A Public Meeting of the

National Quantum Initiative Advisory Committee (NQIAC)

December 16, 2022

Meeting Minutes

MEETING PARTICIPANTS

Committee Members

- Kathryn Ann Moler, Co-Chair
- Charles G. Tahan, Co-Chair
- Jamil Abo-Shaeer
- Fred Chong
- James S. Clarke
- Deborah Ann Frincke
- Gilbert V. Herrera
- Nadya Mason
- William D. Oliver
- John Preskill
- Mark B. Ritter
- Robert J. Schoelkopf
- Krysta M. Svore
- Jinliu Wang
- Jun Ye

National Quantum Coordination Office Staff Supporting the NQIAC

- Charles G. Tahan, Director
- Gretchen K. Campbell, Deputy Director
- Corey A. Stambaugh, Senior Policy Advisor
- Tanner J. Crowder, Policy Analyst
- Thomas G. Wong, Quantum Liaison and NQIAC Designated Federal Officer (DOE)

Invited Speakers

- Denise Caldwell, National Science Foundation
- Barbara Helland, Department of Energy

- Jim Kushmerick, National Institute of Standards and Technology
- John Burke, Department of Defense
- Brad Blakestad, Laboratory for Physical Sciences

Public Speakers

- No members of the public presented statements

START DATE AND TIME: Friday, December 16, 2022 at 9:00 AM Eastern Time

LOCATION: Virtual Meeting via Zoom for Government

WELCOME AND INTRODUCTIONS

Wong called the meeting to order and gave a brief overview of Federal Advisory Committee Act (FACA) considerations, including that NQIAC meetings should be public—although subcommittees can do preparatory work in closed meetings as long as they report to the full committee for deliberation—and minutes should be taken. He also described his responsibilities to the NQIAC as the Designated Federal Officer.

Next, the co-chairs, Moler and Tahan each introduced themselves and gave opening remarks. Each of the NQIAC members then introduced themselves.

STATUS OF THE NATIONAL QUANTUM INITIATIVE

Several members of the National Quantum Coordination Office (NQCO) gave overviews of the National Quantum Initiative (NQI). Tahan began with a summary of the Federal strategy for QIS, which he described as getting the science right, enhancing American competitiveness, and enabling our people. He described Presidential and Congressional actions this year regarding quantum information science (QIS). Presidential actions included an Executive Order on Enhancing the National Quantum Initiative Advisory Committee and a National Security Memorandum on Promoting United States Leadership in Quantum Computing While Mitigating Risks to Vulnerable Cryptographic Systems. Congressional actions included the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2022 and the CHIPS and Science Act, the latter of which amended the NQI Act with new authorizations, but not appropriations.

Tahan described the federal approach to U.S. science funding, that agencies carry out legislation according to their missions. Many agencies are participating in the NQI, and activities are coordinated through the National Science and Technology Council (NSTC) Subcommittee on Quantum Information Science (SCQIS), the NSTC Subcommittee on Economic and Security Implications of Quantum Science (ESIX), the NQCO, the National Quantum Initiative Advisory Committee (NQIAC), and the Quantum Economic Development Consortium (QED-C, a non-governmental entity). Tahan recognized the co-chairs of the SCQIS and ESIX, who are leaders at their agencies and help guide the respective subcommittees.

Returning to strategy, Tahan highlighted the six pillars of the National Strategic Overview for QIS: take a science-first approach, provide key infrastructure, build a quantum-capable workforce, nurture the nascent quantum industry, balance economic and national security, and continue to develop international collaboration and cooperation.

Tahan then gave an overview of activities supporting the NQI, grouped by the three strategy prongs: (1) "Getting the science right" includes the 13 national QIS centers and institutes and is guided by a variety of strategy documents, including on quantum frontiers, quantum networking, and quantum sensing. Agencies have launched several solicitations this year around QIS. (2) "Enhancing competitiveness" involves supporting industry and security, such as through a 2021 White House Summit on Quantum Industry and Society, an ESIX strategy document on The Role of International Talent is QIS, and a Workshop on the Cybersecurity of Quantum Computing. It also encompasses international cooperation, such as through eight bilateral quantum cooperation statements and multilateral dialogues, such a May 2022 meeting of twelve nations co-hosted by the White House and Department of State. (3) "Enabling our people" is guided by the QIS and Technology Workforce Development National Strategic Plan and carried out through the National Q-12 Education Partnership, World Quantum Day, the Workshop on Quantum Recruitment in the Federal Government, and the recently launched Entanglement Exchange, among other activities.

Tahan ended by sharing about QIS in the CHIPS and Science Act and highlighting potential areas for future engagement, such as the new National Science Foundation (NSF) Directorate for Technology, Innovation, and Partnerships (TIP), appropriations for the Science Act, and the reauthorization of the NQI. He looked forward to the NQIAC's report with recommendations.

Next, Stambaugh, Senior Policy Advisor for the NQCO, gave an overview of the NQI Act, as amended by the FY 2022 NDAA and CHIPS and Science Act of 2022. First, he clarified the scope of the NQI Program by quoting directly from President Biden's Executive Order 14073 on Enhancing the NQIAC, which states that the NQI Program includes the QIS activities of agencies in the SCQIS or ESIX, which is broad.

Diving into the NQI Act, Stambaugh summarized Title I of the Act as establishing the NQCO, SCQIS, ESIX, and the NQIAC, as well as providing a sunset for these entities. Title II contains the National Institute of Standards and Technology's (NIST's) technical, workforce, and standardization activities, and the establishment of a quantum industry consortium. These activities were authorized, but not appropriated, by the Act. Title III contains NSF's activities to support basic QIS research and workforce development at all levels, plus the establishment of QIS centers. NSF has authorized, but not appropriated, funding for these activities. Title IV authorizes the Department of Energy's (DOE's) basic research program in QIS, QIS research centers, a quantum networking infrastructure program, and a program to facilitate access to quantum computing hardware. These activities were authorized, but not appropriated, by the Act.

Stambaugh concluded with QIS in the FY 2019, FY 2020, and FY2022 NDAA, which established the defense QIS and technology research and development (R&D) program, including the development of strategic plans, coordination with other agencies, and the establishment of QIS research centers, and codified ESIX.

Then, Crowder, Policy Analyst for the NQCO, described the "Science First" approach of the NQI, which is carried out by a variety of agencies that include the civilian, defense, and intelligence ecosystems to ultimately engage "end user" agencies, with the support of additional agencies. The SCQIS Science Working Group organizes an annual Program Day to gather QIS program managers and stakeholders from the Federal government. The NQCO also recently hosted the White House NQI Centers Summit, which gathered the director, deputy director, and outreach lead of all thirteen NQI centers. The key technical challenges facing the field are presented in the Quantum Frontiers report, which synthesizes feedback from a Request for Information (RFI) and multiple workshops. For quantum networking, two

strategy documents include A Strategic Vision for America's Quantum Networks as well as A Coordinated Approach to Quantum Networking Research, and the CHIPS and Science Act has legislated that an updated strategy document be produced in the future. For quantum sensing, the strategy document, Bringing Quantum Sensors to Fruition, sets the technology as a near-term objective. Historically, long-term, sustained investments have yielded breakthrough technologies and scientific discoveries, such as the Chip-Scale Atomic Clock (CSAC) program and the NSF Laser Interferometer Gravitational-Wave Observatory (LIGO).

Stambaugh returned to discuss workforce activities in the NQI. The strategy is guided by the QIS and Technology Workforce Development National Strategic Plan, which seeks to inspire individuals, provide education and training, and enable accessible experiences in order to guide people into quantum careers. A quantum.gov factsheet on Federal Workforce Activities in QIS gives a sample of some efforts. The National Q-12 Education Partnership is an exemplar, which built on an NSF workshop to identify key concepts for QIS learners in order to develop K-12 learning frameworks, classroom activities, and profiles of quantum careers. World Quantum Day is an exemplar of coordinated interagency outreach, and it led to the creation of a marquee video called "This is Quantum," videos shorts from quantum scientists, an infographic about Planck's constant, a quantum image gallery, and more.

Finally, Campbell, Deputy Director of the NQCO, presented about security and international components of the NQI. First, President Biden's National Security Memorandum on Promoting United States Leadership in Quantum Computing While Mitigating Risks to Vulnerable Cryptographic Systems sets U.S. policy to lead in QIS and to transition to post-quantum cryptography in a timely and equitable manner. It also tasks the U.S. with working to safeguard relevant quantum R&D and intellectual property. As stated in the ESIX report, The Role of International Talent in QIS, the U.S. should develop and support policies and welcome talented individuals from all over the world and cooperate with partners and allies to increase the global pool of talent. One example of this is the recent launch of the Entanglement Exchange, which grew out of a White House roundtable that brought together twelve nations around Pursing Quantum Information Together. The NQCO's presentation ended with a timeline of major events establishing and implementing the NQI.

OVERVIEW OF AGENCY NQI ACTIVITIES

Caldwell presented some highlights of NSF's activities in QIS and the NQI. First, the Transformation Advances in Quantum Systems (TAQS) series of solicitations has incubated interdisciplinary teams of researchers, where teams must be composed of experts from at least three different areas. Four TAQS programs have been launched, starting with a pilot, then an idea incubator, then on interconnects, and this year on sensors. Next, NSF has launched five Quantum Leap Challenge Institutes, each funded at $5M/year for five years. Finally, NSF recently funded its ExpandQISE solicitation to increase research capacity and broaden participation in Quantum Information Science and Engineering (QISE).

Helland shared some highlights of QIS R&D activities at DOE, which span all six Office of Science programs plus DOE's Isotope Program. DOE's five national QIS research centers involve 1200 QIS experts, 600 students and postdocs, and 80 institutions. The CHIPS and Science Act of 2022 has also authorized DOE to launch a Quantum Network Infrastructure R&D Program, as well as a Quantum User Expansion for Science and Technology (QUEST) program.

Kushmerick gave an overview of NIST's QIS research, which spans the entire NQI Program, including quantum sensing, networking, computing, fundamental quantum science, enabling technologies, and

risk mitigation. NIST has three joint research institutes: JILA at the University of Colorado, the Joint Quantum Institute (JQI) at the University of Maryland, and the Joint Center for Quantum Information and Computer Science at the University of Maryland. Across these joint institutes, there are 80 research groups with roughly 500 postdocs and students. NIST also established the Quantum Economic Development Consortium (QED-C), which seeks to grow a robust quantum industry and supply chain in the United States.

Burke shared about QIS in the Department of Defense (DoD), which includes quantum science, quantum technology, and quantum engineering. Quantum science is knowledge-driven and explores processes, controls, and materials; harnessing entanglement; and quantum computer science. Quantum technology is applications-driven and explores navigation and timing; spectrum, imaging, and detection; and computing. Quantum engineering is process-driven and develops specialized components and explores integration and architectures. Quantum technologies can be evaluated by their military impact and military readiness.

Blakestad shared about QIS at the Laboratory for Physical Sciences (LPS). In addition to being a funder of QIS research, LPS conducts state-of-the-art research and is the home of the LPS Qubit Collaboratory (LQC), a national QIS research center established by DoD in response to the FY 2020 NDAA. Their model is to enable scientists to perform research at their own institutions instead of gathering everyone at their building, forming a distributed "center without walls." A broad-agency announcement (BAA) is available for those interested in partnering with the LQC.

OPEN DISCUSSION AMONG MEMBERS AND CHARGE

After all the presentations, Moler and Tahan described the duties of the NQIAC as to advise and make recommendations for improvements on the NQI program, with the six strategy pillars of science, infrastructure, workforce, industry, security, and international as the focuses. This work would be carried out by three subcommittees on science and infrastructure, security and international, and workforce and industry. Then, there was open discussion among the members.

Herrera asked what the length and scope of the report should be. Tahan replied that the length is up to the advisory committee, but he personally thinks brevity is better. He said the scope is the entirety of the NQI and encouraged members to look at the six pillars of the national strategy and consider if anything is missing.

Mason asked if the committee should consider internal or external comparators? Moler responded that it is up to the committee, and we should use whatever we need to fulfill our charge.

Ritter commented that a summary of the research centers would be helpful. Tahan replied that the White House held the NQI Centers Summit recently, and that a readout of the event can be shared with the relevant subcommittee(s). Ritter followed up by stating that quantum is broad, and he asked if the committee's activities should reflect that. Tahan responded by saying the NQIAC is the advisory committee for the National Quantum Initiative, but it should look at the scope of the entire QIST effort to evaluate better how to edit the NQI.

Preskill shared that for the centers, he is not interested in metrics like the number of students or number of states participating. Rather, he is interested in what has really moved the United States toward the important goals, i.e., of realizing quantum technologies. To this, Clarke asked if the centers

are too broad to be impactful. Ritter suggested having the centers brief the NQIAC. Ye said he would imagine that the centers would be happy to brief the NQIAC. Frincke suggested roundtables as a medium.

Frincke asked what we want to accomplish as a nation through the NQI? Mason set a timeframe to this question, asking what the centers have to accomplish in the next 5-10 years to meet our goals.

Moler summarized the discussion, that the focus is not just on activities, but on the real accomplishments that have been made and that need to be made.

CLOSING AND ADJOURNMENT

Moler and Tahan thanked the members for the work they would do, and Wong adjourned the meeting at 11:00 AM Eastern Time.

CERTIFICATION

I hereby certify that, to the best of my knowledge, the foregoing minutes are accurate and complete.

Kathryn Ann Moler, PhD
Co-Chair
National Quantum Initiative Advisory Committee

Charlies G. Tahan, PhD
Co-Chair
National Quantum Initiative Advisory Committee