely to suffer from financial, social, and emotional challenges, and struggle to adjust to college life and expectations. Our goal is to grow the infrastructure needed to support these students, many of whom arrive with little background or outside support necessary to navigate the rigorous coursework required for engineering and computer science. We measure our success in the students who graduate and move on to thriving careers in our nation's industries. Central to our public mission, we strive to identify these students, recruit them, and enable them to succeed.

STEM creates a future of opportunity. It's a pipeline of local talent that will serve students, businesses, and communities across the nation, with benefits for decades. Through key relationships with industry, government, and academic partners, our nation's universities can connect the best and brightest minds to advance quantum technology faster. The success of quantum information is closely aligned to ongoing fundamental science, which is why federal investment is required. Federal leadership and investment are the foundation for these advances for all. As a representative of academia, we stand ready to partner with you. I ask that you continue to accelerate discovery through sustained and increased funding of the federal agencies that enable us to remain a quantum information leader in a fierce global landscape. And I leave you with five areas where federal investment would be particularly impactful:

Increased funding for workforce development and education, support to develop accessible quantum testbeds and quantum cloud computing for all, increased funding for high-risk engineering and science research given the remaining technological barriers for quantum information science to become broadly usable, and more fundamental quantum information research and investment in technology policy.

Thank you for your time and consideration.