Testimony of

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On

"Assessing U.S. Leadership in Quantum Science and Technology"

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Chairman Babin, Ranking Member Lofgren, and Members of the Committee, I am Dr. James Kushmerick, Director of the Physical Measurement Laboratory at the National Institute of Standards and Technology (NIST). Thank you for the opportunity to appear before you today to discuss NIST's leading role in advancing quantum information science and technology.

This hearing comes at a critical time. We are in a fierce international competition for continued leadership in quantum information science and technology. With countries like China making significant investments in quantum research and development, the U.S. cannot afford to take its foot off the gas. NIST appreciates your support and looks forward to working with the committee to ensure continued U.S. leadership in quantum information science and technology development.

NIST is the U.S. national measurement institute with a mission to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST ensures that the U.S. economy runs on fair transactions, that our infrastructure is built with quality construction materials, that our manufacturers can innovate and compete internationally, and that we have access to reliable products at home.

Today, NIST's scientists and engineers conduct research to advance and drive innovation in key areas of critical and emerging technology including artificial intelligence, next-generation communications, cybersecurity, advanced manufacturing, biotechnology, and what will be the focus of my remarks today in quantum information science and technology.

By its very nature, quantum science is the epitome of precision measurements, so by necessity, NIST has been a leader in quantum science research for over fifty years. Our long history of foundational research has made NIST the world's leading institute for quantum technologies. Today, many NIST measurement services – the mechanism by which we disseminate measurement certainty to U.S. industry – use some form of quantum technology. NIST's contributions in quantum science have been recognized by four Nobel Prizes in physics.

It has become clear that quantum science will be the foundation of a new technology revolution. By combining quantum physics and information theory, two of the 20th century's most important scientific developments, quantum information science and technology (QIST) heralds a technological revolution that could transform our society as profoundly as computers and the Internet once did.

NIST has established itself as a key enabler of QIST in the United States, delivering many groundbreaking experimental results: NIST researchers pioneered techniques to manipulate quantum objects, such as atoms and ions; demonstrated quantum logic gates; and developed nearly perfect single-photon detectors. To achieve those results, NIST perfected quantum-enabling auxiliary technologies, such as lasers, and created new ones, such as the optical frequency comb. As a result, basic and applied research from the NIST quantum portfolio has significantly influenced the inception and ongoing development of quantum technologies, which have become a center of attention for the industry.

Technology spun off from NIST and developed through cooperative research and development agreements (CRADAs) with industry and academic partners has seeded U.S. industry, ranging from large corporations to startups, with key quantum technology platforms that are driving today's emerging industry. Perhaps even more impactful, NIST's leading research programs have shaped and trained a significant portion of today's quantum workforce. Hundreds of NIST alumni fill key research, development, and leadership positions in leading quantum companies. NIST-trained associates and former NIST staff have also founded several quantum companies. NIST continues to advance its mission of strengthening U.S. competitiveness, now in the domain of quantum technologies.

To strengthen U.S. competitiveness in the emerging global quantum market, NIST actively contributes to and facilitates U.S. industry engagement in the standardization of quantum technologies. NIST administers the U.S. Technical Advisory Group of the International Electrotechnical Commission/International Organization for Standardization (IEC/ISO) Joint Technical Committee on Quantum Technologies. Additionally, NIST played a leading role in establishing NMI-Q, a global initiative consisting of the National Metrology Institutes (NMIs) of the G7 countries and Australia, to support the development and adoption of quantum technologies. By coordinating measurement best practices and performing pre-standardization research, NMI-Q will help industry, academia, and governments unlock the full potential of quantum innovation.

The National Quantum Initiative Act of 2018 (NQI) recognized the importance of QIST as a critical emerging technology and solidified the development of the cohesive national quantum ecosystem. The NQI leveraged NIST assets to advance American leadership in QIST. Through its core technical programs on quantum sensing, computing, networking, foundational technologies, and risk mitigation, NIST became the key organization in implementing NQI goals, supporting the growth of the U.S. quantum industry, and driving quantum research and development for the economic and national security of the United States. The NQI specifically called on NIST to expand and set up new research programs and other activities to support this effort and provided a mechanism for coordination between NIST and other agencies. NIST also redoubled its efforts in training a quantum-ready workforce. Through the NQI, NIST has approximately doubled the size of its quantum portfolio.

In 2018, as directed by the NQI, NIST established the industry-led Quantum Economic Development Consortium (QED-C). The QED-C is the primary vehicle for the commercialization of quantum technology in the United States. QED-C focuses on the business and industrial infrastructure required to turn fundamental science into a multi-billion-dollar ecosystem. QED-C participants work to identify gaps in technology, standards, and the workforce and to address those gaps through collaboration. Of particular importance is identifying and eliminating gaps in the quantum supply chain. QED-C now has more than 250 member organizations, including 180+ member companies. Through their industry-wide activities, QED-C collects important information that informs Government agencies for their strategic planning. In addition to creating new market opportunities and business cases by surveying the needs of businesses, they also identify technical gaps that should be addressed through fundamental and applied research outside of the private sector. This information also leads to evidence-driven export control and research security policies.

Overall, the last six years have seen the birth and rapid development of the U.S. quantum ecosystem and a world-leading emergent U.S. quantum industry. However, as noted earlier, the United States is facing a challenging and highly competitive landscape, as the battle for global dominance in quantum technologies has intensified with China and other nations making significant advancements. China has reportedly invested over $15 billion – including significant funding for research facilities and infrastructure – and in areas like quantum communications.

To maintain American leadership, we need to adapt our strategy in QIST. Not only must we continue to invest in fundamental research, but we must also prioritize the infrastructure and applied research to develop and scale industrially relevant technologies. To give one example, quantum sensors are ripe for commercialization. Quantum sensors can measure extremely small variations in electric or magnetic fields or the pull of gravity. These have real-world applications, such as detecting submarines undersea or mineral deposits underground. Quantum sensors can enable navigation in areas where access to GPS is denied or unavailable. They could also be used for non-invasive bioimaging of electrical activity in the brain or to assess fetal health. Quantum sensing technologies are also being developed to answer scientific questions about the nature of dark matter and in fundamental studies of the universe. A QED-C survey of 67 quantum sensing companies reported $375 million in revenues in 2024 and expected growth to more than $900 million in 2028.[1]

Quantum computing, the most anticipated use of quantum technology, could solve problems beyond today's classical computers and affect nearly every sector. Examples of these difficult computational problems include modeling and simulation, optimization, and machine learning. These problems are key to practical applications such as drug discovery, developing advanced materials, improving chemical processing, streamlining transportation logistics, detecting financial fraud, and optimizing investment portfolios. Quantum computers will also significantly advance the practical use of artificial intelligence.

While quantum computing offers tremendous benefits, also if used by adversaries it would threaten public-key encryption, which underpins secure, trusted digital communication. In 2024, NIST published the first three post-quantum encryption standards, ushering in a new age of cybersecurity and preparing the world to protect data from the threat of an adversary using a future quantum computer to break or weaken classical encryption. NIST's work in this area lays the foundation to protect trillions of dollars of global commerce, assure the confidentiality of national security information, and secure the intellectual property of U.S. industry.

To achieve these profound goals, the Administration is partnering with the private sector to drive industrial competitiveness, unleashing economic benefits and competitive advantages of U.S. businesses. NIST has established strategic priorities that will ensure that our nation benefits from our unique expertise by working with industry throughout the R&D pipeline, from the most basic science to the adoption and commercialization of quantum technologies. To this end, NIST will adopt an acceleration model focused on:

- Manufacturing of new quantum sensors;
- Manufacturing of scalable, high-performance quantum components; and,
- Development of quantum networks, including deployable atomic clocks.

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[1] https://quantumconsortium.org/publication/2025-market-forecast-quantum-sensing/

With this holistic approach, NIST will enhance its core research and standards programs by developing quantum technologies and conducting fundamental research in quantum sensing and quantum computing with the goal of identifying and eliminating roadblocks for practical deployment. At the same time, NIST will create *accelerators* – adaptive and flexible industry partnerships to rapidly develop and manufacture quantum and quantum-enabling commercial products. This effort will focus on overcoming major engineering challenges and manufacturing barriers that limit the current performance, scalability, and commercial viability of quantum industry products.

The unique feature of this approach is implementing a Co-Development Model, where engineering and manufacturing experts from the private sector will partner with NIST technology experts to jointly achieve co-innovation in U.S. quantum industry manufacturing at unprecedented speed. This partnership will engage with existing quantum technology companies, as well as with commercial end-users of the technology, to understand barriers to technology adoption and to accelerate the transition to market of new or improved quantum technologies. Those technologies will be rapidly developed through targeted R&D with a timeframe of three to five years. For example, the development of commercial integrated (microfabricated) laser packages will create a new market niche for American manufacturing. In turn, this product will enable efficient, cost-effective, and fieldable quantum systems, such as miniature quantum sensors, and will lead to more robust and more scalable quantum computers.

While the NQI mandates collaboration between industry and NQI-funded researchers, more can be done to strengthen these relationships and the elements of the quantum supply chain. As industry shifts from R&D to production, there is a growing demand for engineers who are experienced in product development and project management and for technicians with hands-on experience in quantum-related technologies, as opposed to a doctoral degree in physics.

Consistent with evolving industry needs, the National Quantum Initiative Reauthorization Act that this Committee introduced last Congress marked a strategic shift from the original legislation. While the 2018 Act focused on establishing a federal framework and funding basic research, that reauthorization expanded the original focus to additionally include translation, commercialization, and international security. The new objectives are designed to move quantum technology out of the lab and into the economy while protecting our competitive lead over global competitors, shifting the focus of the ecosystem from basic research to applied science, and from discovery to deployment. The application focus of that reauthorization promises the creation of new markets for domestic quantum manufacturing. Finally, the reauthorization bill capitalizes on NIST's expertise to grow the number of possible QIST applications and use cases. Specifically, and as I alluded to before, NIST has a strategic plan for the development of quantum technologies together with industry, which will contribute significantly more to the ecosystem. Further, NIST works with other Commerce bureaus to maximize the delivery, build out, and competitiveness of the U.S. quantum industry.

In conclusion, QIST has truly become a critical and emergent technology. Thanks to the wealth of fundamental research knowledge, the true American entrepreneurial spirit, and, of course, the NQI Act of 2018, the United States is a global leader in quantum technologies. While the Nation is currently in a strong position, we cannot afford to be complacent in the face of global competition. With the reauthorization of the NQI and continued strong Congressional support for NIST quantum research, we will ensure sustained U.S. leadership in this rapidly developing sector of the global economy, create a large number of domestic, high-paying jobs, and maintain U.S. dominance in the quantum race.

Thank you for the opportunity to testify today on NIST's activities with quantum research, development, technology, and engineering, and I look forward to answering any questions.