THE NATIONAL QUANTUM INITIATIVE ACT: A BID FOR U.S. QUANTUM LEADERSHIP

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Quantum computing has the potential to revolutionize communications, finance, healthcare, transportation, and a host of other sectors — while threatening to render most current cybersecurity obsolete. Recognizing the value of U.S. leadership in such an important field, Congress passed and the President signed into law the National Quantum Initiative Act (H.R. 6227) (the "Act") in December. The Act builds on the National Strategic Overview for Quantum Information Science, released by the Administration in September 2018.

NATIONAL QUANTUM INITIATIVE

The Act directs the President to create a 10-year National Quantum Initiative (NQI) program to accelerate and coordinate federal quantum research and development. The NQI will be led by a National Quantum Coordination Office within the White House's Office of Science and Technology Policy (OSTP). The National Quantum Coordination Office will serve as a clearinghouse and single point of contact for all civilian federal quantum activities and for interaction between federal and non-federal efforts. It will coordinate the NQI's activities, conduct public outreach, and promote access to and application of quantum research, technologies, innovations, and resources.

SUBCOMMITTEE ON QUANTUM INFORMATION SCIENCE

The Act codifies the National Science and Technology Council Subcommittee on Quantum Information Science, requiring that it include representatives from the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the Department of Defense (DOD), the Office of the Director of National Intelligence, the Office of Management and Budget (OMB), and OSTP, with the NIST Director, the OSTP Director, and the Secretary of Energy serving as co-chairs.

The Subcommittee is responsible for coordinating federal quantum research, information-sharing, and education; establishing NQI goals; proposing quantum infrastructure development needs; assessing the U.S. quantum workforce; assessing the global quantum research and development (R&D) outlook; evaluating opportunities for cooperation with allies; and proposing a coordinated interagency quantum budget to OMB. It is charged with

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preparing two successive five-year strategic plans, along with annual program budget reports.

NQI ADVISORY COMMITTEE

The Act directs the President to establish a NQI Advisory Committee, with members representing industry, universities, and federal laboratories, to provide a range of advice and information on R&D, standards, education, technology transfer, commercial applications, national security, and economic matters. The NQI Advisory Committee will conduct assessments of quantum trends, progress in implementing the NQI, whether the NQI's goals and activities are helping maintain U.S. quantum leadership, whether the NQI needs to be revised, whether opportunities exist for further international cooperation, and whether national security, societal, economic, legal, and workforce concerns are being adequately addressed. The NQI Advisory Committee is required to report to the President and Congress after six months and biennially thereafter on its findings. Members are to be appointed by the President with input from Congress, industry, and the scientific and defense communities.

Having outlined the central activities of the NQI, the Act then turns to each of the three key civilian agencies that will implement the Initiative: NIST, NSF, and DOE.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

To NIST, the Act gives responsibility for:

- Supporting and expanding measurement and standards infrastructure necessary to advance commercial development of quantum applications;
- Using existing programs to train quantum scientists to increase participation in the quantum fields;
- Establishing or expanding collaborative ventures with other public or private-sector entities, including industry, universities, and federal laboratories, to advance the field of quantum information science and engineering; and
- Entering into and performing such contracts, grants, or cooperative research and development arrangements as may be necessary.

NIST is required to create a **quantum consortium** of stakeholders to identify the future measurement, standards, cybersecurity, and other appropriate needs for supporting the development of the U.S. quantum industry. The consortium will assess current research, identify any gaps, and provide recommendations on how NIST and the NQI can address them. The Act authorizes up to $80 million per year through fiscal year 2023 for the consortium.

NATIONAL SCIENCE FOUNDATION

The Act gives NSF the responsibility of carrying out a basic research and education program on quantum

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information science and engineering, including the competitive award of grants to universities, nonprofits, or consortia, to support basic interdisciplinary quantum research, and to support human resources development in all aspects of quantum information science and engineering. In particular, NSF is to:

- Use its existing programs to improve quantum education at the undergraduate, graduate, and postgraduate levels, and to increase participation in the quantum fields;
- Formulate goals for quantum science, research, and education activities to be supported by NSF;
- Coordinate NSF research efforts; and
- Engage with the rest of the government, research communities, and potential users of the information NSF produces.

The Act also permits (but does not require) NSF to establish a program to provide traineeships to U.S. citizen graduate students within the United States who choose to pursue quantum masters or doctoral degrees.

The Act directs NSF to establish between two and five **Multidisciplinary Centers for Quantum Research and Education**, through grants to universities, nonprofits, or consortia thereof (potentially including private-sector collaborators). These Centers will conduct basic research and education activities to advance quantum science and engineering, support curriculum and workforce development, as well as leverage industry perspectives, knowledge, and resources. The Act describes application requirements, sets a five-year term with five-year renewals, allows for termination for cause, and authorizes up to $10 million per Center per year through fiscal year 2023 out of NSF funding.

DEPARTMENT OF ENERGY

The Act gives DOE responsibility for a quantum information science research program — a basic research program that will formulate research goals, provide research experiences and training for undergraduate and graduate students, coordinate research throughout the DOE, and engage with the rest of the government, research communities, and potential users of the information the DOE produces.

The Act directs the DOE, through the Office of Science, to establish and operate between two and five **National Quantum Information Science Research Centers** to conduct basic research to accelerate scientific breakthroughs in quantum information science and technology and to support research conducted by the DOE. National Laboratories, universities, research centers, and multi-institutional collaborations are permitted to compete to host these Centers in a merit-reviewed process. The Centers are to coordinate with other DOE efforts, as well as those of the rest of the government and industry. The Act sets a five-year term with five-year renewals, allows for termination for cause, and authorizes up to $25 million per Center per year through fiscal year 2023 out of DOE funding.

NEXT STEPS

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The NQI Act is authorizing legislation; it must be funded through the separate appropriations process. That begins with the submission of the President's Fiscal Year 2020 Budget Request to Congress in February, at which point the Administration's level of commitment to advancing quantum R&D in the upcoming fiscal year will become clearer. The House and Senate will make the ultimate decision about how much funding to direct to each of the programs listed above over the course of 2019 (or longer). The Appropriations Subcommittees on Commerce, Justice, Science, and Related Agencies (NIST, NSF) and Energy & Water (DOE) will have primary responsibility for setting funding levels. National Laboratories, universities, and companies that want to participate in the NQI should work with Congress to ensure full funding.

The Act focuses on the civilian side of quantum R&D, but of course the military and intelligence applications of these technologies are at least as significant. Congress will need to develop complementary legislation to ensure that the DOD and the Intelligence Community are coordinating and accelerating their own research and that they are collaborating — to the extent possible given classification requirements — with civilian efforts. The 2020 National Defense Authorization Act, which Congress will consider this year, is a logical vehicle for such legislation.

Industry organizations such as the Quantum Industry Coalition will be actively working to engage with the Subcommittee on Quantum Information Science, the NQI Advisory Committee, NIST, NSF, the DOE, and Congress to ensure that industry representatives are able to participate, that industry perspectives are heard, that funding is secured, and that military and intelligence needs are met. The quantum race will only heat up in 2019, but the NQI Act is a strong start for the United States.

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