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"OK GOOGLE" PLAY THE NATIONAL ANTHEM: ARMS CONTROL AND EMINENT DOMAIN TO MAINTAIN AMERICA'S TECHNOLOGICAL ADVANTAGE

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The country that first controls and dominates emerging technologies such as artificial intelligence and quantum computing will have the power to re-shape the world to their benefit. The US federal government has historically been the source of breakthroughs in technology and science, but Silicon Valley now controls much of the technology development needed for future defense and weapons systems. Driven by profit, the private sector has been more open to dealing new technologies to foreign adversaries while the US national security apparatus has a vested interest in ensuring powerful new technologies remain unattainable to countries that may wish harm to the United States. This paper recommends changes to export laws to specifically address the quick pace of sensitive technological development in the private sector, and it advocates for new statutory authority to seize technology through eminent domain as a last resort.

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The views presented are those of the author and do not necessarily represent the views of Department of Defense or its Components.

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> *HAWLEY: So I just want to make sure that I understand exactly what you're saying. You're telling me that Google, an American company, supposedly, is refusing to work with the Department of Defense, but is doing work with China, in China, in a way that at least indirectly benefits the Chinese government. Is that correct?*
>
> *SHANAHAN: I haven't heard the word refuse, but there's a lack of willingness to support DOD programs.*
>
> *HAWLEY: General you're nodding your head; do you want to weigh in on this?*
>
> *DUNFORD: You know Senator I'm nodding my head on exactly the point that you made that the work that Google is doing in China is indirectly benefitting the Chinese military. And I've been very public on this issue as well in fact the way I described it to our industry partners is "look, we're the good guys in the values that we represent and the system that we represent is the one that will allow and has allowed you to thrive" and that's the way I've characterized it. I was just nodding that what the Secretary was articulating is the general sense of all of us as leaders. We watch with great concern when industry partners work in China knowing there is that indirect benefit, and frankly "indirect" may be not a full characterization of the way it really is. It's more of a direct benefit to the Chinese military.*[1]

I. INTRODUCTION

In living memory, the U.S. government has operated with a global technological advantage. Our current advantage relies on access to advanced technology developed by private industries—while simultaneously limiting our adversaries' access to that same technology.[2] The government cannot take a *laissez faire* approach and hope that the status quo will hold. Unless existing export control regulations are strengthened, and a new eminent domain authority is enacted, the

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[1] *Hearing to Receive Testimony on the Department of Defense Budget Posture in Review of the Defense Authorization Request for Fiscal Year 2020 and the Future Years Defense Program: Hearing Before the S. Comm. On Armed Services*, 116th Cong. 83-84 (2019) (statement of General Joseph F. Dunford, Jr., United States Marine Corps 19th Chairman of the Joint Chiefs of Staff).

[2] *See* David Shepardson, *U.S. tightening restrictions on Huawei access to technology, chips*, REUTERS (Aug. 17, 2020), https://www.reuters.com/article/us-usa-huawei-tech/u-s-tightening-restrictions-on-huawei-access-to-technology-chips-idUSKCN25D1CC.

United States risks losing its advantage and becoming beholden to Silicon Valley's whims.

The consequences of losing are clear: whoever controls emerging technologies like artificial intelligence ("AI") and quantum computers ("QC") will have the power to re-shape the world to their benefit. "Artificial intelligence is the future, not only for Russia, but for all humankind. It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world."[3]

The private sector is the new driver of innovation for technology with national security implications. This is a major shift away from the historical model of the federal government funding research that guided the cutting edge.[4] On October 23, 2019, Mr. Michael Brown, director of the Department of Defense (DoD) Defense Innovation Unit noted that:

> [A] lack of U.S. government investment is part of the problem. Sixty years ago, most of the country's technology innovation was supported by the military. But the government's investment has been on a steady decline since the 1960s . . . . That leaves technology for defense and weapons systems, and humanitarian and disaster relief, to Silicon Valley.[5]

When the federal government played a greater role in technological development, they also had greater control over how new technology was dispersed and used. Now that the government is more of a customer than a creator, the tech behemoths act as the gatekeepers.[6] But, unlike the federal government, Silicon Valley does not have the same incentive to limit access to emerging technology—

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[3] *'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day*, RT (Sep. 1, 2017), https://www.rt.com/news/401731-ai-rule-world-putin/.

[4] Caleb Foote & Robert Atkinson, *Federal Support for R&D Continues Its Ignominious Slide*, INFO. TECH. AND INNOVATION FOUND. (Aug. 12, 2019), https://itif.org/publications/2019/08/12/federal-support-rd-continues-its-ignominious-slide.

[5] Heather Somerville, *China Has 'Concerning' Leads Over U.S. in Tech, Defense Department Official Says*, WALL STREET J. (Oct. 23, 2019), https://www.wsj.com/articles/china-has-concerning-leads-over-u-s-in-tech-defense-department-official-says-11571856288.

[6] *See* Scott Rosenburg, *Tech giants are the new gatekeepers*, AXIOS (Feb. 1, 2019) https://www.axios.com/tech-giants-new-gatekeepers-1548976974-25f26494-a67c-4252-9c18-418588f8de06.html.

companies see new technology through the lens of profit, while the federal government see through the lens of national security.

Recently, private U.S. companies have shown a willingness to do business with foreign competitors and a reluctance to do business with their own government.[7] In 2017, Google reentered the Chinese market after a seven-year absence by opening an artificial intelligence development center.[8] At the same time, Google chose not to renew a contract with the DoD.[9] Once the DoD contract with Google that was up for renewal became public, Google employees revolted.[10] They sent a letter to Google's CEO, Mr. Sundar Pichai, arguing "that Google should not be in the business of war. Therefore we ask that Project Maven be canceled, and that Google draft, publicize and enforce a clear policy stating that neither Google nor its contractors will ever build warfare technology." [11] Google capitulated, and did not renew the Project Maven contract. [12] One of America's largest technology companies, the global leader of AI development, opened an AI center in China but limited its AI business with the United States.[13] It is this dichotomy that that must be reckoned with.

The paper begins by outlining the emerging technologies at issue, mainly AI and QC (Part II). This paper then discusses the current state of export control laws, and makes recommends that those laws need to be upgraded to keep pace with technological development (Part III). This paper concludes by exploring the concept of eminent domain, bounded by the Fifth Amendment, as applied to emerging technology. This paper argues for new statutory authority to seize

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[7] Scott Shane & Daisuke Wakabayashi, *'The Business of War': Google Employees Protest Work for the Pentagon*, N.Y. TIMES (Apr. 4, 2018), https://www.nytimes.com/2018/04/04/technology/google-letter-ceo-pentagon-project.html.

[8] Carlos Tejada, *Google, Looking to Tiptoe Back into China, Announces A.I. Center*, N.Y. TIMES (Dec. 13, 2017), https://www.nytimes.com/2017/12/13/business/google-ai-china.html.

[9] Daisuke Wakabayashi & Scott Shane, *Google Will Not Renew Pentagon Contract That Upset Employees*, N.Y. TIMES (June 1, 2018), https://www.nytimes.com/2018/06/01/technology/google-pentagon-project-maven.html.

[10] *Id.*

[11] *Google should not be in business of war, say employees*, BBC (Apr. 5, 2018), https://www.bbc.com/news/business-43656378 (noting that Project Maven was a Department of Defense (DoD) contract held by Google, in which the DoD used Google's image recognition artificial intelligence (AI) to search for targets of potential military significance in satellite imagery).

[12] Sundar Pichai, *AI at Google: our principles*, GOOGLE BLOG (June 7, 2018), https://www.blog.google/technology/ai/ai-principles/.

[13]Cheang Ming, *Google is blocked in China, but that's not stopping it from opening an A.I. center there*, CNBC (Dec. 13, 2017), https://www.cnbc.com/2017/12/13/alphabets-google-opens-china-ai-centre.html.

technology using eminent domain as a last resort (Part IV). If the United Sates limits our adversaries' access to American made emerging technology, while guaranteeing that the U.S. government will always have access to that technology, as the age-old maxim says, we can have our cake and eat it too. First, let's turn to the technology.

II. EMERGING TECHNOLOGY

In August 2018, as part of the National Defense Authorization Act for Fiscal Year 2019, Congress enacted the Export Control Reform Act of 2018 (ECRA).[14] The ECRA authorizes the Department of Commerce to "establish appropriate controls" on "emerging and foundational technologies" that are essential to the "national security of the U.S."[15] The ECRA does not define what constitutes "emerging and foundational technologies," the ECRA leaves that to an interagency process.[16] In December 2018, the Department of Commerce published an advance notice of proposed rulemaking requesting comments on, "criteria for identifying emerging technologies that are essential to U.S. national security."[17]

For two years, the Department of Commerce took no action. On January 6, 2020, the Bureau of Industry and Security ("BIS") issued its first interim final rule which "amends the Export Administration Regulations (EAR) to make certain items subject to the EAR and to impose a license requirement for the export and reexport of those items to all destinations, except Canada."[18] Specifically, this rule restricts export, without a license, for "[g]eospatial imagery 'software' 'specially designed' for training a Deep Convolutional Neural Network to automate the analysis of geospatial imagery and point clouds . . . ."[19] The 2018 advance notice of proposed rulemaking identified fourteen categories of interest.[20] The 2020 interim final rule is the first rule to come out of the advanced notice of proposed

[14] 50 U.S.C.A. § 4801 (2018).
[15] 50 U.S.C.A. § 4817(b) (2018).
[16] 50 U.S.C.A. § 4817(a) (2018).
[17] DEP'T OF COM., BUREAU OF INDUS. AND SEC., R. OF CONTROLS FOR CERTAIN EMERGING TECH. (2018), https://www.regulations.gov/document?D=BIS-2018-0024-0001 (stating that merging technologies are considered essential to U.S. national security "because they have potential conventional weapons, intelligence collection, weapons of mass destruction, or terrorist applications or could provide the United States with a qualitative military or intelligence advantage . . . .").
[18] Addition of Software Specially Designed to Automate the Analysis of Geospatial Imagery to the Export Control Classification Number 0Y521 Series, 85 Fed. Reg. 459 (proposed Jan. 6, 2020) (to be codified at 15 C.F.R. pt. 774).
[19] *Id.* (discussing the technology underpinning Google's Project Maven).
[20] DEP'T OF COM., BUREAU OF INDUS. AND SEC., *supra* note 17.

rulemaking and only addresses one category.[21] Two years, one problem addressed, thirteen to go.

A. ARTIFICIAL INTELLIGENCE

The DoD defines AI as "the ability of machines to perform tasks that normally require human intelligence—for example, recognizing patterns, learning from experience, drawing conclusions, making predictions, or taking action—whether digitally or as the smart software behind autonomous physical systems."[22] In the 1950s, when AI was first theorized, the goal was to "mimic human cogn[ition]" by allowing a system to learn from its own experiences and make decisions based on reasoning.[23]

Today, AI encompasses a broad swath of modern computing types, from seemingly simple optical character recognition, to machine learning, and up to yet-to-be-realized human-level AI.[24] Both the United States and China have identified AI development as a strategic main effort. The United States has recognized that "[t]o maintain our competitive advantage, the United States will prioritize emerging technologies critical to economic growth and security, such as data science, encryption, . . . advanced computing technologies, and artificial intelligence."[25] The White House has requested approximately $350 million in national security-related AI funding for fiscal year 2020, out of a total budget request for $973 million in AI research and development funding spread across 28 agencies.[26]

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[21] Addition of Software Specially Designed to Automate the Analysis of Geospatial Imagery to the Export Control Classification Number 0Y521 Series, 85 Fed. Reg. 459 (proposed Jan. 6, 2020) (to be codified at 15 C.F.R. pt. 774).

[22] U.S. DEP'T DEF., SUMMARY OF THE 2018 DEP'T OF DEF. ARTIFICIAL INTEL. STRATEGY: HARNESSING AI TO ADVANCE OUR SEC. AND PROSPERITY 5 (2019), https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

[23] Ron Schmelzer, *Is Machine Learning Really AI?*, FORBES (Nov. 21, 2019), https://www.forbes.com/sites/cognitiveworld/2019/11/21/is-machine-learning-really-ai/#15d707f62621.

[24] *Id.*

[25] EXEC. OFFICE OF THE PRESIDENT OF THE UNITED STATES, NAT'L SEC. STRATEGY OF THE UNITED STATES OF AMERICA 20 (2017), https://apps.dtic.mil/dtic/tr/fulltext/u2/1043812.pdf.

[26] EXEC. OFFICE OF THE PRESIDENT OF THE UNITED STATES, NAT'L SCI. AND TECH. RESEARCH AND DEV. PROGRAM SUPPLEMENT TO THE PRESIDENT'S FY2020 BUDGET 10 (Sept. 2019), https://www.whitehouse.gov/wp-content/uploads/2019/09/FY2020-NITRD-AI-RD-Budget-September-2019.pdf.

Like the United States, China is making direct strategic investments in developing the next generation of technology, including AI.[27] In 2017, China announced that by 2030, it plans to "become the world's major artificial intelligence innovation center."[28] China's efforts will focus on research areas including big data, cross-media perception computing, hybrid augmented intelligence, swarm intelligence, autonomous collaborative control, brain-like intelligent computing, and quantum intelligent computing.[29] China has backed that plan with a $30-billion venture capital fund.[30]

Unlike the United States, China goes beyond legitimate direct investment in research and development and persistently engages in nation state-level intellectual property theft to fuel its ambitious 2030 goal of leapfrogging the United States.[31] "Chinese industrial policy seeks to 'introduce, digest, absorb, and re-innovate' technologies and intellectual property (IP) from around the world. This policy is carried out through state-sponsored IP theft through physical theft, cyber-enabled espionage and theft, evasion of U.S. export control laws, and counterfeiting and piracy. . . ."[32]

Despite direct U.S. and Chinese government investment, and Chinese theft, the private sector is driving AI innovation: "tech behemoths like Google, Microsoft, IBM and Apple, [in] the United States is where the bulk of A.I. innovation has taken place."[33] Chinese companies like "Alibaba, Tencent, and Baidu, [are] moving rapidly to close the gap."[34]

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[27] Major Andrew S. Bowne, *Innovation Acquisition Practices in the Age of AI*, ARMY LAW., no. 1, 2019, 74, 76, https://www.loc.gov/rr/frd/Military_Law/pdf/01-2019.pdf.
[28] St. Council on Issuing Notification of New Generation Artificial Intelligence Development Planning, ST. COUNCIL (2017) (China), http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm.
[29] *Id.*
[30] *China Sets Up 30 Bln-dollar State Venture Capital Fund*, CHINA.ORG.CN (Aug. 18, 2016), http://www.china.org.cn/business/2016-08/18/content_39120255.htm (China.org.cn is the authorized government portal site to China and is under the auspices of the State Council Information Office and the China International Publishing Group (CIPG) in Beijing).
[31] *See* WHITE HOUSE, HOW CHINA'S ECON. AGGRESSION THREATENS THE TECH. AND INTEL. PROP. OF THE U.S. AND THE WORLD (2018), https://www.whitehouse.gov/wp-content/uploads/2018/06/FINAL-China-Technology-Report-6.18.18-PDF.pdf.
[32] *Id.*
[33] Vikram Barhat, *China is Determined to Steal A.I. Crown From US and Nothing, Not Even a Trade War, Will Stop it*, CNBC (May 4, 2018), https://www.cnbc.com/2018/05/04/china-aims-to-steal-us-a-i-crown-and-not-even-trade-war-will-stop-it.html.
[34] *Id.*

The stakes are high. The DoD has acknowledged that "[f]ailure to adopt AI will result in legacy systems irrelevant to the defense of our people. . . ."[35] The United States has a strategic interest in maintaining an AI advantage over countries like China, but the United States cannot become myopic in its focus on AI. Both AI and QC are synergetic, as "Google's long-term strategy is to use quantum computers for machine-learning applications."[36] Quantum computing is an equally disruptive technology on the verge of real-world applications.

B. QUANTUM COMPUTERS

Quantum computers are an alternative to existing classical computers. Current desktop computers, smartphones, and supercomputers all work the same way. They sequentially process individual bits of data coded as either a 1 or a 0 by turning switches called transistors on or off.[37]

By contrast, quantum computers hurtle through calculations instantaneously, with each quantum bit, or qubit, able to represent data as both zero and one, permitting two simultaneous calculations. The more qubits, the greater the computing power . . . . [A] 300-qubit system could in an instant 'run more calculations than there are atoms in the universe.'[38]

U.S. companies like Google, IBM, Microsoft, Intel, and Lockheed Martin are all developing QC technology. [39] Foreign companies like Baidu, Hitachi,

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[35] U.S. DEP'T DEF., SUMMARY OF THE 2018 DEPT. OF DEF. ARTIFICIAL INTEL. STRATEGY: HARNESSING AI TO ADVANCE OUR SECURITY AND PROSPERITY 5 (2019), https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

[36] Charles Q. Choi, *Qubit Revolution*, ASEE PRISM, Jan. 2017, at 22, 27.

[37] *Id.* at 25. For a more detailed explanation of quantum computing and how it is revolutionizing business, *see Quantum Computing Is Coming, Bit by Quibit*, N.Y. TIMES (Oct. 21, 2019), https://www.nytimes.com/2019/10/21/science/quantum-computer-physics-qubits.html.

[38] Choi, *supra* note 36.

[39] *Quantum*, GOOGLE RESEARCH, https://research.google/teams/applied-science/quantum/ (last visited Dec 16, 2019); *Quantum Starts Here*, IBM Q, https://www.ibm.com/quantum-computing/ (last visited Dec 16, 2019); *Quantum Computing*, MICROSOFT, https://www.microsoft.com/en-us/quantum/ (last visited Dec 16, 2019); *Quantum Computing*, INTEL, https://www.intel.com/content/www/us/en/research/quantum-computing.html (last visited Dec 16, 2019); *Quantum Computing: Spot-Checking Millions of Lines of Code*, LOCKHEED MARTIN, https://www.lockheedmartin.com/en-us/news/features/2017/quantum-computing-spot-checking-millions-lines-code.html (last visited Dec 16, 2019).

Fujitsu, and D-Wave are also developing their own QC technology.[40] The U.S.,[41] China, Russia, and the European Union are all investing billions of dollars into developing quantum technology.[42] In July 2019, Google announced a milestone in quantum computing, in a proof of concept called "quantum supremacy."[43] Quantum supremacy is the point at which a quantum computer can perform a calculation that would be impossible for a classical computer.[44] Google claims that their "Sycamore processor takes about 200 seconds to sample one instance of a quantum circuit a million times—our benchmarks currently indicate that the equivalent task for a state-of-the-art classical supercomputer would take approximately 10,000 years."[45] While practical QC is likely years away, the potential for disruption is undeniable.

Quantum computing can be both a sword and a shield. Like a sword, QC could solve the complex algorithms that encrypt billions of daily banking and online transactions.[46] "In theory, quantum computers could ace complex problems that stymie even the strongest supercomputers, such as factoring numbers that are hundreds of digits long—an ability that could crack encryption. . . ."[47] The National Security Agency grew concerned enough that it has partnered with the National

[40] *Quantum Computing*, BAIDU RESEARCH, http://research.baidu.com/Research_Areas/index-view?id=75 (last visited Dec 16, 2019); *Quantum Computer*, HITACHI, https://www.hitachi.com/rd/portal/glossary/q/quantum_computer.html (last visited Dec 16, 2019); *Digital Annealer*, FUJITSU, https://www.fujitsu.com/global/digitalannealer/ (last visited Dec 16, 2019); *Practical Quantum Computing*, DWAVE, https://www.dwavesys.com (last visited Dec 16, 2019).

[41] *OSTP Leads Implementation of the National Quantum Initiative Act*, U.S. DEP'T OF ENERGY (Mar. 5, 2019), https://www.energy.gov/articles/ostp-leads-implementation-national-quantum-initiative-act.

[42] Michael J. Biercuk & Richard Fontaine, *The Leap Into Quantum Technology: A Primer For National Security Professionals*, WAR ON THE ROCKS (Nov. 17, 2017), https://warontherocks.com/2017/11/leap-quantum-technology-primer-national-security-professionals/.

[43] Frank Arute et al., *Quantum Supremacy Using a Programmable Superconducting Processor*, 574 NATURE 505, 505 (2019) (https://doi.org/10.1038/s41586-019-1666-5).

[44] *Id.*

[45] *Id.; but see* Jordan Novet, *IBM and Google disagree on quantum computing achievement*, CNBC (Oct. 23, 2019), https://www.cnbc.com/2019/10/23/google-quantum-computing-supremacy-claim-disputed-by-ibm.html (explaining IBM's disagreement with Google's assertion and disagreeing with the 10,000-year calculation).

[46] Choi, *supra* note 36, at 24.

[47] *Id.* at 26.

Institute of Standards and Technology to evaluate new post-quantum era encryption algorithms.[48]

As a shield, QC can make theoretically unbreakable encryption.[49] "The most prevalent approach is known as quantum key distribution (QKD), through which cryptographic keys are exchanged in quantum states through entanglement. In accordance with the 'no cloning' theorem, quantum information cannot be copied, and any attempted interference or eavesdropping within a quantum system can be readily detected."[50] Quantum cryptography offers the promise that if a third party intercepts a communication, the very act of intercepting the communication alters the quantum state of the communication link, thus alerting operators that the communication is not secure.[51]

The national security implications of performing at the speed of computer processing, defeating all existing encryption, and unbreakably secure communications are profound. Thankfully, the United States has laws and regulations to mitigate the spread of valuable yet risky technology—arms control.

III. CYBER ARMS CONTROL

The United States employs a two-tier arms control framework to control the export of sensitive technology. The Department of State controls weapons exports through the Arms Export Control Act (AECA).[52] The Department of Commerce controls the export of dual-use technology through the Export Administration Regulations (EAR).[53] Neither the AECA nor the EAR has been updated to address the threat of exporting U.S. innovation in areas like AI or QC. The President, acting through the Departments of State and Commerce, has the statutory and regulatory authority to designate defense articles, defense services, or dual-use items that have

[48] *NSA Cybersecurity Perspectives on Quantum Key Distribution and Quantum Cryptography'*, NAT'L SECURITY AGENCY, (Oct. 26, 2020) https://www.nsa.gov/News-Features/Feature-Stories/Article-View/Article/2394053/nsa-cybersecurity-perspectives-on-quantum-key-distribution-and-quantum-cryptogr)/.
[49] Elsa B. Kania & John K. Costello, *Quantum Hegemony? China's Ambitions and the Challenge to U.S. Innovation Leadership*, CTR. FOR A NEW AM. SEC. 1, 3 (Sept. 12, 2018), https://s3.amazonaws.com/files.cnas.org/documents/CNASReport-Quantum-Tech_FINAL.pdf?mtime=20180912133406.
[50] *Id.*
[51] *Id.*
[52] 22 U.S.C.A. § 2751 (West 2014).
[53] 15 C.F.R. § 730.1 (2019).

both civilian and military applications.[54] Export control licensing requirements should apply to both AI and QC.

A. ARMS EXPORT CONTROL ACT

The Arms Export Control Act of 1976 authorizes the President to "control the import and the export of defense articles and defense services and to provide foreign policy guidance to persons of the United States involved in the export and import of such articles and services."[55] Any item that the President designates under the AECA "shall constitute the United States Munitions List."[56] The United States Munitions List (USML) is the comprehensive list of what defense articles and services are subject to AECA export controls. Exporting any item listed on the USML, triggers the International Traffic in Arms Regulations (ITAR), which is the U.S. regulatory regime to "ensur[e] commercial exports of defense articles and defense services advance U.S. national security and foreign policy objectives."[57]

Both the USML and ITAR are managed by the Directorate of Defense Trade Controls (DDTC) within the Department of State. Before exporting an item listed on the USML, the individual or business must obtain an export license from the DDTC.[58] Exporting a listed item, without a license, is a criminal offense punishable with a $1,000,000 fine per instance, or imprisonment for not more than 20 years, or both.[59] The Secretary of State may also assess civil penalties up to $500,000 for each violation.[60]

The USML covers twenty-one categories of defense articles and services, ranging from shotguns to nuclear weapons. The USML does not designate AI or QC as defense articles or services.[61] But, in 2014 ITAR was updated to include the firmware and software running the items listed on the USML as falling under the same licensing requirements as the listed item.[62] In practice, this is only a partially

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[54] 22 U.S.C.A. § 2778 (West 2014); 15 C.F.R. § 730.3 (2019).
[55] 22 U.S.C.A. § 2778 (West 2014).
[56] *Id.* For more explanation on the process of designating an item under the United States Munitions Lists (USML), *see* Kathryn Toomey, *What Experts Need to Know About the U.S. Munitions List (USML)*, INT'L TRADE BLOG (May 16, 2016), https://www.shippingsolutions.com/blog/what-exporters-need-to-know-about-the-us-munitions-list-usml.
[57.] Robert L. Hobart, *DDTC: Evaluating U.S. Defense Exports in 2020*, DEP'T OF STATE (Mar. 26, 2020), https://www.state.gov/ddtc-elevating-u-s-defense-exports-in-2020/.
[58] 22 U.S.C.A. § 2778(b)(1)(a)(ii)(III) (West 2014).
[59] 22 U.S.C.A. § 2778(c) (West 2014).
[60] 22 U.S.C.A. § 2778(e) (West 2014).
[61] *See* 22 C.F.R. § 121.1 (2020).
[62] 22 C.F.R. § 120.45 (2020) (adding to the ITAR).

effective control. It does not place any practical limits on commercial companies exporting AI and QC, so long as they are not related to a listed defense article. Companies have an incentive to not incorporate their technology into defense articles listed on the USML to avoid ITAR licensing requirements.

There is precedent to use the USML to limit the export of technology with similar national security equities that AI and QC present today. For example, from World War II until 1996, nearly all cryptography was listed on the USML and required an export license under ITAR.[63] Though unlike cryptography from the mid-20th century, AI and QC straddle military and commercial enterprises.[64] The EAR fills the regulatory gap for technology that is neither solely military nor solely commercial.

B. EXPORT ADMINISTRATION REGULATIONS

The Department of Commerce, through the BIS implements the EAR.[65] The EAR, like the ITAR, requires individuals or businesses to obtain a license before exporting certain items listed on the Commerce Control List (CCL).[66] The restrictions of the EAR are:

> intended to serve the national security, foreign policy, nonproliferation of weapons of mass destruction, and other interests of the U.S, . . . [s]ome controls are designed to restrict access to items subject to the EAR by countries or persons that might apply such items to uses inimical to U.S. interests.[67]

The EAR generally applies to dual-use items: "[a] 'dual-use' item is one that has civil applications as well as terrorism and military or weapons of mass destruction

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[63] 22 C.F.R. § 121.1 (1995) (including cryptography before changing in 1996); *see* Bernstein v. U.S. Dep't of Commerce, No. C 95-0582 MHP, 2004 WL 838163, at *1 , *2 n.2 (N.D. Cal. Apr. 19, 2004); Bernstein v. U.S. Dep't of Commerce, No. C 95-0582 MHP, 2004 WL 838163, at *1 , *2 n.2 (N.D. Cal. Apr. 19, 2004); Tamotsu Aoi, *Historical Background of Export Control and Development in Selected Countries and Regions*, INT'L SEC. TRADE CONTROL DEP. 12 (2016), https://www.cistec.or.jp/english/service/report/1605historical_background_export_control_development.pdf.

[64] *See generally* Andrew P. Hunter et al., *Artificial Intelligence and National Security: The Importance of the AI Ecosystem*, CENTER FOR STRATEGIC AND INT'L STUDIES, 2018, at 3; Kania & Costello, *supra* note 49 at 3.

[65] 15 C.F.R. § 730.1 (2020).

[66] *See* 15 C.F.R. § 730.7 (2020).

[67] 15 C.F.R. § 730.6 (2020).

(WMD)-related applications."[68] The CCL, like the USML, is a list of items requiring an export license under the EAR.[69] The items on the CCL are dual-use.[70]

Unlike the USML, the CCL is expansive, spanning 751 pages—compared to the USML's paltry 107 pages. The CCL also incorporates detailed technical specifications to define the scope of what is covered.[71] Also, unlike the USML, the CCL does contain some controls on computer technology that could encompass AI and QC.[72] The question is, are the USML and CCL sufficient to maintain the U.S. advantage in emerging technologies like AI and QC?

1. EXPORT CONTROLS ON ARTIFICIAL INTELLIGENCE

There are some export controls on AI, but they are inadequate for the next generation of AIs. The CCL requires a license to export a type of computer on which current AIs operate called "neural computers."[73] Neural computers are "computational devices designed or modified to mimic the behavior of a neuron or a collection of neurons, i.e., computational devices which are distinguished by their hardware capability to modulate the weights and numbers of the interconnections of a multiplicity of computational components based on previous data."[74] In simpler terms, neural computers mimic the way a human brain processes information. The export restriction on neural computers only controls the current generation of AI, like machine learning algorithms used for tasks like image recognition.[75] The BIS should expand the scope of the CCL to include AI with greater function, and greater risk.

According to a paper recently published by AI researcher and Google software engineer François Chollet, there are three levels of AI.[76] The lowest level is capable of accomplishing task-specific skills like differentiating between a dog

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[68] 15 C.F.R. § 730.3 (2020).
[69] *See* 15 C.F.R. § 774.1 (2019).
[70] *See Commerce Control List*, LEGAL INFO. INST. (2020), https://www.law.cornell.edu/wex/commerce_control_list.
[71] *See, e.g.*, 15 C.F.R. § 774, Supp. 1, Cat. 4 (2020).
[72] *Id.*
[73] 15 C.F.R. § 774, Supp. 1, Cat. 4 (2020).
[74] *Id.*
[75] *See generally* Paul Mozur, *One Month, 500,000 Face Scans: How China Is Using A.I. to Profile a Minority*, N.Y. TIMES (Apr. 14, 2019), https://www.nytimes.com/2019/04/14/technology/china-surveillance-artificial-intelligence-racial-profiling.html (discussing algorithms for image recognition of members of a Muslim minority group in China).
[76] *See* François Chollet, *On the Measure of Intelligence*, ARXIV.ORG (Nov. 5, 2019), https://arxiv.org/ abs/1911.01547.

and a cat in an image after being trained on may examples.[77] These are AIs with "local generalization."[78] "This is the form of generalization that machine learning has been concerned with from the 1950s up to this day."[79] The second level is AI that can be applied to varied, yet related, tasks without having to be retrained.[80] These are AIs with "broad generalization." "For instance, a L5 self-driving vehicle, or a domestic robot capable of passing Wozniak's coffee cup test (entering a random kitchen and making a cup of coffee) could be said to display broad generalization."[81] To date, no AI has achieved broad generalization.[82] The highest level of AI is one with human-like general intelligence, called "extreme generalization."[83]

The CCL-specific restriction on "neural computers" does little to maintain our national security advantage, because low-level AI is already widely available.[84] The current CCL only requires a license for AI running on a neural computer.[85] The CCL should be *capability driven*, not hardware-architecture driven. The CCL should be amended to include AI with broad or extreme generalization as the benchmark to trigger an EAR license requirement. A capability-based definition is harder for developers to get around and captures what the U.S. should be concerned about—losing a comparative advantage for the next generation of AI.

The Department of Commerce should define what AIs are within the scope of the CCL by reference to an AI intelligence test. François Chollet helpfully published a formula to measure how intelligent an AI is.[86] His formula measures

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[77] *Id.* at 11; *see also* Shane & Wakabayashi, *supra* note 7 (illustrating an example of low-level, task-specific A.I. in Google's Project Maven).
[78] Chollet, *supra* note 76.
[79] Chollet, *supra* note 76; *see generally* Douglas Heaven, *Why Deep-Leaning AIs Are So Easy to Fool*, NATURE, (Oct. 9, 2019), https://www.nature.com/articles/d41586-019-03013-5 (providing an in-depth discussion of local generalization AI).
[80] Chollet, *supra* note 76.
[81] Chollet, *supra* note 76; *see generally* Steve Wozniak, *Steve Wozniak aka "The Woz,"* WOZ.ORG (2019), http://www.woz.org/about/ (describing Steve Wozniak, who co-founded Apple with Steve Jobs).
[82] Chollet, *supra* note 76, at 11.
[83] *Id.*; *see generally* Editorial, *Human-Level AI Is Right Around the Corner—Or Hundreds of Years Away*, IEEE SPECTRUM (May 31, 2017), https://spectrum.ieee.org/computing/software/humanlevel-ai-is-right-around-the-corner-or-hundreds-of-years-away (presenting the predictions of nine technologists as to when "brainlike" AI computing would become a reality, with responses ranging from one decade to four hundred years).
[84] *See generally* Mozur, *supra* note 75; Roszel C. Thomsen II, *Artificial Intelligence and Export Controls: Conceivable, But Counterproductive?* 22 J. OF INTERNET L., 17 (2018).
[85] 15 C.F.R. § 774, Supp. 1, Cat. 4 (2020);
[86] Chollet, *supra* note 76, at 39.

an AI's ability to sufficiently accomplish a task using the lowest number of training inputs.[87] This formula is a reasonable starting point for the Department of Commerce to amend the CCL and bring truly advanced AIs within the regulatory scope of the EAR. Using the formula would accomplish the goal of defending our national advantage in AI technology, and thus promoting our national security.

2. EXPORT CONTROLS ON QUANTUM COMPUTERS

The CCL should also be amended to control the export of QC technology. The CCL has existing restrictions on exporting computers, but not QCs specifically.[88] In 2006, the CCL redefined the scope of which computers are regulated by implementing a standardized formula called Adjusted Peak Performance (APP).[89] Adjusted Peak Performance calculates a computer's processing power in a unit called Weighted TeraFLOPS (WT)[90] and is intended to also be able to identify high-performance computers (HPC) that can be "used for national security applications [to] include vector supercomputers, massively-parallel processor systems, and proprietary cluster architectures."[91] The CCL restricts the export of HPC that can compute between 16-29 WT.[92] For reference, the new $50,000 Apple Mac Pro with a 28 core Intel Xeon W processor has a WT of 2.4.[93] The fastest supercomputer in the world can perform 200,000 trillion calculations per second, or 200 petaflops.[94] That is equivalent to an APP score of between 60,000 and 180,000 WT (depending on how the technical specifications of the supercomputer are accounted for in the APP formula).[95]

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[87] *See id.* at 39-40.
[88] *See* 15 C.F.R. § 774, Supp. 1, Cat. 4 (2020) (mentioning no quantum computing).
[89] *U.S. Dep't of Com., Bureau of Industry and Security*, A PRACTITIONER'S GUIDE TO ADJUSTED PEAK PERFORMANCE, at 4 (2006), https://www.bis.doc.gov/index.php/documents/product-guidance/865-practioner-s-guide-to-adjusted-peak-performance/file.
[90] *Id.*
[91] *Id.*
[92] 15 C.F.R. § 774, Supp. 6 (2020); 15 C.F.R. § 774, Supp. 1, Cat. 4 (2020).
[93] Chance Miller, *Apple's New Mac Pro Maxes Out at Over $50,000, and Higher Specs are Coming*, 9 TO 5 MAC, (Dec. 10, 2019), https://9to5mac.com/2019/12/10/mac-pro-max-price/; *see Export Compliance Metrics for Intel® Microprocessors: Intel® Xeon® Processors*, INTEL (2020), https://www.intel.com/content/dam/support/us/en/documents/processors/APP-for-Intel-Xeon-Processors.pdf.
[94] *ORNL Launches Summit Supercomputer*, OAK RIDGE NAT'L LAB'Y (June 8, 2018), https://www.ornl.gov/news/ornl-launches-summit-supercomputer.
[95] Indiana University, *Understand Measures of Supercomputer Performance and Storage System Capacity*, KNOWLEDGE BASE (2020), https://kb.iu.edu/d/apeq; A PRACTITIONER'S GUIDE TO ADJUSTED PEAK PERFORMANCE, *supra* note 89, at 6-7 (illustrating that the APP applies a weighting factor of .3 or .9 depending on the type of processer used. 200 petaflops equal 200,000 teraflops, so 200,000 x .3 = 60,000, and 200,000 x .9 = 180,000).

The fastest supercomputer in the world is subject to the EAR because the APP can calculate its WT.[96] Meanwhile, Google's QC which reportedly calculated in 200 seconds what would have taken that very same supercomputer 10,000 years to calculate is likely not subject to any expert control based on the APP. [97] That is because the APP measures the processing capacity in a way that only applies to classical, not quantum.[98] A quantum computer does not use bits or a traditional processor, it solves problems using particles called quibits. [99] The technical specifications of QC do not match the inputs for the APP formula.[100] Therefore, the APP cannot calculate a QC WT.[101] The CCL only regulates HPC with a WT over a certain threshold, so without a WT, QCs escape regulation.

Quantum computing has the potential to revolutionize areas like drug discovery, but it also has the potential to make current cryptography obsolete.[102] This is a classic example of the dual-use technology that the EAR regulates.[103] However, QC is not regulated by the EAR because the Department of Commerce has defined regulated HPC in a way that requires the APP formula to work. For QC, this is a loophole.

Quantum computing is still in its infancy and no standard benchmark of QC performance has emerged on which to base an updated CCL formula. That alone may be cause to restrict the export of all QC technology until the technology has matured. To maintain the U.S. advantage in HPC, the government should bring QC within the scope of the EAR by adding a second benchmark or formula to the CCL to account for the unique characteristics of QC. For example, the number of qubits a QC uses or a capability-based definition that uses existing HPC capabilities at a certain WT benchmark to make an equivalency determination.

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[96] *See ORNL Launches Summit Supercomputer*, *supra* note 94.
[97] Arute, *supra* note 43, at 505.
[98] A PRACTITIONER'S GUIDE TO ADJUSTED PEAK PERFORMANCE, *supra* note 89, at 4, 6.
[99] Choi, *supra* note 36, at 25.
[100] A PRACTITIONER'S GUIDE TO ADJUSTED PEAK PERFORMANCE, *supra* note 89, at 6 (showing the variables in the APP formula as follows: n number of processors in the "digital computer," i processor number, ti processor cycle time, Fi processor frequency, Ri peak floating point calculating rate, and Wi architecture adjustment factor).
[101] *Id.* ("For processors not capable of performing calculations on floating-point operands of 64-bits or more the effective calculating rate R is zero.").
[102] *See generally*, Rick Mullin, *Let's Talk About Quantum Computing in Drug Discovery*, CHEMICAL AND ENGINEERING NEWS (Sept. 13, 2020), https://cen.acs.org/business/informatics/Lets-talk-quantum-computing-drug/98/i35; Kania & Costello, *supra* note 49 at 3-4.
[103] DEP'T OF COM., BUREAU OF INDUS. AND SEC., *supra* note 17 ("The Bureau of Industry and Security (BIS) controls the export of dual-use and less sensitive military items through the Export Administration Regulations (EAR).").

Export controls provide a shield for the U.S. to prevent the erosion of the U.S. technological advantage. But, what if a U.S. company refuses to contract with the government for critical advanced technology needed for military or national security purposes? The Fifth Amendment offers a solution—a sword.

IV. TAKINGS CLAUSE 2.0

A private company will inevitably develop the next generation of technology that is vital to our national defense. It is also foreseeable that a company who possesses that technology may be unwilling to contract with the U.S. government.[104] The government then must choose between either ceding a comparative technological advantage, or compelling the company's cooperation to aid in our national defense. However, without congressional approval, the President cannot use the power written into the Constitution to solve this problem.[105]

A. THE FIFTH AMENDMENT

The U.S. Constitution, in particular the Bill of Rights, devolves to the individual certain inalienable rights. Among them, private property is protected against government seizure by both the Fifth and Fourteenth Amendments. The Fourteenth Amendment guarantees individual due process: "nor shall any State deprive any person of life, liberty, or property, without due process of law."[106] The Fifth Amendment protects individual property rights: "nor shall private property be taken for public use, without just compensation."[107] This clause is referred to as the "Takings Clause."

While the Takings Clause seemingly protects property rights, it is also the source of the government's constitutional authority to take private property from the individual for public benefit.[108] "The power of eminent domain . . . is an essential attribute of sovereignty and has long been recognized as a power of the

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[104] *See, e.g.*, Scott Shane & Daisuke Wakabayashi, *The Business of War: Google Employees Protest Work for the Pentagon*, N.Y. TIMES (Apr. 4, 2018), https://www.nytimes.com/2018/04/04/technology/google-letter-ceo-pentagon-project.html.
[105] *See* Youngstown, 343 U.S. at 585, 87.
[106] U.S. Const. amend. XIV, § 1, cl 3.
[107] U.S. Const. amend. V, cl. 8.
[108] Robert Meltz, *Takings Law Today: A Primer for the Perplexed*, 34 ECOLOGY L.Q. 307, 311 (2007) ("An overarching principle endlessly quoted in the cases should be highlighted at the outset. The Takings Clause, says the Supreme Court, 'was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole.'") (quoting Armstrong v. United States, 364 U.S. 40, 49 (1960)).

Federal Government."[109] The government uses the legal concept of eminent domain to exercise this power: "[t]akings law flows from eminent domain: the inherent power of the sovereign to take private property, as principally constrained by the 'public use' and 'just compensation' prerequisites of the Takings Clause."[110]

1. PUBLIC USE

The first constitutional requirement is that a taking be "for public use."[111] The Supreme Court has held that a taking is for the "public use" when that taking serves a "public purpose."[112] Public purposes that may justify the taking of private property include "alleviating blight, reducing the concentration of land ownership, and promoting economic development[.]"[113] National security as a "public purpose" rationale has not been explicitly ruled on by the court. However, national security (defense production) was the underlying rationale for the government's attempted seizure of steel mills in *Youngstown Sheet & Tube Co., v. Sawyer*.[114] The Supreme Court did not decide if national security was a "public use" in *Youngstown*, and instead decided the case on another issue and ruled against the government because the President acted without legislative authority.[115]

Courts have largely deferred to the legislature in deciding what constitutes a "public purpose."[116] In its most cited eminent domain case, the Supreme Court stated, "[f]or more than a century, our public use jurisprudence has wisely eschewed rigid formulas and intrusive scrutiny in favor of affording legislatures broad latitude in determining what public needs justify the use of the takings power."[117] Simply put, "'[i]t is only the taking's purpose, and not its mechanics' . . . that matters in determining public use."[118]

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[109] Youngstown Tube & Sheet Co., v. Sawyer, 343 U.S. 579, 680 (1952) (Vinson, J., dissenting).
[110] Meltz, *supra* note 108, at 310 (footnote omitted).
[111] U.S. Const. amend. V, cl. 8.
[112] Kelo v. City of New London, Conn., 545 U.S. 469, 480 (2005).
[113] Michael C. Pollack, *Taking Data*, 86 U. CHI. L. REV. 77, 101 (2019) (footnotes omitted).
[114] Youngstown, 343 U.S. at 582.
[115] *Id.* at 588-89.
[116] Haw. Hous. Auth. v. Midkiff, 467 U.S. 229, 244 (1984) ("Judicial deference is required because, in our system of government, legislatures are better able to assess what public purposes should be advanced by an exercise of the taking power.").
[117] Kelo, 545 U.S. at 483.
[118] Kelo, 545 U.S. at 480 (quoting Haw. Hous. Auth. v. Midkiff, 467 U.S. 229, 244 (1984)).

2. JUST COMPENSATION

The second constitutional requirement is that the government pay "just compensation."[119] Just compensation is equivalent to the fair market value of what was taken.[120] This paper does not address what compensation would be fair for the most advanced technology ever created. If the situation becomes so dire that the government must resort to a coercive power, like the Takings Clause, the pressing question will not be money—it will be the authority to act.

3. SEIZING TECHNOLOGY

The Takings Clause is not limited to real property. The government can use eminent domain to take private land to build something like a road or a border wall.[121] The Takings Clause can also be used to seize "tangible and intangible" personal property including: "franchises, money, debts of a lender, liens, most contract rights, patents and copyrights, trade secrets, unpatented mining claims, and causes of action once reduced to final, unreviewable judgment."[122]

However, this author has yet to find an instance where the government has seized technology or its underlying intellectual property using eminent domain. While there is no historical example of seizing intellectual property, based on the government's previous seizure of intangible property, the intellectual property underpinning AI and QC is likely subject to seizure if Congress passes specific authority for the executive to act. While seizing intellectual property would be novel, so was every use of eminent domain to seize a new form of property for the public good.

Over the last century, eminent domain was used for the public's benefit to construct highways, build flood control, and increase electrification of the U.S..[123] The intellectual property underpinning our modern world is as inseparable from the public welfare as those public works projects of the past: "[t]oday's public interests

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[119] U.S. Const. amend. V, cl. 8.
[120] U.S. v. Reynolds, 397 U.S. 14, 16 (1970) (footnotes omitted).
[121] *See* Katie Zezima and Mark Berman, *Trump's wall needs private property. But some Texans won't give up their land without a fight*, WASH. POST (Jan. 10, 2019), https://www.washingtonpost.com/national/trumps-border-wall-would-need-private-property-but-texas-landowners-plan-to-dig-in-for-lengthy-legal-fight/2019/01/10/d7e4cba8-1443-11e9-803c-4ef28312c8b9_story.html (discussing government attempts to invoke eminent domain to build a border wall, which have resulted in unresolved disputes).
[122] Meltz, *supra* note 108 at 319-20.
[123] Richard V. Adkisson, *Intellectual Property and Eminent Domain: If Ever the Twain Shall Meet*, 36 J. ECON. ISSUES 41, 42 (2002).

will require that the public be able to acquire the intellectual property it needs, even if its owners are unwilling to part with it."[124] Again, when determining whether a taking is in the public interest, "'it is only the taking's purpose, and not its mechanics,' . . . that matters."[125]

Congress has the power to define "public use."[126] If Congress determines that the seizure of privately owned advanced technology is in the interest of the country's national security—a public purpose—courts are unlikely to overrule Congress's judgment.[127] The Supreme Court has broadly defined what "serves a 'public purpose' . . . [by] reflecting our longstanding policy of deference to legislative judgments in this field."[128] In 1952, President Truman attempted to use his inherent executive authority to seize private property for a national security purpose, but the Supreme Court rebuked him.[129] The Court held that the President must act with some congressional authority, expressed or implied, to seize property under the Constitution. [130] "The President's power . . . must stem either from an act of Congress or from the Constitution itself."[131]

B. NEW STATUTORY AUTHORITY

The long-held legal axiom, drawn from *Youngstown*, that the president cannot use eminent domain to solve a national security issue is misplaced. The core presumption in *Youngstown* is that if Congress grants the president the authority to use eminent domain, the courts will not stand in the way.[132] Congress should heed history's warning and authorize the President to use the Takings Clause of the Fifth Amendment as a backstop to corporate intransigence. The Declaration of Taking Act (DTA) grants the President both the standing authority and a procedural mechanism to seize real property.[133] Congress should enact analogous legislation to the DTA, but for emerging technology.

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[124] *Id.*
[125] Kelo, 545 U.S. at 482.
[126] Haw. Hous. Auth., 467 U.S. at 244.
[127] *See* Laura K. Donohue, *The Limits of National Security*, 48 AM. CRIM. L. REV. 1573, 1582 (2011) ("The Supreme Court, for its part, has recognized national security as a compelling interest, and one with regard to which, in certain setting, deference should be given to the political branches."); *see also* COUNCIL ON FOREIGN REL., INDEP. TASK FORCE REP. NO. 77, INNOVATION AND NAT'L SEC.: KEEPING OUR EDGE, 2 (2019) (explaining that "many of advanced technologies necessary for national security are developed in the private sector.").
[128] Kelo, 545 U.S. at 480.
[129] *See* Youngstown, 343 U.S. at 659.
[130] *Id.* at 585.
[131] *Id.*
[132] *See also* United States *ex rel.* Tenn. Valley Auth. v. Welch, 327 U.S. 546, 551-52 (1946).
[133] 40 U.S.C. § 3114 (2002).

In a recent article, Professor Pollack makes the case for such a statute, the Data Taking Act, modeled after the DTA.[134] While the likelihood is small that the government would be able to convince a private company to sell their technology in aid of our national defense, the risk is significant enough that we should establish contingent authority. Congress should grant the President eminent domain authority, and a mechanism to exercise such authority, modeled on the DTA to seize vital technology in the national interest. Even if never used, having the authority to unilaterally act would be a powerful incentive for private companies to contract with government, or risk having their technology taken.

V. NOT ALL ROSES

Arms control regulations and eminent domain legislation can and should be part of the U.S. national strategy to maintain our strategic technological advantage. However, neither of these options should be our first choice. We should continue to do what has kept America great: outcompeting the competition. Arms control and eminent domain are only appropriate when outcompeting is not enough. Arms control is a stop-gap measure to stem the flow of technology transfer. Eminent domain forces private enterprise to align with U.S. national security interests. Both are blunt-force options, but not long-term solutions.[135]

A. EXPORT CONTROL

Of the two options discussed in this paper, export control regulations are the most likely to succeed. They can be tailored and targeted to a specific technology.[136] They describe what technology is subject to a give restriction using detailed technical language and specify to which countries a specific technology can and cannot be exported.[137] Arms and commerce control regulations are also not all that controversial. They have been used for decades.[138]

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[134] Pollack, *supra* note 113, at 102 (Professor Pollack's premise is that the government's Fifth Amendment eminent domain power can achieve what the government's Fourth Amendment search and seizure power has not).
[135] Heather Somerville, *China Has 'Concerning' Leads Over U.S. in Tech, Defense Department Official Says*, WALL STREET J. (Oct. 23, 2019), https://www.wsj.com/articles/china-has-concerning-leads-over-u-s-in-tech-defense-department-official-says-11571856288.
[136] BUREAU OF INDUS. AND SEC., U.S. DEP'T OF COM., EXPORT COMPLIANCE GUIDELINES: THE ELEMENTS OF AN EFFECTIVE EXPORT COMPLIANCE PROGRAM (2017).
[137] *See* 15 C.F.R. § 730.8 (2020).
[138] EXPORT COMPLIANCE GUIDELINES, *supra* note 136.

Nevertheless, export control regulations still carry risk. The main risk being that companies will develop technology outside of the United States to avoid export controls altogether. The United States' goal should be to promote the domestic development of technology to maintain our global technological advantage. If the U.S. erects a closed development system through regulation, that would disincentivize companies from creating the next generation of technology in the US.

The U.S. can overcome this catch-22 by using a tiered approach. Only the most significant and advanced technology would be subject to strict export controls. Technology like QC that is barely more than theoretical can have stringent controls will little consequence. Artificial intelligence export controls would require a tiered approach. The more advanced the AI the more restrictions are imposed on its export. U.S. national security would not benefit from regulating AI that is already commercially available. But, for AI that is capable of "broad" or "extreme generalization," the author opines that the advantage gained by stringent export controls far outweighs the risk of companies avoiding technology development in the US.[139]

B. EMINENT DOMAIN

It is undeniable that eminent domain offers the government a solution to the problem identified by this paper. If a company possesses advanced technology but restricts government access to it, and that in turn harms the U.S. technological advantage, the government can simply use eminent domain to seize that technology. It is also undeniable that using eminent domain in such a manner would be opening a Pandora's box.

If Congress passed a Data Taking Act, and then that legislature was utilized to actually seize technology, intellectual property would flee the country and be offshored to escape the reach of the U.S.'s long-arm. Thus, defeating the goal of the U.S. government's access to U.S. developed technology. If the U.S. government determines that a piece of technology is so vital to the national interest and that the only way to gain access to it is through eminent domain, it should act knowing that eminent domain is a one-shot weapon.

[139] Chollet, *supra* note 76.

VI. CONCLUSION

The United States is the global leader in AT and QC technology, but our global competitors are not far behind.[140] Maintaining our advantage in emerging technologies, like AI and QC, is vital to the U.S. national security interest. However, unlike the past, private companies—not the government—are the driving force of innovation.[141] The government has lost direct control of the distribution and use of the technology that is vital to its future.[142] But, we have the legal tools to confront both problems.

First, the President, through the Departments of State and Commerce, should update existing export control regulations to bring AI and QC within their purview.[143] These regulations need to catch up with emerging technology. Second, Congress should grant the President the authority to seize vital technology using the federal government's eminent domain power under the Fifth Amendment's Taking Clause.[144] Such an authority will prevent a U.S. company's self-interest from overriding the country's national interest. The United States can benefit from private sector innovation while maintaining our global advantage. We can have our cake and eat it too.

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[140] Sintia Radu, *Despite Chinese Efforts, the U.S. Still Leads in AI*, U.S. NEWS & WORLD REP. (Aug. 19, 2019), https://www.usnews.com/news/best-countries/articles/2019-08-19/the-us-is-still-the-global-leader-in-artificial-intelligence.

[141] *See* EXEC. OFFICE OF THE PRESIDENT, CYBERSPACE POL'Y R.: ASSURING A TRUSTED AND RESILIENT INFO. AND COMMC'N INFRASTRUCTURE i (2014).

[142] *Id.*

[143] *See infra* Appendix A; *infra* Appendix B.

[144] *See infra* Appendix C (proposing statutory authority to exercise eminent domain power).

APPENDIX

Appendix A. Artificial Intelligence Export Control Classification Number

4D004 “Artificial Intelligence”

License Requirements

Reason for Control: NS, CC, AT

Control(s)	**Country Chart (See Supp. No. 1 to part 738)**
NS applies to entire entry	NS Column 1
RS applies to entire entry	RS Column 2
AT applies to entire entry	AT Column 1

Reporting Requirements
See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End–User authorizations.

List Based License Exceptions (See Part 740 for a Description of All License Exceptions)
List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. “Artificial Intelligence” shall include “software”, that that is capable of the following:

a.1. “Broad generalization”, adaptation to unknown unknowns across a broad category of related tasks; or

a.2. “Human-level generalization”, adaptation to unknown unknowns across an unknown range of tasks and domains at or near the level of biological forms of intelligence.

b. “Artificial Intelligence” shall include any component, hardware, firmware, or other unique technical capability, working individually or collectively, that allows “software” to achieve “broad generalization” or “human-level generalization”.

Appendix B. Quantum Computer Export Control Classification Number

4D999 Computers as follows (see List of Items Controlled) and "specially designed" related equipment, "electronic assemblies" and "components" therefore.

License Requirements

Reason for Control: NS, CC, AT

Control(s)	**Country Chart (See Supp. No. 1 to part 738)**
NS applies to entire entry	NS Column 1
RS applies to entire entry	RS Column 2
AT applies to entire entry	AT Column 1

Reporting Requirements
See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End–User authorizations.

List Based License Exceptions (See Part 740 for a Description of All License Exceptions)
List of Items Controlled

Related Controls: 4A003, 4A004

Related Definitions: "digital computer", "Adjusted Peak Performance"

Items:

a. "Quantum Computers"; or

b. Any computing device having the ability to solve a computation problem that a "digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 1,000 Weighted TeraFLOPS (WT) is capable of solving in less than 1 hour.

Technical Notes:
1. "Quantum Computers" are any computers that calculate using particles suspended in superposition or rely upon the principle or entanglement.

Appendix C. Taking Authority for Critical Technology Act (TACT Act)

(a) Filing and Content.—In any proceeding in any court of the United States outside of the District of Columbia brought by and in the name of the United States and under the authority of the Federal Government to acquire technology, or its sub-components, or underlying intellectual property for the public use, the petitioner may file, with the petition or at any time before judgment, a declaration of taking signed by the authority empowered by law to acquire the land described in the petition, declaring that the technology, sub-component(s), or intellectual property is taken for the use of the Government. The declaration of taking shall contain or have annexed to it—

(1) a statement of the authority under which, and the public use for which, the technology, its sub-components, or underlying intellectual property is taken;

(2) a description sufficient to identify what has been taken;

(3) a statement of the extent of what has been taken for public use;

(4) a list of the tangible or intangible property taken, including a specific identification of any patented intellectual property taken;

(5) a statement of the amount of money estimated by the acquiring authority to be just compensation for property taken; and

(6) a description of the Government's prior attempt seeking to purchase, lease, or otherwise gain amenable mutual access to the property at issue.

(b) Vesting of Ownership.—On filing the declaration of taking and depositing in the court, to the use of the persons entitled to the compensation, the amount of the estimated compensation stated in the declaration—

(1) Ownership or interest specified in the declaration vests in the Government; and

(2) the right to just compensation for the property taken vests in the persons entitled to the compensation.

(c) Compensation.—

(1) Determination and award.—

Compensation shall be determined and awarded in the proceeding and established by judgment. The judgment shall include interest, in accordance with 28 U.S.C. 1961, on the amount finally awarded as the value of the property as of the date of taking and shall be awarded from that date to the date of payment. Interest shall not be allowed on as much of the compensation as has been paid into the court. Amounts paid into the court shall not be charged with commissions or poundage.

(2) Order to pay.—

On application of the parties in interest, the court may order that any part of the money deposited in the court be paid immediately for or on account of the compensation to be awarded in the proceeding.

(3) Deficiency judgment.—

If the compensation finally awarded is more than the amount of money received by any person entitled to compensation, the court shall enter judgment against the Government for the amount of the deficiency.

(d) Authority of Court.—On the filing of a declaration of taking, the court—

(1) may fix the time within which, and the terms on which, the parties in possession shall be required to surrender possession to the petitioner; and

(2) may make just and equitable orders to make respondent financially whole.

(e) Vesting Not Prevented or Delayed.—
An appeal or undertaking given in a proceeding does not prevent or delay the vesting of ownership in the Government.