National Quantum Initiative Advisory Committee

March 24, 2023

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Agenda

Time (am EST)	Topic
9:00 – 9:15 (15 min)	*Opening* • Kathryn Ann Moler and Charles Tahan, NQIAC Co-Chairs
9:15 – 10:15 (1 hr)	*Science and Infrastructure Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
10:15 – 10:25 (10 min)	*Break*
10:25 – 11:25 (1 hr)	*Workforce and Industry Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
11:25 – 11:35 (10 min)	*Break*
11:35 – 11:40 (5 min)	*Remarks* • Asad Ramzanali, Chief of Staff, Office of Science and Technology Policy
11:40 – 12:40 (1 hr)	*Security and international Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
12:40 – 1:00 (20 min)	*Discussion and Closing Remarks* • Kathryn Ann Moler and Charles Tahan, NQIAC Co-Chairs

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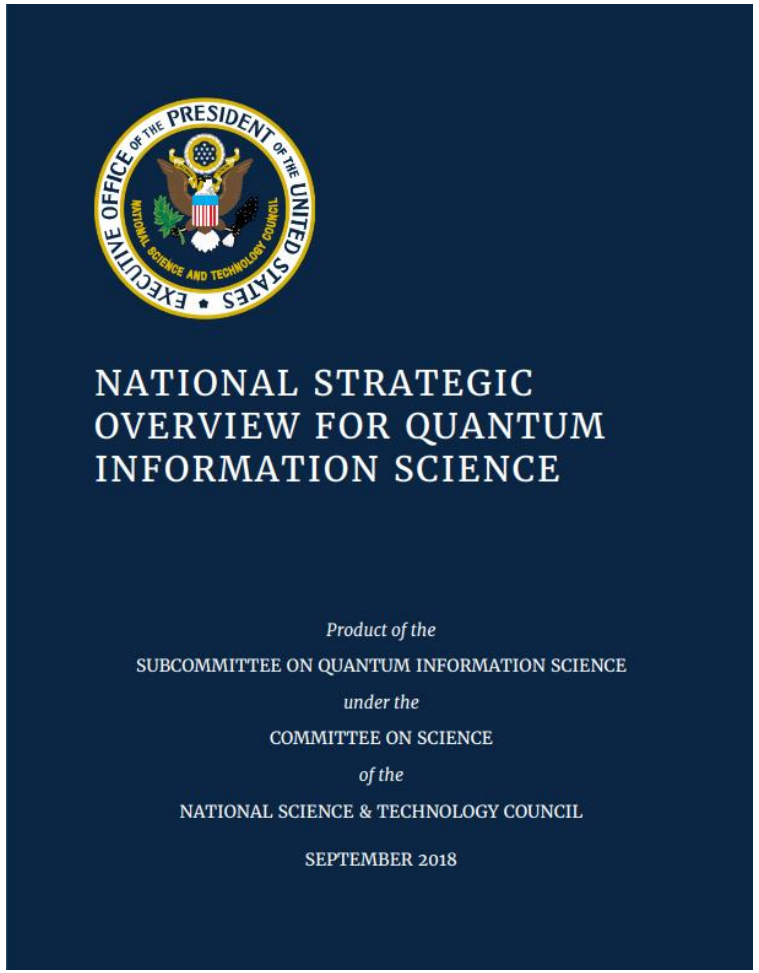
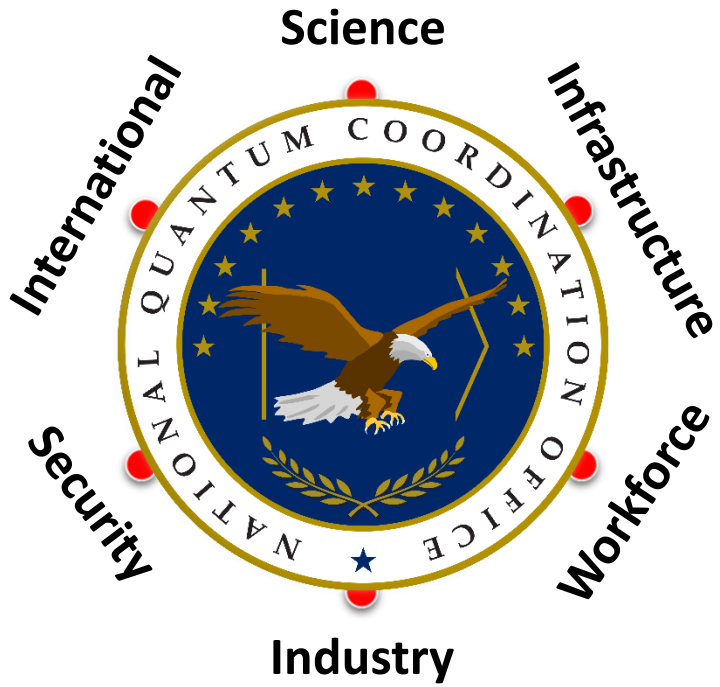
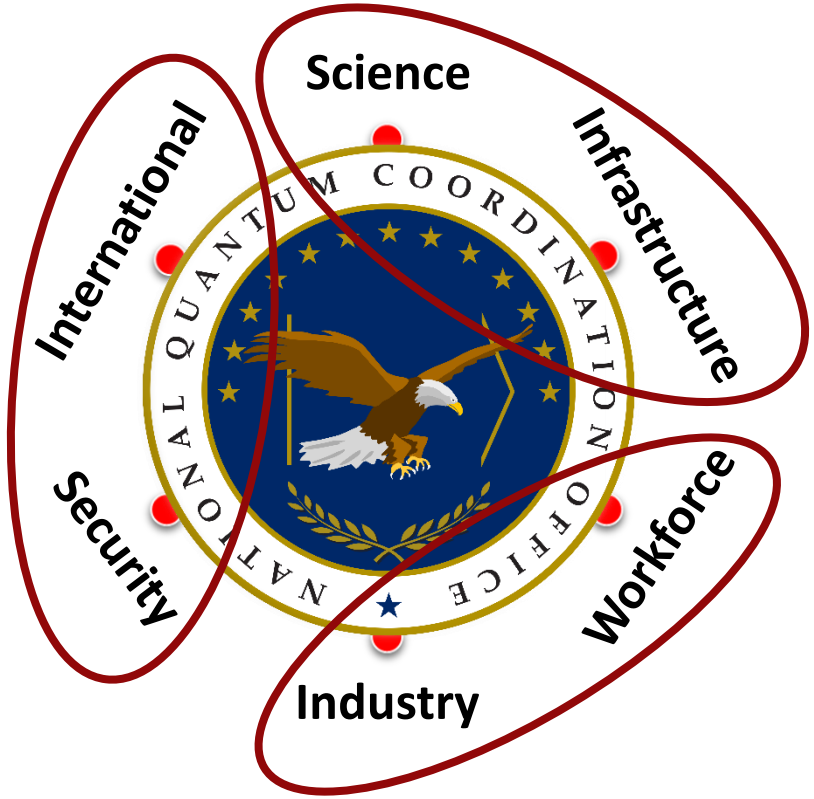
U.S. National Strategic Overview for QIS



Six Pillars



3 NQIAC Subcommittees



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NQIAC Subcommittee Charges

The NQIAC Subcommittee on *Pillar A* and *Pillar B* is tasked with assessing the National Quantum Initiative (NQI) Program's *Pillar A* and *Pillar B* components, and to make recommendations for the President, appropriate committees of Congress and appropriate NSTC subcommittees to consider when reviewing and revising the NQI Program.

Pillar A and Pillar B are…

1. Science and Infrastructure
2. Workforce and Industry
3. Security and International

Science and Infrastructure Subcommittee

Draft Findings and Recommendations

Nadya Mason (Co-Chair)
Will Oliver (Co-Chair)
Fred Chong
John Preskill
Mark Ritter
Jun Ye

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NQI Science and Infrastructure Themes and Priorities

NATIONAL STRATEGIC OVERVIEW FOR QUANTUM INFORMATION SCIENCE

"Focus on a science-first approach that aims to identify and solve Grand Challenges: problems whose solutions enable transformative scientific and industrial progress"

"Provide the key infrastructure and support needed to realize the scientific and technological opportunities"

QUANTUM FRONTIERS
REPORT ON COMMUNITY INPUT TO THE NATION'S STRATEGY FOR QUANTUM INFORMATION SCIENCE

1. Expanding Opportunities for Quantum Technologies to Benefit Society
2. Building the Discipline of Quantum Engineering
3. Targeting Materials Science for Quantum Technologies
4. Exploring Quantum Mechanics through Quantum Simulations
5. Harnessing Quantum Information Technology for Precision Measurements
6. Generating and Distributing Quantum Entanglement for New Applications
7. Characterizing and Mitigating Quantum Errors
8. Understanding the Universe through Quantum Information

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National QIS Research Centers

5 NSF Quantum Leap Challenge Institutes (authorized under NQIA)

- Q-SEnSE: Quantum Systems through Entangled Science and Engineering
- HQAN: Hybrid Quantum Architectures and Networks
- CIQC: Challenge Institute for Quantum Computation
- QuBBE: Quantum Sensing for Biophysics and Bioengineering
- RQS: Institute for Robust Quantum Simulation

5 DOE National QIS Research Centers (authorized under NQIA)

- Q-NEXT: Next Generation Quantum Science and Engineering
- C2QA: Co-Design Center for Quantum Advantage
- SQMS: Superconducting Quantum Materials and Systems Center
- QSA: Quantum Systems Accelerator
- QSC: The Quantum Science Center

3 DoD Centers (authorized under NDAA)

- LQC: LPS Qubit Collaboratory
- Air Force Research Laboratory
- Naval Research Laboratory

Science and Infrastructure Subcommittee Process

- Met weekly beginning January 3, 2023
- Reviewed Federal NQI-related publications
- Focused on NQI centers and other agency QIS activities
- Developed questions to probe current NQI status, accomplishments, and needs related to Science and Infrastructure
- Interviewed and requested written responses from:
  - Directors or other representatives of the 13 National QIS Research Centers
  - Federal agency staff from NSF, DOE, NIST, and DoD
- Reviewed input, identified common themes, discussed priorities for NQI 2.0
- Developed draft findings and recommendations for NQIAC feedback

General Subcommittee Observations

- The NQI has raised U.S. capacity for QIST R&D and competitiveness by:
  - Leveraging and augmenting long-standing Federal R&D activities, and
  - Improving coordination across sectors and within the USG.
- The NQI has already enabled:
  - New scientific discoveries,
  - Cross-disciplinary collaboration between different organizations from all sectors,
  - First steps in developing new technologies required to scale quantum systems, and
  - Enhanced awareness of QIST and its likely benefit to society.
- While the United States is making important progress,
  - Key science and fundamental engineering questions remain to be answered for benefits to be realized.
  - Other nations and regions have announced QIS funding that surpasses our nation's.

The Subcommittee believes that development of QIST is critical to our economic and national security. Continued and increased funding for NQI 2.0 and beyond will be necessary for our nation to win the race to realize the potential benefits of QIST.

NQI Centers: Status and Accomplishments

Findings

1. NQI funding for new QIS Centers has led to enhanced facilities, collaborations, and connections between national labs, academia, and industry.
2. Important scientific achievements have already been reported by Centers.
3. Over the past 4 years, the Centers have established their new physical infrastructure and collaborations.
4. Centers are now poised to use this investment to realize new science and applications.
5. Sustained investments in QIS Centers over the next 5 years could yield important advances in quantum error correction, networked quantum sensing, and more.

Recommendations

Congress should:

1. Renew Center funding for at least 5 years, with refreshed goals.
2. Fund several new smaller-scale centers, to gain cutting-edge science and engineering and encourage new collaborations across the QIS community.
3. Consider extending the NQI Act beyond the initial 10 years and announce that intent during the proposal renewal period. This will help researchers plan to reach bigger goals as they see a greater time span.
4. Appropriate what has been and will be authorized under the NQI.

NQI Scientific Scope and Grand Challenges

Findings

1. Topics covered by NQI activities so far have been of a reasonable scale and scope.
2. Basic scientific and fundamental engineering questions still need to be answered to support future technology development.
3. Gaps in scope include:
   - Quantum algorithms that are commercializable at scale
   - Quantum error correction
   - Demonstrator scale
4. Science-first research needs both smaller-scale (PI-level) and larger-scale (Center-level) activities.

Recommendations

1. The NQI should continue with science-first focus with added emphasis on fundamental engineering and foundational technology platforms to accelerate economic impact.
2. Congress should appropriate and augment funding for access to commercial quantum systems and increase investment in research on quantum algorithms, software, and error correction.
3. NQI funding should be balanced between single PIs, few PIs, small-scale Centers, and large-scale Centers.
4. Congress should increase agency funding for single- and few-PI QIS programs.
5. Congress should establish a Center focused on the fundamental engineering needed to build future quantum technologies
6. NQI 2.0 should be based on a long-term scientific vision for QIS that will enable the science and technology necessary to scale quantum systems.

Collaborations and Partnerships

Findings

1. NQI has expanded collaboration among Federal agencies.
2. Collaborations within Centers are developing well, mostly at individual PI level.
3. Interagency diversification and coordination can cover more territory, more efficiently, primarily as related to larger-scale activities.

Recommendations

1. Scientific goals should drive the scale and level of coordination. Centers should provide a framework for collaboration, rather than imposing it.
2. Congress should fund agencies to focus on their respective strengths.
3. Agency funds should be set aside for cross-cutting seed grants, to amplify individual partnerships, tool development, scientific development, and cross-center collaboration.
4. Agencies should create a joint call for proposals based on their respective strengths (for example, building a quantum sensor and deploying it).

Administrative Burden

Findings

1. Administrative requirements are slowing progress and are becoming more burdensome, including:
   a. Inadequate funding for administrative support for NSF Centers
   b. Cumbersome and slow agreement processes
   c. Over-regulation or regulations with unintended consequences that limit industry participation
2. PI-level burden
   a. Procurement is slow, due to compliance requirements, and getting worse
   b. Fear of audit drives PIs and institutions to overcompensate
3. We need a spirit/culture of “get to yes” and “get it done.”
4. It entails some risk, and this risk must be managed/handled for workers or compliance officers.

Recommendations

1. Congress should augment NSF Center funding to support professional administrative staff.
2. Government agreement processes should be streamlined, whether interagency or with academia and industry.
3. Efforts should be made to homogenize forms and agreements that permit interagency collaboration, and to simplify and limit procurement compliance regulations that cause research bottlenecks.

Infrastructure

Findings

1. Lack of access to infrastructure impedes research and workforce development at universities.
2. User facilities are helpful, but access is limited and turn-around times are often slow.
3. Shared user facilities are heavily used for QIS, and need to be upgraded regularly.
4. Small- and mid-scale infrastructure can advance local research and better bridge to user facilities.
5. Qubit foundries are useful and have been established for several qubit types.
6. There is an increasing need for materials growth, characterization, and instrument development targeting QIS R&D.
7. Availability of isotopes is increasingly important to the advancement of QIS.

Infrastructure

Recommendations

1. Congress should increase agency funding for “growth/fabrication-service” foundries and unique-instrument development to meet and anticipate advancing researcher needs.
2. The USG should fund engineering for increasingly large-sized quantum demonstrators where industry is not already engaged to help accelerate technology development.
3. Expand investment in small-scale and mid-scale infrastructure at more locations to support both research and workforce development.
4. Agencies should consider regional QIS stakeholders when investing in large-scale infrastructure to encourage the development of regional QIS ecosystems.
5. DOE should develop a roadmap of critical isotope needs to guide further potential investment as some isotope production takes 10 years to ramp up.
6. DOE should increase rare isotope production in the United States and make them available to the broader research community.

Testbeds

Findings

1. Science and engineering needs should drive testbed development.
2. Quantum sensing is most mature QIS technology and would benefit the most from testbeds.
3. Testbeds for quantum computing and quantum networking exist through NSF, DOE, and NIST at varying levels.
4. Access to commercial quantum technology is funded out of base agency funding rather than through NQI appropriations.
5. Several DOE Centers fund commercial technology access (not supported by the current NQI), and the newly authorized QUEST program in the CHIPS and Science Act is not appropriated and is possibly inadequate in scale for quantum software development.
6. Challenging to build and maintain a testbed at state-of-art continuously, as the technology and user needs change rapidly.

Testbeds

Recommendations

1. Fund and co-locate Quantum Access Centers with DOE/NSF Centers to curate researcher access to commercial QIST technologies as they become useful. (This funding would support DOE/NSF personnel to generate calls for proposals, review and curation of competitively-selected proposals.)
2. Fund quantum computing access, like HPC access in the past. This funding would include the CHIPS Act QUEST, but also augment it by providing funding for commercial quantum systems based on user demand ramp.
3. Fund researchers (not already funded by the DOE and NSF Centers) to develop quantum software through access to commercial quantum technologies. Make sure broader access to these technologies, beyond R1 (including MSIs) is assured.
4. Provide additional funding to quantum foundries to create regional quantum technology testbeds for workforce training and for SMB access to these technologies to develop and test their ancillary quantum technologies and develop the national quantum ecosystem. (This de-risks the quantum system supply chain).

Key Recommendations

1. Congress should renew Center funding for at least 5 years, with refreshed goals, and consider adding new NSF-scale centers to gain cutting-edge science and engineering and encourage new collaborations.
2. The NQI should continue with science-first focus with added emphasis on fundamental engineering and foundational technology platforms to accelerate economic impact.
3. Congress should appropriate all authorized funds for agency contributions to QIS R&D.
4. Agencies should increase investment in research on quantum algorithms, software, and error correction.
5. SCQIS and NQCO should encourage greater collaboration among Federal agencies, including joint calls for proposals based on respective strengths.
6. Efforts should be made to streamline and homogenize interagency agreements to enable more efficient collaborations.

Key Recommendations

7. Efforts should be undertaken to simplify and limit procurement compliance regulations to make U.S. research more competitive.
8. Agencies should expand investment in small-scale and mid-scale infrastructure at more locations. This will benefit workforce development as well as research.
9. Agencies should fund single-PI and few-PI QIS research activities, as well as small-scale and large-scale Centers.
10. The DOE should develop a roadmap of critical isotope needs to guide further potential investment in support of QIS, as some isotope production takes 10 years to ramp up.
11. Agencies should establish a fundamental engineering center that focuses on the foundational technology platforms needed to build future machines with long term scientific goals and economic impacts.

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Workforce and Industry Subcommittee

Draft Findings and Recommendations

Jim Clarke (Co-Chair)
Grace Wang (Co-Chair)
Jamil Abo-Shaeer
Robert Schoelkopf
Krysta Svore

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Workforce and Industry Subcommittee Process

- Met weekly beginning January 3, 2023
- Interviewed and requested written responses from:
  - National Q-12 Educational Partnership
  - SCQIS Interagency Working Group on Workforce
  - QED-C and NIST
  - Immigration Attorneys
- Reviewed input, identified common themes, and discussed priorities for NQI 2.0
- Developed draft findings and recommendations for NQIAC feedback

Workforce Findings

1. A holistic, systematic study is critically needed to assess current and future quantum workforce needs and trends.
2. We anticipate a growing QIST industry, implying the current pipeline will not be sufficient to ensure U.S. leadership and competitiveness in coming years and decades.
3. QIST and QIST-related talent demand can be additionally met through cross-skilling of the existing STEM workforce and STEM talent pipeline.
4. More than half of doctoral students who graduated with QIST-relevant backgrounds are non-US citizens or non-permanent residents, which given U.S. STEM immigration policy places challenges on hiring and retaining STEM and QIST talent.

Workforce Recommendation for Data Collection

Workforce Recommendation 1

A holistic, systematic study of quantum workforce needs, trends, and education capacity should be conducted and monitored over the course of the next 10 years to ensure U.S. leadership in QIST and competitiveness in the burgeoning quantum industry.

Workforce Recommendations for QIST K-12 Education

Workforce Recommendation 2

The U.S. Government should accelerate the incorporation of core, fundamental quantum concepts into K-12 curricula via partnerships with education agencies at the state level to address policy barriers and the need to train educators.

Workforce Recommendation 3

A consolidated set of outreach programs should be developed, which would allow QIST researchers to tap into these programs for their “broader impacts” on federally-funded work, rather than independently creating new outreach programs.

Workforce Recommendation 4

The U.S. Government should assess the industry need and requirements for QIST vocational programs exists, including at the high school level.

Workforce Recommendations for Post-Secondary STEM Education

Workforce Recommendation 5

NSF and other relevant Federal agencies should leverage existing and new STEM education and outreach programs to create quantum talent at all degree levels.

Workforce Recommendation 6

The subcommittee endorses the recommendation in *Quantum Information Science and Technology Workforce Development National Strategic Plan* that agencies should take advantage of existing programs, and develop new ones as needed, that expand the range of institutions that can offer on-ramps to QIST jobs. The subcommittee recommended NSF create and/or fund more QIST graduate fellowships to increase the domestic student talent pool.

Workforce Recommendation 7

The subcommittee endorses the recommendation in the *Quantum Information Science and Technology Workforce Development National Strategic Plan*: "Agencies should look for ways to leverage graduate fellowships and undergraduate stipends to incentivize students to include QIST-related courses and research experiences in their educational pathway. For example, one could create a QuantumCorps scholarship program patterned after the successful NSF CyberCorps Scholarships for Service program."

Workforce Recommendation 8

The subcommittee recommended a coordinated effort to build quantum engineering courses, concentrations, and degree programs.

Workforce Recommendations for Immigration

Workforce Recommendation 9

The USG should increase the access to and the portability of visas and green cards for extraordinary QIST talent in a timely manner.

Industry Findings

1. The National Quantum Initiative (NQI) expanded the breadth of agencies involved in supporting and growing the U.S. QIST ecosystem.
2. The Federal Government plays a critical role in funding high-risk, high-impact QIST research, which is crucial for the Nation's leadership in building a quantum industry ecosystem and in enabling economic growth around the quantum industry.
3. In NQI 1.0, large, interdisciplinary QIST research centers have been established via partnerships across academia, national labs, and industry, supporting more fundamental research and stimulating more QIST R&D interest and visibility across the nation. To date, the transition from R&D to economic and commercial impact of QIST has been limited.
4. To stay at the forefront of QIST, it is critical that the U.S. focuses on accelerating QIS technology commercialization and the growth of the quantum industry, while balancing the issues related to immigration, export control, and R&D investment.
5. There is a tension between the goals of developing commercially-relevant and security-relevant QIST systems, and this tension impacts USG policymaking around research security protocols, immigration policy, export controls, funding authorization, and more.
6. A consortium of QIST industry members, QED-C, was formed to provide resources and coordinate partnerships. The majority of QED-C's membership consists of small companies and start-ups.

Industry Recommendations for Quantum Integration

Industry Recommendation 1

NQI 2.0 should develop economically-valuable and commercially-viable QIST systems and use cases by accelerating the R&D of small- and medium-sized quantum integrated systems, and the integration of quantum computing systems with the public cloud, through deep partnerships with industry.

Industry Recommendations for QIST R&D

Industry Recommendation 2

The U.S. Government and NQI should focus on supporting policies targeting economic security (i.e., support QIST R&D focusing on its economic and commercial capabilities, balancing with national security applications).

Industry Recommendation 3

The U.S Government and NQI should provide seed funding to quantum startup companies to help them mitigate risks at early stages and to go through “the valley of death.”

Industry Recommendation 4

The U.S. Government may serve as an early customer, adopter, and validator of quantum technologies via technology acquisition to ensure and accelerate the translation of QIST basic research into commercially-viable technologies and products in the U.S.

Industry Recommendations for Supply Chain

Industry Recommendation 5

The Federal government (perhaps Department of Commerce) should negotiate long-term contracts with U.S.-based suppliers of the shared components or infrastructure needed by the QIST industry.

Industry Recommendation 6

The US Government should explore the possibility of catalyzing bulk purchasing of critical equipment to enable discounted or prioritized fulfillment. A model with joint pooling of IP across industry might be explored to enable a bulk or discounted purchase or prioritized purchase of critical equipment or supply.

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Security and International Subcommittee

Draft Findings and Recommendations

Gilbert Herrera (Co-Chair)
John Preskill (Co-Chair)
James Clarke
Deborah Frincke
Mark Ritter
Robert Schoelkopf

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Briefings

From January – March 2023, the Subcommittee received briefings on:

- Research Security, Technology Control, International Cooperation (OSTP/NQCO)
- Technology controls for QIST (Commerce, State, NSA)
- QIST Research Security (FBI, QED-C)
- QIST Research Security
- Subcommittee on Economic Security Implications of Quantum Science (ESIX) (DoD, LPS)
- Migration to Post-Quantum Cryptography (NIST, NSA)
- Committee on Foreign Investment in the United States (CFIUS) (OSTP)
- International PhD students in QIST (STPI)

The Big Picture

***Quantum Information Science and Technology (QIST) is central to the national security and economic security of the United States*.**

Finding: Cryptanalytically capable quantum computers, once developed, could be used by adversaries to break widely used cryptosystems, creating a catastrophic vulnerability for commercial and national security information systems.

Finding: Quantum technology, as it matures, can confer a broadly beneficial economic impact on the world through potentially transformative advances in metrology, networking, information processing, materials simulation, and fundamental quantum science.

Recommendation 1: Maintain US world leadership in quantum science and in the development and deployment of related technologies by reauthorizing and enhancing the NQI Act.

Recommendation 2: **Strike an appropriate balance between accelerating progress and protecting technology developed by US universities, national laboratories, companies, and international partners from malign actors.**

Issues Considered by the Subcommittee

1. Migration to Post-Quantum Cryptography
2. Protecting Quantum Information Science and Technology
3. Cooperation with International Partners
4. Promoting International Talent in Quantum Information Science and Technology

Subcommittee on the Economic and Security Implications of Quantum Science (ESIX)

The National Science and Technology Council (NSTC) Subcommittee on the Economic and Security Implications of Quantum Science (ESIX) was established in 2022 to ensure that economic and security implications of QIS are understood across the agencies. The subcommittee provides a national security perspective to QIS related research. The ESIX Subcommittee coordinates with NSTC subcommittees, such as the SCQIS, to ensure that the economic and national security implications of basic research and development in QIS, along with derived technologies are fully understood. The subcommittee is co-chaired by the Office of Science and Technology Policy (OSTP), Department of Defense (DOD), Department of Energy (DOE), and the National Security Agency (NSA).

See: National Defense Authorization Act for Fiscal Year 2022

National Security Memorandum 10

National Security Memorandum 10 (NSM-10), signed in 2022, identifies steps to promote US leadership in quantum computing while mitigating risks to vulnerable cryptographic systems. NSM-10 directives include:

A. US Government agencies that fund research in, develop, or acquire quantum computers or related QIS technologies are to develop comprehensive technology protection plans (TPPs) to safeguard QIST research and development, acquisition, and user access.

B. NIST, in coordination with other agencies, will work with the private sector to address challenges posed by the transition to quantum-resistant cryptography (a.k.a. post-quantum cryptography = PQC).

C. NSA, in coordination with other agencies, will manage migration to PQC for national security systems.

Migration to Post-Quantum Cryptography

***Through an extensive and carefully vetted public competition, NIST has tentatively identified a suite of candidate PQC algorithms for standardization. Publication of standards is anticipated in 2024*.**

A. Algorithm selection balanced resistance to classical and quantum attacks with ease of use and flexible applications.

B. 2035 is the target date for migration of federal systems as directed by NSM-10. A similar schedule is recommended for migration of commercial systems. This timeline is aggressive but should be achievable through vigorous action by government and industry.

Finding: Even if cryptanalytically relevant quantum computers are still many years away, migration to post-quantum cryptography is urgent now, in view of the long time scale for the migration process, and because of concerns that communications captured now or in the near future could be decrypted by future machines.

Recommendation 3: Once the new standards are published, proceed expeditiously with migration to PQC in the public and private sectors. Provide appropriate resources to accomplish this task effectively, thoroughly, and efficiently.

Protecting Quantum Information Science and Technology

***Following the Export Control Reform Act of 2018 (ECRA) and NDAA for FY2022, a US Government interagency working group has been weighing protective measures that specifically target quantum computing technologies (components, systems, and peripheral equipment), but so far no explicit action has been recommended. US companies and allied nations have been engaged during this process*.**

A. Potential protective measures include export controls, reviewing foreign investments in the US that might threaten national or economic security, restricting access to sensitive technology by non-US persons, restricting collaborative research with international partners, steering US government research funding away from sensitive topics, requiring disclosure by researchers of potential conflicts of interest, building awareness of risks across academia, industry, government agencies, and international partners, taking corrective action for misconduct, etc.

B. Concern focuses especially on technological advances that might accelerate the development of large-scale quantum systems that could be extended to become cryptanalytically relevant.

C. Some existing export controls impact quantum computing technologies, though that was not their intent when initially established.

Protecting Quantum Information Science and Technology

D. ESIX, the interagency subcommittee on the Economic and Security Implications of Quantum Science makes policy recommendations and convenes and coordinates US agencies concerned with security aspects of QIST.

E. US Government discussions seek an appropriate balance between protecting sensitive technology from adversaries and facilitating QIST advances that will benefit the US and the world.

F. Export controls can be particularly burdensome for small companies and startups.

G. For a critical and emerging technology such as quantum computing, the US Patent system is problematic. Companies feel compelled to patent innovations to protect against litigation, but patent declarations can be very revealing to competitors and adversaries.

H. The undue administrative burden of meeting varying and emerging security and reporting requirements for US national laboratories, research universities, and companies continues to slow down progress in QIST.

I. The proper approach to protection should reflect the maturity level of the relevant technology. Quite different measures are appropriate depending on whether one believes that cryptanalytically relevant quantum computers are 5 years away or more than 20 years away. The committee believes that the longer time scale is more realistic.

Protecting Quantum Information Science and Technology

Finding: Steps to protect quantum computing technology should take into account the current immature status of the technology. Some risk of exposure is preferable to control measures that impede essential innovations that will be needed for QIST to fulfill its scientific and economic potential. Controls that significantly impede progress in QIST would be counter to the national and economic security interests of the US.

Recommendation 4: Implement measures to protect QIST only if they are clear, appropriately targeted, and compatible with the paramount goal of facilitating progress in QIST for the benefit of the nation and the world.

Recommendation 5: Frequently reassess the efficacy of protection measures as QIST advances. This review process (for example by ESIX) should entail thorough consideration of the balance between managing risk and impeding progress.

Recommendation 6: Work with international partners to establish measures for protecting QIST that are shared across countries. Avoid unilateral controls that impede our nation's QIST technology development and undermine US economic and national security.

Cooperation with International Partners

***Ongoing discussions with allies and partners aim to ensure a vibrant and secure international QIST ecosystem of collaborators and suppliers*.**

A. The US Government is exploring opportunities for international collaboration while also seeking mutual agreement with international partners on protective measures for sensitive quantum technology.

B. So far bilateral quantum cooperation statements have been signed with Japan, the United Kingdom, Australia, Finland, Sweden, Denmark, Switzerland, France, and the Netherlands.

C. The Quantum Economic Development Consortium (QED-C), established by NIST as directed by the NQI Act, has recently expanded to include companies and research institutions outside the US.

D. An effort involving NIST and QED-C is underway to identify critical technologies with an eye on protecting international supply chains.

E. Controls of quantum technology can interfere with collaborative research and development in other countries and can be particularly burdensome for US companies that conduct research activities outside the US.

F. Funding of international basic research projects by the Federal Government is handled by individual agencies rather than at the national level. NQCO, SCQIS, and ESIX oversee and coordinate these activities.

Cooperation with International Partners

Finding: International cooperation statements concerning QIST can accelerate research progress while also enhancing US national and economic security.

Finding: US efforts to act upon international quantum cooperation statements are currently hampered by inadequate funding.

Finding: Because companies around the world have capabilities that are critical for the QIST industry, reliable international supply chains are necessary for maintaining a healthy QIST ecosystem.

Recommendation 7: Provide new dedicated research funding to ensure that international collaborations with countries that have signed international cooperation statements are scientifically productive. Place negotiation and implementation of international cooperation statements under the leadership of an appropriate agency.

Recommendation 8: Task the appropriate agency in coordination with industry (perhaps through the QED-C) to develop and maintain a supply chain risk analysis for key QIST technologies. As QIST progresses, continually review and update measures to de-risk and secure international supply chains.

Promoting International Talent in QIST

Attracted by US scientific leadership and industrial opportunity, talented scientists and engineers from around the world flow to the US seeking education, training, and employment. Meanwhile, the QIST companies have rapidly growing needs for qualified technically trained people.

A. Students can work on many Federally funded QIST projects at US universities without regard to nationality, but may be blocked from working for US companies and laboratories after their training is complete.

B. Visa processing for postdoctoral researchers and industry hires (including applications for H-1 visas, O-1 visas, and Green Cards) often involves long delays. Industry is often hesitant to hire researchers without Green Cards when technology controls prohibit them from working in their skill area. Our nation is likely to lose top talent to other nations due to slow immigration processes.

C. Deemed export controls can prevent personnel from controlled countries from working on sensitive quantum technologies. Export licenses can allow such work, but this option is impractical because it is expensive, time-consuming, and not ensured to succeed. This path is especially burdensome for small and mid-sized businesses.

Promoting International Talent in QIST

Finding: Immigration policies hinder basic research in QIST and exacerbate the acute shortage of QIST talent needed by US companies.

Finding: Attracting and retaining more international talent in QIST will benefit US national and economic security.

Recommendation 9: Establish well-targeted immigration opportunities for international QIST students and workers who will bolster the US research effort and workforce in QIST.

Recommendation 10: Provide an expedited path to Permanent Residency for highly qualified and appropriately vetted QIST students and workers.

Summary of Recommendations

Recommendation 1: Maintain US world leadership in quantum science and in the development and deployment of related technologies by reauthorizing and enhancing the NQI Act.

Recommendation 2: Strike an appropriate balance between accelerating progress and protecting technology developed by US universities, national laboratories, companies, and international partners from malign actors.

Recommendation 3: Once the new standards are published, proceed expeditiously with migration to PQC in the public and private sectors. Provide appropriate resources to accomplish this task effectively, thoroughly, and efficiently.

Recommendation 4: Implement measures to protect QIST only if they are clear, appropriately targeted, and compatible with the paramount goal of facilitating progress in QIST for the benefit of the nation and the world.

Recommendation 5: Frequently reassess the efficacy of protection measures as QIST advances. This review process (for example by ESIX) should entail thorough consideration of the balance between managing risk and impeding progress.

Summary of Recommendations

Recommendation 6: Work with international partners to establish measures for protecting QIST that are shared across countries. Avoid unilateral controls that impede our nation's QIST technology development and undermine US economic and national security.

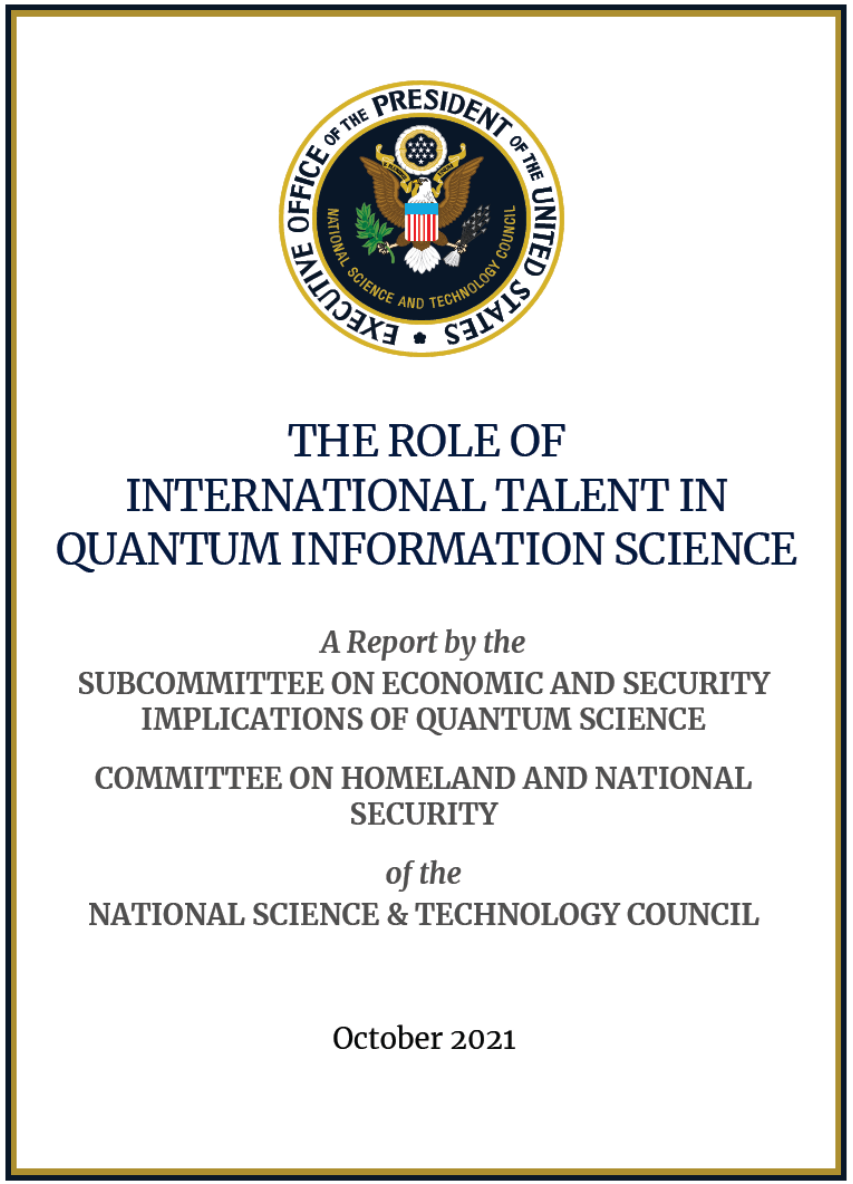
Recommendation 7: Provide new dedicated research funding to ensure that international collaborations with countries that have signed international cooperation statements are scientifically productive. Place negotiation and implementation of international cooperation statements under the leadership of an appropriate agency.

Recommendation 8: Task the appropriate agency in coordination with industry (perhaps through the QED-C) to develop and maintain a supply chain risk analysis for key QIST technologies. As QIST progresses, continually review and update measures to de-risk and secure international supply chains.

Recommendation 9: Establish well-targeted immigration opportunities for international QIST students and workers who will bolster the US research effort and workforce in QIST.

Recommendation 10: Provide an expedited path to Permanent Residency for highly qualified and appropriately vetted QIST students and workers.

Useful References



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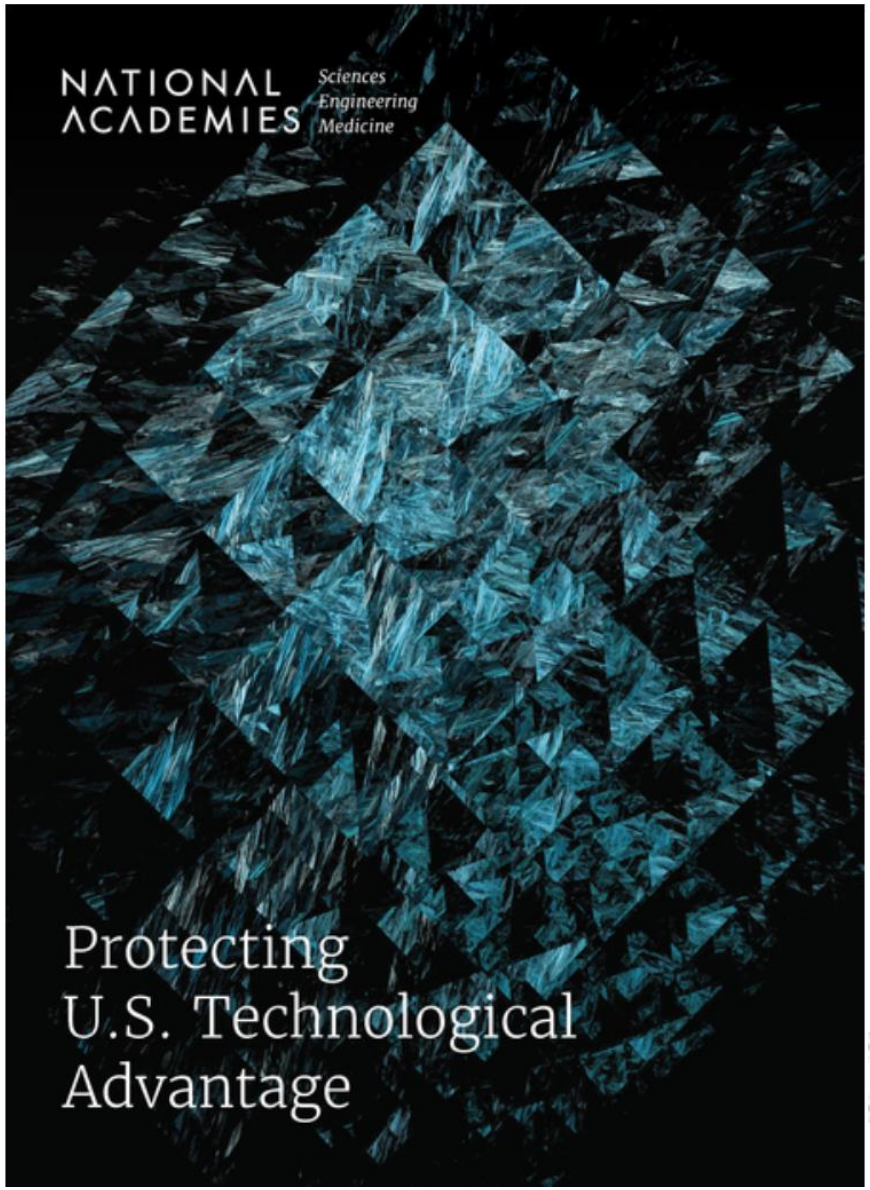

Agenda

Time (am EST)	Topic
9:00 – 9:15 (15 min)	*Opening* • Kathryn Ann Moler and Charles Tahan, NQIAC Co-Chairs
9:15 – 10:15 (1 hr)	*Science and Infrastructure Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
10:15 – 10:25 (10 min)	*Break*
10:25 – 11:25 (1 hr)	*Workforce and Industry Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
11:25 – 11:35 (10 min)	*Break*
11:35 – 11:40 (5 min)	*Remarks* • Asad Ramzanali, Chief of Staff, Office of Science and Technology Policy
11:40 – 12:40 (1 hr)	*Security and international Subcommittee Findings and Recommendations* • The subcommittee will brief the NQIAC on their draft findings and recommendations for deliberation.
12:40 – 1:00 (20 min)	*Discussion and Closing Remarks* • Kathryn Ann Moler and Charles Tahan, NQIAC Co-Chairs

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Highlights from the Draft Recommendations of NQIAC

- Reauthorize and enhance NQI 2.0 so that our nation can realize the economic and national security benefits promised by QIS technologies.
- Authorize and appropriate for a whole of government approach, including Centers, shared infrastructure, bilateral cooperations with other nations, and systems integration to take technologies from lab to market.
- Recognize the importance of appropriate national security controls - but don't sacrifice speed and discovery in emerging, pre-competitive or fundamental research.
- Enable workforce development through K-12 and beyond by investing in STEM education for Americans, conducting ongoing studies to determine quantum workforce needs and trends, offering competitive fellowships for graduate study targeting both US citizens and (with appropriate vetting and visas) international scholars, and expediting visas in some cases.

National Quantum Initiative Advisory Committee

March 24, 2023

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