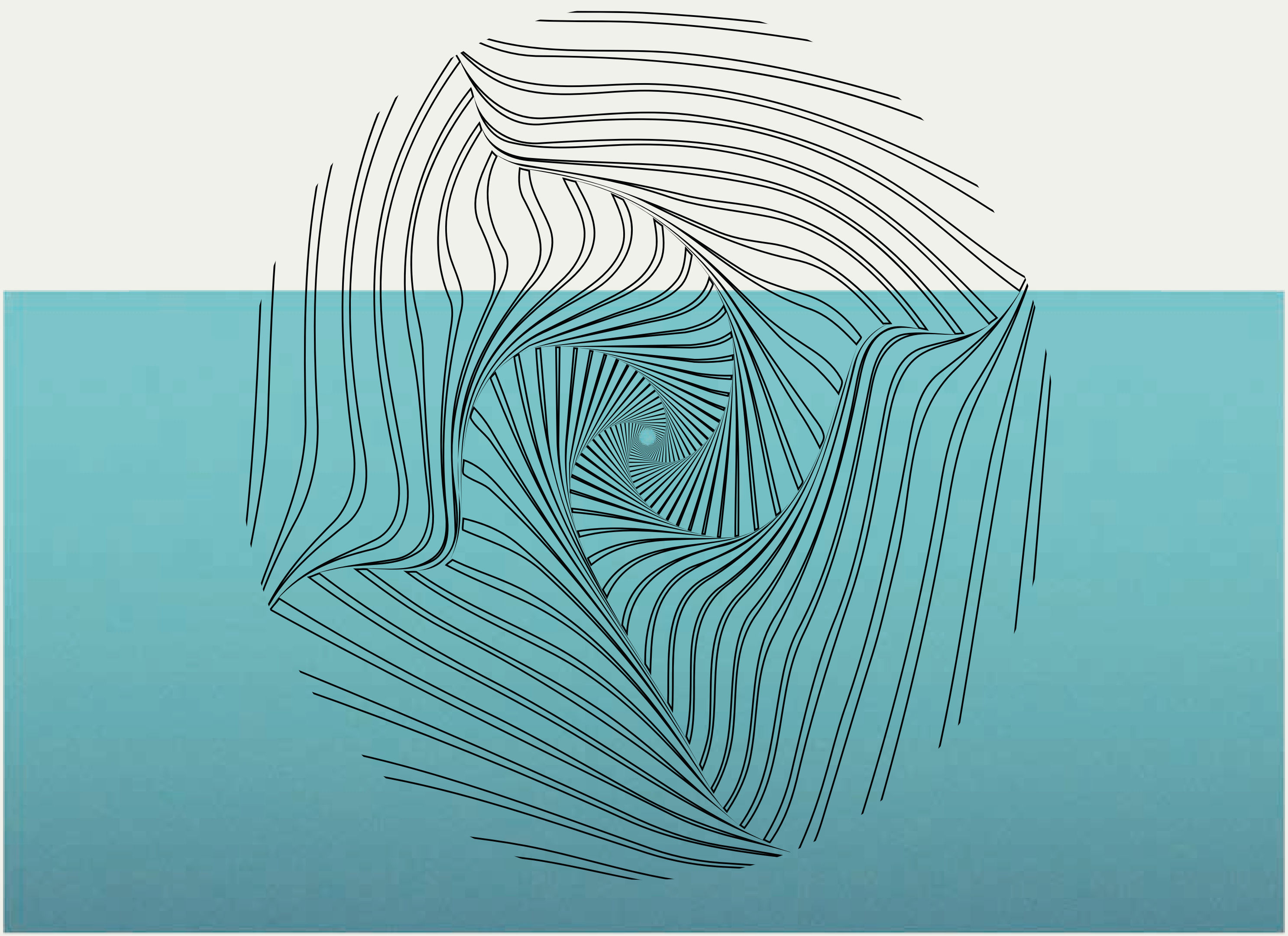
CHICAGO QUANTUM EXCHANGE

Barnes & Thornburg

THE QUANTUM LAW NAVIGATOR



Navigating U.S. Policies, Laws, and Regulations to Advance the Quantum Economy

About the Quantum Law Navigator

What is it? The Quantum Law Navigator is a two-part, ten-chapter report that maps the U.S. policy, legal, and regulatory landscape shaping the quantum industry. It provides clear, practical analysis of four cross-cutting challenges—national security, funding, workforce, and supply chain—to help organizations translate complex rules into actionable strategy.

Who should read it? Leaders and practitioners across the quantum ecosystem—including founders, executives, investors, in-house counsel, and researchers—who need to navigate U.S. legal frameworks to accelerate technology development, commercialization, partnerships, and growth.

Who created it? The Chicago Quantum Exchange and Barnes & Thornburg LLP, with support from leading legal and quantum technology sector advisors.

The Chicago Quantum Exchange is an intellectual hub in Illinois, Wisconsin, and Indiana that advances quantum research, builds the future workforce, and drives the quantum economy by connecting leading universities, national labs, and industry partners. The CQE leads two federal grant initiatives driving national impact: the US Economic Development Administration–designated Bloch Quantum Tech Hub, which is focused on scaling regional assets to compete globally in future industries, and a National Science Foundation Regional Innovation Engines (NSF Engines) Development Award aimed at deepening partnerships and strengthening workforce development plans to drive quantum-enabled security.

Barnes & Thornburg LLP is one of the largest law firms in the United States, known for its broad national reach and deep bench of attorneys across key practice areas. With offices spanning major U.S. cities, the firm represents clients ranging from startups to Fortune 500 companies, government entities, and nonprofits. Its work covers corporate law, litigation, intellectual property, labor and employment, real estate, and regulatory matters, with particular strengths in highly regulated industries such as technology, healthcare, life sciences, and energy. With a focus on combining sophisticated legal knowledge with practical, business-oriented advice, Barnes & Thornburg is recognized for its ability to help clients navigate complex legal challenges while advancing their strategic goals.

Executive Summary

Quantum technologies are reaching commercial utility and, beginning in the next decade, could reshape how we fight disease, run our cities, secure our data, protect the energy grid, guide ships and airplanes, combat fraud, and defend our country. But this transformative potential also complicates the sector's interactions with legal frameworks, leading to layers of laws and regulations that can impede stakeholders' access to global talent, foreign equipment, public funding, and more.

These challenges grow from quantum's long and uncertain development timelines, scientific complexity, and relevance to national security. Scientists and technologists do not always understand the law, and lawmakers and lawyers do not always understand the science. This disconnect could hinder the development of a robust, sustainable US quantum economy by favoring large institutions that can afford legal teams while discouraging smaller, less-resourced institutions and innovators. If left unaddressed, this disparity could lead to concentration in the quantum market, limiting which innovations reach the public. Ultimately, the lack of diffusion through the US economy could cost the nation its global leadership.

To help address this, the Chicago Quantum Exchange partnered with Barnes & Thornburg LLP to develop the Quantum Law Navigator, a report that helps equip universities, startups, established companies, investors, and policymakers with the tools they need to begin to understand the complex intersection of quantum innovation and legal regimes.

The Navigator has two key aims. The first is to serve as a foundation for critical dialogue between the quantum technology and legal communities by laying out the ways in which the quantum sector interacts with the law, identifying pain points, and mapping out opportunities. These conversations will be key to guiding adaptations that lead to responsible, productive growth. The second is to level the playing field by offering an introductory tool for quantum stakeholders of all types, sizes, and means.

HOW TO USE THE QUANTUM LAW NAVIGATOR

The Navigator is divided into two sections corresponding to these aims.

Part I (Chapters 1 and 2) provides the framework for dialogue between the quantum and law sectors. It is about 10 pages. This section lays out the arguments for bridging the quantum-law gap and examines the US policies, laws, and regulations that impact the sector. These laws are presented through the lens of the four core challenges faced by nations building a quantum economy. Many of the policies, laws, and regulations flow from or are related to these core challenges. They are: (1) Safeguarding national security while fostering quantum innovation; (2) Securing adequate funding for quantum innovation; (3) Confronting the shortage of skilled quantum professionals essential for sustained progress; and (4) Mitigating supply chain vulnerabilities.

This section is the recommended starting place for anyone who wants to understand how the law and quantum interact and why better aligning the two will strengthen the US economy and advance US leadership in quantum technology.

Part II (Chapters 3 through 10) is a tool that users should reference as needed, turning to the sections they most need at any given time. It is organized by eight key legal concepts: Intellectual Property (Chapter 3), Export Controls (Chapter 4), Foreign Investment Controls (Chapter 5), America First Trade Policy and Tariffs (Chapter 6), Global Talent and Immigration (Chapter 7), Government Funding (Chapter 8), Venture Capital (Chapter 9), and Managing Financial Risk (Chapter 10). Each chapter begins by highlighting why the area matters to the quantum sector, then digs into compliance and other details before concluding with key considerations to guide strategy. Recent developments and other key points are called out in boxes throughout the chapters.

This section is for the startup company that needs to know where to begin when it comes to venture capital or wonders whether it is too early to file for a patent. It is for the researcher who needs to understand the obligations associated with government funding or whether she should segment data storage now that she has an international student working in her lab. It is for the company struggling to import critical components, the innovators concerned about their confidential assets in the case of bankruptcy, and the quantum employers trying to make sense of visa and immigration requirements. Ultimately, it is for any quantum stakeholder who needs a starting point for understanding specific issues related to laws, regulations, and compliance.

A LIVING DOCUMENT

The Quantum Law Navigator, while relevant for longer term use, reflects U.S. law as of October 17, 2025. The Quantum Law Navigator is intended as a first edition and the start of a larger initiative. This is an important and fast-evolving topic, and there will be more to examine and unpack in the coming months and years. We encourage readers to visit https://chicagoquantum.org/quantum-law-navigator and subscribe to receive updates on the Quantum Law Navigator project. We welcome ideas and feedback. Please reach out to the QLN team at QLN@uchicago.edu.

Foreword

When DeepSeek shocked the global AI community in January 2025, the quantum technology community took notice as well. The little-known Chinese startup company had released an unexpectedly efficient, low-cost chatbot that raised serious questions about the United States's ability to beat China in the race for technological superiority. It also underscored some salient lessons. First, breakthroughs can come from anywhere or anyone. A tiny startup in Indiana might finally build a working quantum repeater and open the door to the quantum internet. Second, we cannot know whether an unexpected innovation will advance the public good, threaten it, or do both, depending on who uses it. We should assume dual-use developments such as quantum-enabled decryption could arrive at any time, even if conventional wisdom says they remain years away.

Interestingly, both of these possibilities demand a similar response, at least in part: we must close the gap between quantum technology and the law, and we must do it soon. Laws and regulations that aim to keep hostile actors from acquiring quantum technology can create barriers to innovation. We can reduce those barriers by helping scientists understand the law and helping lawyers understand the science. We also must ensure the law is ready for the novel scenarios that may accompany the emergence of a powerful new technology. Again, we can best address this by connecting the quantum technology sector with lawyers, lawmakers, and policymakers, and creating channels for open dialogue.

> **"Bridging these worlds is not easy. Scientists and lawyers operate in different spheres and speak what can feel like different languages. ... [but] we cannot afford to delay conversations about how quantum technologies and the law interact."**

Bridging these worlds is not easy. Scientists and lawyers operate in different spheres and speak what can feel like different languages. I admit I would rather focus on protein qubits and entanglement swapping than worry whether a conversation qualifies as a "deemed export." But I do not have a choice; if I want to pursue the international collaborations that drive scientific advancement, I must understand the rules. Fortunately, I work at a large university with access to legal counsel. Not all scientists share this advantage, and that disparity can limit contributions when the sector needs all hands on deck.

Imagine that a promising researcher at a small institution inadvertently violates export control laws and derails work headed toward a breakthrough. Or consider that regulators might make rules governing foreign hiring, investment, and sensitive technology imports so complex that only the largest, richest quantum companies survive. Concentration, as we know, often stifles innovation. And what if that concentration were to extend to end users, with only the largest companies able to adopt the technologies? That would hinder the widespread diffusion that drives economic impact and global competitive advantage. On the flip side, imagine quantum-enabled decryption arriving before protective post-quantum cryptographic (PQC) algorithms are in place—and imagine that the U.S. lacks the legal guardrails to prevent inventors from sharing that innovation widely.

The truth is, we cannot afford to delay conversations about how quantum technologies and the law interact. For this reason, the Chicago Quantum Exchange partnered with Barnes & Thornburg to develop the Quantum Law Navigator, a report that helps equip universities, companies, investors, and policymakers with the tools they need to begin to understand the complex intersection of quantum innovation and legal regimes. Barnes & Thornburg lawyers with deep knowledge in export controls, intellectual property, government grants and contracts, private funding, immigration, and more offer clear explanations of the laws and how they apply to quantum technology.

We launched the Quantum Law Navigator project in April 2025 with a panel discussion at the University of Chicago Law School, and it aligns with the mission that drove the creation of the CQE at UChicago more than eight years ago. That mission focuses on the development of deep partnerships to seed and develop a Midwest quantum ecosystem that will advance quantum research, expand the workforce, and drive economic growth. Since the CQE launched, our cross-sector community has worked together to ensure widespread participation in the national quantum ecosystem by launching a quantum startup accelerator, bringing cross-sector coalitions together through the U.S. Economic Development Administration-designated Bloch Quantum Tech Hub and a National Science Foundation Regional Innovation Engines Development Award, and building programs to scale the future quantum workforce. These efforts strengthen U.S. leadership in quantum technologies by identifying key gaps and galvanizing Midwest assets to address them. The Quantum Law Navigator marks the latest step in that mission by providing critical tools for the quantum technology sector and laying the foundation for scientists, business leaders, lawyers, lawmakers, and others to engage in dialogue that will shape our quantum future.

David Awschalom
Liew Family Professor of Molecular Engineering and Physics at the University of Chicago;
Founding Director of the Chicago Quantum Exchange;
and Senior Scientist at Argonne National Laboratory

November 3, 2025

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Acknowledgements

CHAIRS

David Awschalom
Liew Family Professor of Molecular Engineering and Physics, University of Chicago;
Senior Scientist, Argonne National Laboratory;
Director, Chicago Quantum Exchange

Kate Waimey Timmerman
Chief Executive Officer of the Chicago Quantum Exchange

EDITORS-IN-CHIEF

Robert W. Karr, Jr.
Partner, Chicago
Quantum Technology Industry Group Co-Chair
Barnes & Thornburg LLP

Becky Beaupre Gillespie
Senior Director of Communications and Strategic Reporting
Chicago Quantum Exchange

ADVISORS

Aziz Huq
Frank and Bernice J. Greenberg Professor of Law
The University of Chicago

Celia Merzbacher
Executive Director,
Quantum Economic Development Consortium

Hannah Parnes
Head of Policy, EeroQ

ADDITIONAL CONTRIBUTORS

Jean-Luc Cambier
Regional Innovation Officer
The Bloch Quantum Tech Hub and the Chicago Quantum Exchange

Andrew Grotto
Research Scholar, Center for International Security and Cooperation; Director, Program on Geopolitics, Technology, and Governance
Stanford University

Lior Strahilevitz
Sidley Austin Professor of Law
The University of Chicago

Thelma Tennant
Assistant Vice President, Corporate Engagement
The University of Chicago

BARNES & THORNBURG LLP

Luis Arandia
Partner, Washington D.C.
Quantum Technology Industry Group
International Trade Law and Regulations

Drew Bader
Associate, New York
Quantum Technology Industry Group
Emerging Companies & Venture Capital

Michael Carrillo
Partner, Chicago
Quantum Technology Industry Group Co-Chair
Intellectual Property

Scott Carter
Associate, Ann Arbor
Quantum Technology Industry Group
Emerging Companies & Venture Capital

Thomas Donovan
Partner, Chicago
Quantum Technology Industry Group
Intellectual Property

Pia Dorn, Ph.D.
European Transaction Specialist, Chicago
Quantum Technology Industry Group

Sophi J. Gorman
Associate, Minneapolis
Quantum Technology Industry Group
Emerging Companies & Venture Capital

BARNES & THORNBURG LLP *continued*

Mark Hagedorn
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Mikaela Heck
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Kenneth Kansa
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Martin Montes
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Quantum Technology Industry Group Co-Chair
Government Relations

Joe Morrison
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Emerging Companies & Venture Capital Chair

Tejas Shah
Partner, Chicago
Quantum Technology Industry Group
Immigration

Timo Rehbock
Partner, Chicago and New York
Quantum Technology Industry Group
European Practice Group Chair, Logistics and Transportation Chair

***Robert Weiss**
Partner, Chicago
Quantum Technology Industry Group
Information Technology

Clinton Yu
Partner, Washington D.C.
Quantum Technology Industry Group
International Trade Law and Regulations

*indicates member of the editing team

EDITORS

Meredith Fore
Science Writer
Chicago Quantum Exchange

Julie Johnson
Senior Manager, Client Solutions
Barnes & Thornburg LLP

Cory Zwolinski
Senior Trade Specialist
Barnes & Thornburg LLP

PRODUCTION

Cover art: **Nick Wright**

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PART I
CHALLENGES, POLICIES, AND IMPACTS

1 | Bridging the Quantum - Law Gap

1.1 THE PROMISE OF QUANTUM TECHNOLOGIES

Quantum information science and technology (QIST) harnesses the properties of matter at nature's smallest scales to unlock capabilities far beyond today's classical technologies. Beginning as early as the next decade, these innovations could reach commercial utility and reshape industries, economies, and societies, with the ultimate potential to shift the global balance of power.

Quantum technologies already support very early, highly specialized applications. Quantum sensors, which are beginning to enter the market, enable the detection of minute environmental changes and deliver unprecedented accuracy in navigation, imaging, and measurement, with current and future applications ranging from defense and climate monitoring to early disease detection and GPS-free navigation. Quantum computers, which some predict could reach commercial utility within five to ten years, may solve once intractable optimization, measurement, and cryptographic problems, revolutionizing sectors from pharmaceuticals to finance. Quantum communication technologies, already in experimental use in Illinois, Massachusetts, Tennessee, and elsewhere, may someday offer nearly perfect information security through entanglement-based networks that immediately break when eavesdropped upon, providing resilience in an era of escalating cyber threats. Quantum networks could also amplify quantum sensing and computing innovations by enabling secure, distributed systems for both.

This vast transformative potential sparks dedicated efforts worldwide, with a growing number of countries investing millions or even billions of dollars in comprehensive initiatives aimed at accelerating QIST and securing global leadership. Although the commercialization timeline varies by application—with quantum computing generally recognized as the furthest out—the QIST sector is now at a pivotal point with initial deployment already underway. NASA has begun using quantum sensors to precisely measure gravity, magnetic fields, and other forces aboard the International Space Station, and in 2024 Boeing completed the world's first recorded flight using multiple quantum navigation systems instead of GPS. Quantum computing companies have shifted toward revenue generation; the leading QC companies have road maps toward scalable universal quantum computers, according to McKinsey's June 2025 Quantum Technology Monitor. Expanded commercialization is expected over the next decade, with total quantum economic value creation projected to grow to nearly $1 trillion by 2035 from about $3 billion today, according to a Boston Consulting Group analysis for the CQE. By 2040, we could see widespread economic integration, with quantum technologies transforming entire industries and everyday life.

Realizing these ambitions, however, requires confronting several vexing core challenges—such as building a domestic supply chain, scaling the quantum workforce, and navigating funding constraints—while simultaneously aiding QIST stakeholders as they navigate the evolving thicket of laws and regulations that grow from these challenges. Points of friction are already emerging. Laws that advance national security often stifle quantum innovation, which itself is essential to national security—creating a conflict without an easy answer. Laws will need to adapt to new technological capabilities, too, both in ways that are already apparent and in ways that have yet to surface.

These efforts cannot wait. Governments and institutions must start working now to align legal frameworks with the accelerating quantum technology landscape to ensure the resilience of the quantum economy—and they must do so in a coordinated and even manner.

In the United States, QIST stakeholders arrive at this pivotal juncture with different tools and at different times. They may stumble into their first patent question, run afoul of deemed export rules that prohibit certain discussions with foreign researchers, or encounter a tangle of rules that impede the acquisition of essential components and materials. Large, well-funded research institutions and companies can retain legal teams, but smaller, less-resourced stakeholders often cannot. Compliance remains costly, confusing, and often discouraging for both groups. The Quantum Law Navigator aims to mitigate this potential chilling effect to ensure that it does not threaten the sector's reach across the domestic economy and, in turn, jeopardize the global leadership the United States has sought to build.

Members of the emerging quantum economy need a common language to understand how legal frameworks intersect with their sector, both to ensure the continued development of their innovations and to clear the way for critical dialogue. If stakeholders do not know how to discuss a shared challenge, they will struggle to address it. The same holds for lawyers and policymakers, especially given the inherent complexity of quantum information science, a field few of them fully understand. That knowledge gap slows efforts to evaluate how fast-changing rules on imports, exports, immigration, and more apply to this equally fast-changing technology.

Creating a common language to unite quantum technologists and lawyers matters globally, too. QIST could upend existing scientific paradigms, generate trillions of dollars in economic value, and reshape global influence. That potential has sparked a worldwide race for technological supremacy even as the need for science-first international collaboration continues. This race brings serious risks, including heightened geopolitical tensions that pressure states caught in the middle; uneven development that leaves some countries economically, technologically, and militarily vulnerable; and the opportunity costs of government limitations on international collaboration.

1.2 ACHIEVING U.S. LEADERSHIP IN QUANTUM

Nations around the world have spent an estimated $56.7 billion USD developing quantum technologies, with China widely regarded as the largest spender at $15.3 billion USD, according to 2025 estimates from QURECA, a UK-based quantum workforce and business development company. QURECA estimates quantum spending at $7.91 billion USD by Japan; $7.67 billion by the United States; $5.49 billion USD by the UK; $3.45 billion USD by Germany; $2.14 billion USD by South Korea; and $1.9 billion USD by Canada. Meanwhile, a growing number of countries and regions have adopted formal national strategies to coordinate and accelerate their QIST efforts, with the UK announcing their first more than a decade ago.

The United States, which was instrumental in launching the quantum revolution through decades of spending on foundational quantum research in universities and national labs, launched its national strategy in 2018 with the National Quantum Initiative (NQI). The NQI Act established a coordinated federal program to accelerate quantum research and development, channeling significant resources and fostering partnerships among universities, national labs, and a dynamic private sector. Four years later, the CHIPS and Science Act amended the NQI Act, authorizing expanded investments in applications-focused research, workforce development, and critical infrastructure and standards. Individual U.S. states, including Illinois, Colorado, Maryland, and New Mexico, are also fueling QIST growth through appropriations, tax incentives, and other measures.

Alongside these domestic investments, the United States has deepened its international cooperation with allies such as Canada, the United Kingdom, European Union members, Japan, South Korea, India, and Australia to pool resources, harmonize standards, and strengthen supply chains. Although difficult, this collaboration is essential to accelerate breakthroughs, ensure interoperability, and address the security and ethical risks of quantum information science and technology. At the same time, strategic rivalry, most notably between the U.S. and China, has driven tighter export controls, curtailed scientific exchange, and threatened to fracture the innovation ecosystem into competing blocs. The drive to quantum leadership forms an integral part of Beijing's broader competition with Washington. China's state-driven approach, exemplified by milestones such as Micius (the world's first quantum communication satellite), leverages vast domestic investment and selective international partnerships with U.S. adversaries such as Russia.

To build a robust quantum economy and avoid ceding quantum leadership, the United States must accelerate domestic QIST progress while carefully managing technology transfer risks that could aid strategic competitors. It must also cultivate a quantum economy that promotes the broad adoption of quantum technologies across sectors and regions. As political scientist Jeffrey Ding notes, scientific breakthroughs constitute only part of technological power; true global success depends on "domestic diffusion"—the ability to integrate new technologies throughout the entire economy. Complexity, long and uncertain deployment timelines, and national security sensitivities set quantum apart from other technologies and can lead to legal and policy hurdles that limit the sector's positive impact on productivity and growth. To address this, the U.S. should focus on pairing research excellence with policies that lower barriers to adoption, expand workforce pipelines, enable interoperable and secure infrastructure, and ensure that small and medium-sized enterprises, public institutions, and all communities can meaningfully participate in and benefit from quantum advances. One avenue to broad participation is ensuring that QIST stakeholders, regardless of size, are able to understand and comply with relevant laws.

1.3 NAVIGATING THE POLICY AND LEGAL LANDSCAPE

Nations face many of the same hurdles in building a durable quantum economy. Although the list is long, it converges on four core challenges:

1. Safeguarding national security while fostering quantum innovation;
2. Securing adequate funding for quantum innovation;
3. Solving the growing shortage of skilled quantum professionals essential for sustained progress; and
4. Mitigating supply chain vulnerabilities.

Each nation sets its own approach to these challenges based on its own priorities, resources, and geopolitical context, which makes the path to success both highly competitive and rife with trade-offs. How we contend with these challenges will shape not only national outcomes but also the global trajectory of quantum technology.

Viewing quantum policies, laws, and regulations through the lens of these four core challenges offers a useful framework for understanding their purpose and practical application. Legal regimes that govern the QIST sector can be very complex because they serve high-stakes policy goals, and they often fail to fully align with the rapidly changing technological landscape. New technologies, such as artificial intelligence, have caught regulators unprepared and tested existing legal precedent. This is likely to continue as quantum technologies enter the market, raising questions such as how to apply intellectual property protections to quantum algorithms. Technology typically evolves more quickly than the law, and those developing the technologies are not necessarily trained to avoid legal pitfalls or navigate dense compliance requirements.

In addition, aligning legal frameworks across borders is a significant need and challenge. A lack of global harmonization can weaken and disrupt complex supply chains, slow innovation, lead to gaps in information security, and complicate market adoption. The U.S. federal system adds a layer of complexity, too. While the U.S. government continues to provide strategic direction for national quantum initiatives, subnational budget appropriations, state statutes, and municipal ordinances also have significant influence on the quantum innovation landscape. Subnational measures can serve as catalysts for quantum development, but they also introduce an additional regulatory layer. The existence of a patchwork of rules that differ widely in scope, maturity, and enforceability may affect where quantum enterprises choose to locate, allocate capital, attract and retain talent, and manage risk.

1.4 THE QUANTUM LAW NAVIGATOR

The Quantum Law Navigator lowers barriers to full participation in the quantum economy by providing U.S. stakeholders information and logistical considerations as they seek to navigate complex, sector-relevant laws and policies, and to encourage adoption of U.S.-sanctioned quantum standards. This effort begins with a grounded understanding of the distinct policy, legal, and regulatory framework relevant to QIST, which helps industry participants identify compliance issues, reduce transaction costs, and accelerate broad-based yet secure adoption of quantum technology across the economy.

Part I of the Quantum Law Navigator examines the four core challenges, links each to relevant policies, laws, and regulations, explores their impact on stakeholders, and previews navigation strategies.

Part II details navigation strategies in chapters organized by key legal concepts: Intellectual Property (Chapter 3), Export Controls (Chapter 4), Foreign Investment Controls (Chapter 5), America First Trade Policy and Tariffs (Chapter 6), Global Talent and Immigration (Chapter 7), Government Funding (Chapter 8), Venture Capital (Chapter 9), and Managing Financial Risk (Chapter 10).

2 | Four Core Quantum Challenges

The global race to harness quantum science is reshaping the landscape of technological competition and national power. As governments strive to transform quantum potential into real-world advantage, they confront a shared set of formidable challenges. These challenges will ultimately determine the contours of global leadership, influence, and cooperation in the quantum era, as well as when, or even whether, we realize the sector's true technological and economic potential.

Though diverse, these challenges converge on four critical themes: (1) national security dilemmas that arise from quantum's dual-use capabilities (i.e., military and civilian), which both empower and threaten; (2) the immense financial commitments required to develop, scale, and sustain quantum technologies; (3) a persistent shortage of highly skilled talent needed to advance, implement, and secure QIST; and (4) vulnerabilities in global supply chains that expose nations to risks from dependence on foreign sources for essential components and raw materials.

Many stakeholders in the U.S. quantum ecosystem have already faced these challenges to some degree, for example by enduring lengthy hiring processes for specialized talent, struggling to secure essential and often scarce components, or grappling with the intricate and evolving rules that govern access to public funding. The difficulty of finding reliable resources and guidance on the complex web of laws and regulations applicable to the industry only serves to exacerbate these struggles. In addition to these four challenges, stakeholders must grapple with the patchwork system of laws, both among countries and, in the US, among states; the need to prepare for future adversarial use; and questions surrounding responsible development—all issues rife for exploration in future iterations of the Navigator.

Policy choices that address these challenges reflect each nation's industrial base, research ecosystem, fiscal capacity, and geopolitical posture. And choices that leaders make in response to one challenge can impact others. For example, actions that strengthen security can dampen international collaboration. Incentives to speed commercialization may widen regional or sectoral gaps. Efforts to set global standards can erode national leverage. Difficult trade-offs will define the path forward, and strategic judgment will matter as much as technological breakthroughs.

This chapter aims to serve as a general roadmap for stakeholders at all levels. It highlights the key laws and regulatory frameworks related to each major challenge; explains their practical implications for QIST researchers, companies, investors, and policymakers; discusses ways in which these laws may differ when applied to sensitive technologies such as QIST; and directs readers to relevant chapters within the Quantum Law Navigator.

CHALLENGE 1
Safeguarding National Security While Fostering Quantum Innovation

As the United States builds a competitive quantum economy, it faces one of its most complex challenges: safeguarding national security while keeping the path to quantum innovation open. The U.S. approach emphasizes deep research investment, agile public-private partnerships, and targeted international cooperation alongside robust security measures. These policies operate to protect sensitive technologies and prevent illicit transfers. They also require compliance with overlapping legal regimes that can dampen cross-border collaboration and slow scientific progress.

U.S. law shapes how researchers, startups, and industry partners engage foreign collaborators, source critical components and materials, secure financing, and share and protect data. Proactive compliance is essential. In academia, institutions may require additional review for a co-authored paper, and laboratories may delay a visiting scholar's access. In the private sector, regulators may impose burdensome controls when companies export products or technical data, and authorities may require governmental review when a startup raises capital from foreign investors. Failure to anticipate and comply with applicable rules can be fatal.

Heightened scrutiny of the cross-border movement of goods, capital, information, and talent connected to sensitive quantum technologies creates the most common pressure points. Because national security interests underpin these controls, we address them throughout the Quantum Law Navigator, including in sections applicable to global talent, funding, and supply chains.

Navigating the law: What quantum stakeholders may need to know

Due to U.S. national security interests in quantum, sector stakeholders could confront legal restrictions in the following areas:

- **Patent filing requirements.** When seeking patent protection for quantum technologies, businesses should weigh disclosure risks and government restrictions designed to safeguard sensitive technologies against the requirements of filing jurisdictions. International treaties, such as the Patent Cooperation Treaty (PCT), enable a streamlined path to global protection of inventions by preserving priority and deferring country-by-country decisions. But because export controls may cover quantum innovations, companies would be smart to implement additional compliance safeguards before filing abroad or under the PCT. More specifically, industry participants seeking a patent should determine the export-control status of their product, secure any required foreign filing licenses, assess the risk of secrecy orders, and coordinate with counsel experienced in both patent and export-control law. These steps help to ensure compliance with all applicable laws and protect valuable patent rights worldwide. ***(See Chapter 3, "Intellectual Property Rights and Protections.")***

- **U.S. export regulations.** Export Administration Regulations (EAR) govern the export, reexport, and transfer of "dual-use" items, which are technologies with both civilian and military applications. International Traffic in Arms Regulations (ITAR) control the export of defense-related articles and services, which can include certain quantum technologies specifically designed for military use. For QIST stakeholders, these regulations may require registration or licensing, the implementation of internal compliance programs around risk assessment, training, screening, auditing, and more—including compliance with "deemed export" rules that govern information shared with foreign nationals. ***(See Chapter 4, "Export Controls.")***

- **Foreign investment review.** The Committee on Foreign Investment in the United States (CFIUS), an interagency body, reviews and, when needed, blocks or mitigates foreign investments in U.S. companies that develop or possess critical technologies, including those in the quantum sector. Companies seeking foreign investors must track investors and partners, report certain deals to CFIUS, and ensure their products comply with export controls. They also may need to restrict access to sensitive information. These requirements increase legal and administrative costs and also influence decisions about where to build, whom to partner with, and how to secure operations. This process can build investor trust, but it takes time and resources. As a result, some companies have shifted from overseas partnerships to U.S.-based collaborations. ***(See Chapter 5, "Foreign Investment Controls.")***

- **"Reverse" foreign investment review.** The U.S. Outbound Investment Program, a U.S. Treasury initiative effective January 2025 (often called "Reverse CFIUS"), screens outbound investments by U.S. persons involving specified national security technologies, including semiconductors, microelectronics, and quantum technologies, in countries of concern, including China. This screening places additional constraints on investors in companies in the quantum sector and can exacerbate inequalities by favoring stakeholders who know how to navigate the rules, enabling them to unlock government customers, attract blue chip investors, and mitigate risks. ***(See Chapter 5, "Foreign Investment Controls.")***

- **The America First Trade Policy and tariffs.** The America First Trade Policy, renewed in 2025, imposes tariffs to strengthen U.S. technological leadership and national security, with the aim of reshoring manufacturing and reducing reliance on foreign suppliers. Tariffs on components essential to quantum, like ultra-pure metals, precision optics, and advanced electronics can result in higher costs, potential supply chain disruptions, and increased compliance burdens for quantum manufacturers, whether startups or more established companies, and research labs. Although these measures aim to protect intellectual property and secure domestic supply chains, they may also make it harder for quantum companies to source alternatives and manage rising costs. For example, quantum computing firms now pay higher import duties on specialized cryogenic equipment and high-frequency microwave components that are critical for quantum processors, which results in increased production expenses, longer lead times, and the need to identify new suppliers. ***(See Chapter 6, "America First Trade Policy and Tariffs.")***

- **Immigration rules.** The Immigration and Nationality Act (INA) is the foundational body of law that governs immigration and citizenship in the United States. It establishes a framework for all visa categories, permanent residency, and naturalization. To attract and retain foreign talent, quantum stakeholders must track changing immigration measures, maintain strong records, build flexible strategies, coordinate across departments, educate human resources staff, and support international employees. ***(See Chapter 7, "Global Talent and Immigration."***)

- **Buy American Act restrictions.** Companies that develop, manufacture, or supply quantum technologies and seek U.S. government funding or contracts must ensure their products meet strict U.S. domestic content requirements under the Buy American Act. This obligation requires planning supply chains and documentation accordingly and preparing to seek waivers if compliance is not feasible. Meeting these requirements is essential for eligibility and competitiveness in federally funded quantum projects. ***(See Chapter 8, "Government Funding.")***

- **Post-quantum cryptography requirements.** The National Institute of Standards and Technology (NIST) has mandated post-quantum cryptography (PQC) measures that apply to U.S. federal agencies and their contractors. NIST also recommends these measures for any organization concerned with long-term data security, including critical infrastructure and supply chain vendors. ***(To learn more about PQC standards, visit https://www.nist.gov/cybersecurity/what-post-quantum-cryptography.)***

CHALLENGE 2
Securing Adequate Funding for Quantum Innovation

The United States faces distinctive pressures as it secures adequate, sustained funding for quantum research, startups, large-scale infrastructure, and the development of practical applications.

First, delivering fault-tolerant quantum computers, national quantum networks, and advanced sensing systems demands patient, long-horizon capital that exceeds typical venture timelines. Quantum technology depends on specialized equipment, top talent, and intensive research and development, all of which drive heavy up-front investment with uncertain payoff timelines. Creating a utility-scale quantum computer will require multiple breakthroughs across error correction, algorithm development, and physical hardware. No one can know which company or architecture will succeed first. Companies are developing more than half a dozen architectures, including superconducting (Google and IBM), photonic (Xanadu and PsiQuantum), neutral atoms (QuEra and Infleqtion), trapped ions (Quantinuum and IonQ), electrons on helium (primarily EeroQ), and quantum dots (Intel and Diraq).

Second, fragmentation across agencies, regions, and programs creates duplication and leaves gaps, especially at Technology Readiness Levels 4–7, where demonstrations, pilot deployments, and scale-up are most capital-intensive. Third, the United States must balance the benefits of openness with security concerns and supply chain resilience to preserve leadership while protecting critical capabilities.

These pressures ripple across the quantum ecosystem and have sparked serious strategic initiatives by the U.S. government, the private sector, and academic and research institutions.

- **The U.S. government** has taken a proactive, multi-agency approach to secure funding for quantum innovation, primarily through the National Quantum Initiative (NQI) Act of 2018. Subsequent legislation—the fiscal year 2022 National Defense Authorization Act and the CHIPS and Science Act—authorized more than $1.2 billion in federal investment, established the National Quantum Coordination Office, and created major research centers and consortia across the Department of Energy (DOE), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST). These agencies fund basic and applied research, infrastructure, and workforce development, and they coordinate efforts to avoid duplication and maximize impact.

In recent years, DOE, NSF, and NIST have received hundreds of millions of dollars annually for quantum research and development, reflecting sustained or increased federal budgets. The government also supports commercialization and technology transfer through programs such as Small Business Innovation Research (SBIR), Other Transaction Authorities (OTAs), and advanced market commitments, which bridge the gap between lab research and commercial deployment. The government acts as an early buyer of quantum systems and provides incentives for domestic supply chain development. (Note: The SBIR and STTR program authorities expired on September 30, 2025, but it is anticipated the authority will be renewed once the government shutdown ends.)

- **The private sector,** including major technology companies such as IBM, Google, and Microsoft, quantum technology companies such as Infleqtion, EeroQ, and PsiQuantum, and suppliers and potential end users, has ramped up investment in quantum technologies, often matching or exceeding public funding. However, quantum remains a high-risk, long-horizon field, and private investment is sensitive to market conditions and perceived return on investment. In 2023, venture capital funding for quantum startups dropped by 50 percent compared with the previous year, reflecting broader technology investment trends.

  To mitigate risk and attract capital, private companies often partner with government agencies and academic institutions, leveraging public grants, joint research projects, and public–private consortia such as the Quantum Economic Development Consortium (QED-C) and the Chicago Quantum Exchange (CQE). These collaborations share costs, expand access to talent, and accelerate innovation. The private sector also advocates for government policies that support supply chain resilience, workforce development, and early-stage market creation.

- **Universities and national labs** drive quantum innovation, conduct foundational research, and train the next generation of quantum scientists and engineers. They also develop the workforce, modernize curricula, and broaden the talent pipeline, which remains constrained. This sector relies heavily on federal grants from DOE, NSF, NIST, the Department of Defense (DOD), and the National Institutes of Health (NIH). It increasingly pursues state and local grants, philanthropic support, and private-sector partnerships to supplement federal funding. Academic institutions also participate in large-scale research centers established by the NQI Act (specifically, the DOE National Quantum Information Science Research Centers and the NSF Quantum Leap Challenge Institutes) and regional innovation hubs that concentrate resources and expertise.

All three sectors recognize that quantum innovation is inherently collaborative and global. The U.S. government has prioritized international cooperation, entering into bilateral agreements and participating in multinational initiatives to pool resources, share knowledge, and ensure secure supply chains. Academia and industry also engage in cross-border research projects and talent exchanges.

Navigating the law: What quantum stakeholders may need to know

Funding brings obligations, and requirements sometimes become more stringent when quantum technologies are involved. Stakeholders may need to consider several legal issues related to government and private funding.

- **Obligations related to government grants, contracts, and other funding mechanisms.** Federal frameworks governing grants, contracts, and other funding mechanisms may impose stringent requirements for protecting intellectual property, safeguarding classified information, maintaining supply chain integrity, and complying with export control laws. Agencies often require contractors to participate in audits and inspections and to submit proposed publications, presentations, or public communications for review and approval before release to prevent inadvertent disclosure of restricted information. The QIST sector often faces more stringent requirements because sensitive algorithms, cryptographic methods, and hardware designs can raise national security concerns. Government agencies offer support programs, but stakeholders need knowledgeable and well-organized legal advice, and they must stay apprised of changing regulations. ***(See Chapter 8, “Government Funding.”)***

- **Obligations related to private investment.** Governance and control rights are core considerations when a startup raises outside capital. Investors often expect a defined level of control over and visibility into the company's operations. Startups must understand the economic terms and the rights and privileges associated with the securities they issue to investors. Federal and state securities laws require strict compliance and emphasize that investors in early-stage or high-growth companies should have the opportunity to become fully informed of all material facts about a prospective investment. Startups need careful legal guidance on compliance, which can include regular filings. ***(See Chapter 9, "Venture Capital.")***

- **Foreign investment review.** CFIUS reviews and, when needed, blocks or mitigates foreign investments in U.S. companies that develop or possess critical technologies, including those in the quantum sector. ***(See Chapter 5, "Foreign Investment Controls"; foreign investment review also addressed in Challenge 1.)***

CHALLENGE 3
Confronting the Growing Shortage of Skilled Quantum Professionals Essential for Sustained Progress

The United States leads the world in quantum technology, but a workforce bottleneck increasingly constrains its momentum—a challenge shared across advanced economies. Demand for interdisciplinary expertise in quantum information science and engineering far outpaces the supply of trained professionals, and universities and industry training programs do not yet produce enough talent to meet that demand. The U.S. government has advanced a coordinated policy, legal, and regulatory agenda that links national strategy for quantum workforce development to regional execution, and states have translated these national priorities into regional capacity by building hubs and talent pipelines that connect universities, community colleges, and employers. Still, policymakers must scale the workforce.

As a result, foreign talent remains essential to the U.S. quantum ecosystem, but immigration frictions, green card backlogs, and lengthy security reviews raise labor costs, slow critical programs, and disproportionately impact smaller, less-resourced institutions.

Large universities and established companies can absorb legal and visa costs, run parallel hiring pipelines abroad to hedge against delays, staff dedicated compliance offices, and build in-house quantum training environments that safeguard scarce quantum hardware. But startup companies and smaller colleges and universities have fewer resources to navigate quantum export controls and visa processes, and they are more likely to lose quantum candidates to better-resourced employers.

Navigating the law: What quantum stakeholders may need to know

Below are two of the primary legal areas stakeholders may need to consider:

- **Immigration and visas:** The United States has long depended on global talent, yet visa and work authorization processes are often slow and uncertain, delaying hires and impeding both research timelines and commercialization.
  - **National laboratories** feel these pressures acutely, as the DOE restrictions on foreign talent narrow candidate pools for specialized hardware positions, extend vacancies, and threaten the continuity of critical facilities.
  - **For companies,** restrictive and unpredictable U.S. visa processes hinder quick hiring and retention. The pathways are frequently capped, lottery-driven, expensive, or otherwise constrained. These challenges most affect startups and small laboratories that lack dedicated legal resources. Employment-based green cards can provide a route to permanence, but long backlogs and per-country limits, particularly for nationals of India and China, slow retention and undermine workforce stability. The weakening bipartisan consensus on immigration has made U.S. immigration policy less stable, resulting in greater uncertainty for companies navigating a complex system. This instability puts U.S. companies at a disadvantage compared to countries with streamlined and stable immigration rules for deep-tech workers. As a result, U.S. companies may lose top talent and may need to form international collaborations or distributed teams, which can dilute expertise within the country.

- **At universities,** international scholars and professionals comprise a large share of graduate students, postdoctoral researchers, and new hires, and they often enter through the F-1 STEM OPT program or visas such as H-1B, O-1, and J-1. Although most research institutions and universities in the United States are not limited by the H-1B visa cap, which mainly affects private employers, they still face challenges related to visa processing times, costs, compliance, and volatile immigration policies. These hurdles can delay, complicate, or otherwise make unaffordable the hiring of international quantum researchers, even when the cap does not apply. In addition, universities may hesitate to admit quantum graduate students, postdocs, or visiting scholars from certain countries if the candidates will work on controlled quantum projects. Visa reviews for sensitive quantum technology can further delay or prevent international student participation in quantum labs. Resource disparities across institutions further magnify these problems in quantum science and technology. Finally, increasing scrutiny of international students entering the United States and proposed regulatory changes to U.S. immigration policy are making the United States a less attractive destination for international students, resulting in a marked decrease in international student enrollment in 2025. ***(See Chapter 7, "Global Talent and Immigration.")***

- **U.S. export regulations** apply to international quantum workers through "deemed exports," which occur when a person releases controlled technologies or data to foreign nationals, even domestically within U.S. labs, through visual inspection, conversations, emails, or practical application of knowledge. QIST stakeholders first must determine whether their technology or data appears on the Commerce Control List, and if so, compliance with deemed export rules will be crucial.

  - **For companies,** these rules limit the roles foreign hires can fill and add compliance costs, which are especially onerous for startups. The compliance costs and the risk of violations discourage hiring non-U.S. persons for sensitive work and can limit a company's collaborations with universities, which typically have many international researchers. Larger firms can better absorb these burdens, spread costs, and maintain multiple hiring pipelines. This dynamic produces a stratified market in which scale and location determine who can compete and deliver at the pace the industry demands. It also pushes trained graduates toward competing countries that offer faster and more predictable immigration options.

  - **Universities** must carefully determine when quantum lab training or collaborative quantum research might cross regulatory lines. This obligation can conflict with the academic mission of openness and global collaboration in quantum science. Navigating the complex regulatory landscape, including the Commerce Control List and International Traffic in Arms Regulations (ITAR) categories, requires technical and circumstance-specific legal expertise that many universities, especially in QIST, do not have. Quantum researchers may inadvertently share restricted quantum knowledge, and compliance offices are often under-resourced compared to those in industry. These gaps can lead to uneven enforcement and significant administrative burdens. ***(See Chapter 4, "Export Controls"; deemed export controls also addressed in Challenge 1.)***

CHALLENGE 4
Mitigating Supply Chain Vulnerabilities

The U.S. quantum industry leads technological innovation. As the sector expands, however, supply chain vulnerabilities undermine progress, resilience, and global competitiveness. The core challenge involves securing scarce inputs, including isotopically pure silicon and germanium, rare earth elements, and highly specialized hardware and manufacturing processes.

Foreign suppliers often dominate these markets, creating choke points across the quantum ecosystem. When a single supplier or country controls a critical component or material, any disruption, whether arising from geopolitical tension, trade restriction, or natural disaster, can cascade through the entire chain. The sector's fragmented structure, which spans academic labs, startups, and multinational corporations with complex ownership and partnership networks, heightens risk. And threat actors can exploit weaknesses among smaller, less secure vendors to compromise larger, more secure organizations.

The United States has mounted a coordinated suite of policies, laws, and regulations to harden critical inputs, protect sensitive technologies, and expand domestic capacity. State governments reinforce federal priorities through tax incentives, grants, and site-readiness programs for suppliers in cryogenics, photonics, and microelectronics. Many states also streamline permitting and deploy clean energy credits to offset the high power demands of cryogenic operations and fabrication facilities. Investments in regional ecosystems are accelerating in Illinois, Wisconsin, and Indiana through the Chicago Quantum Exchange; in Colorado, New Mexico, and Wyoming through Elevate Quantum; in Washington state and Oregon through Northwest Quantum Nexus; and in Maryland, Connecticut, Arizona, Texas, Massachusetts, Ohio, and other states that have invested in shared facilities, incubators, and workforce pipelines.

Despite these national and subnational efforts, stakeholders still need additional investment in domestic supply chains and manufacturing capacity to reduce foreign dependence. This need creates further policy opportunities at both levels of government.

It also means stakeholders must work alongside their chosen counsel to navigate laws that tighten trade and capital flows. This obligation applies to U.S. quantum stakeholders importing components and materials, and, as domestic supply grows, to U.S. companies exporting quantum components.

Navigating the law: What quantum stakeholders may need to know

Stakeholders must be aware of laws that can tighten trade and capital flows, including:

- **The America First Trade Policy and tariffs.** Although policymakers designed these measures to increase domestic manufacturing and reduce reliance on foreign suppliers, tariffs on essential components like ultrapure metals, precision optics, and advanced electronics can drive up costs, disrupt the supply chain, and add compliance burdens, forcing companies to search for new suppliers and lengthening production timelines. ***(See Chapter 6, "America First Trade Policy and Tariffs"; America First Trade Policy also addressed in Challenge 1.)***

- **Federal procurement requirements.** Federal agencies must now conduct thorough supply chain risk assessments for all quantum-related procurements. This requirement changes how agencies plan research, purchase equipment, and select partners. For example, the DOE must verify the origin and security of quantum components, such as dilution refrigerators and control electronics, before using them in research projects. Agencies must also check that software and hardware are free from vulnerabilities, especially when connecting quantum systems to classical networks. ***(See Chapter 8, specifically 8.4 on government contracting; government contract requirements also addressed in Challenge 2.)***

- **Foreign investment review.** The Committee on Foreign Investment in the United States (CFIUS) applies rigorous screening to foreign investments that threaten supply chain integrity. These controls aim to protect intellectual property, preserve technological advantage, and prevent adversaries from exploiting U.S. research and manufacturing infrastructure. Although CFIUS generally does not cover standard imports, it could apply in certain scenarios related to quantum technology. ***(See Chapter 5, "Foreign Investment Controls"; CFIUS review also addressed in Challenge 1.)***

- **Export controls.** U.S. regulations can apply to U.S. companies exporting quantum components to other countries. EAR and ITAR restrict the transfer of cryogenic systems, precision lasers, detectors, high-performance data converters, radio frequency and microwave components, vacuum and optical equipment, and related software or technical data. Companies may need licenses to sell certain products abroad, leading some to create domestic demo centers or to limit sensitive data to the United States. Others implement screening programs and technical safeguards to prevent misuse or unauthorized exports. ***(See Chapter 4, "Export Controls"; export controls also addressed in Challenge 1.)***

- **NIST guidance.** The National Institute of Standards and Technology provides detailed guidance for supply chain risk management, including methodologies to identify, assess, and mitigate risks unique to quantum technologies. These measures collectively shape incentives and expectations for both government and industry.

Navigating the complexities outlined above begins with developing basic knowledge about the relevant laws and regulations, understanding how they interact with the quantum technology sector, and developing a strategy for navigating compliance. The remainder of the Navigator provides the foundation for that learning.

Part II is divided into eight key legal concepts that QIST stakeholders confront most consistently. The chapters explain each of the areas, beginning with an explanation of why it matters to the quantum technology sector and then breaking down the relevant policies, laws, regulations, and standards. When applicable, the chapters call out recent changes to law. Each chapter ends with “key considerations” to help QIST stakeholders develop strategies for navigating that legal area.

Visit **https://chicagoquantum.org/quantum-law-navigator** and subscribe to receive updates on the Quantum Law Navigator project. We welcome ideas and feedback. Please reach out to the QLN team at **QLN@uchicago.edu**.

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