# HEARING ON CHINA'S PURSUIT OF DEFENSE TECHNOLOGIES: IMPLICATIONS FOR U.S. AND MULTILATERAL EXPORT CONTROL AND INVESTMENT SCREENING REGIMES

---

**HEARING**

BEFORE THE

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

**ONE HUNDRED EIGHTEENTH CONGRESS**
FIRST SESSION

THURSDAY, APRIL 13, 2023

Printed for use of the
U.S.-China Economic and Security Review Commission
Available online at: www.USCC.gov

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

WASHINGTON: 2023

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

CAROLYN BARTHOLOMEW, *CHAIRMAN*
ALEX N. WONG, *VICE CHAIRMAN*

Commissioners:
BOB BOROCHOFF
ROBIN CLEVELAND
AARON FRIEDBERG
KIMBERLY T. GLAS
HON. CARTE P. GOODWIN
JACOB HELBERG
JAMES MANN
REVA PRICE
HON. RANDALL SCHRIVER
MICHAEL R. WESSEL

The Commission was created on October 30, 2000 by the Floyd D. Spence National Defense Authorization Act of 2001, Pub. L. No. 106–398 (codified at 22 U.S.C. § 7002), as amended by: The Treasury and General Government Appropriations Act, 2002, Pub. L. No. 107–67 (Nov. 12, 2001) (regarding employment status of staff and changing annual report due date from March to June); The Consolidated Appropriations Resolution, 2003, Pub. L. No. 108–7 (Feb. 20, 2003) (regarding Commission name change, terms of Commissioners, and responsibilities of the Commission); The Science, State, Justice, Commerce, and Related Agencies Appropriations Act, 2006, Pub. L. No. 109–108 (Nov. 22, 2005) (regarding responsibilities of the Commission and applicability of FACA); The Consolidated Appropriations Act, 2008, Pub. L. No. 110–161 (Dec. 26, 2007) (regarding submission of accounting reports; printing and binding; compensation for the executive director; changing annual report due date from June to December; and travel by members of the Commission and its staff); The Carl Levin and Howard P. ''Buck'' McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113–291 (Dec. 19, 2014) (regarding responsibilities of the Commission).

The Commission's full charter and statutory mandate are available online at: https://www.uscc.gov/charter.

**CONTENTS**

THURSDAY, APRIL 13, 2023

HEARING ON CHINA'S PURSUIT OF DEFENSE TECHNOLOGIES: IMPLICATIONS FOR U.S. AND MULTILATERAL EXPORT CONTROL AND INVESTMENT SCREENING REGIMES



**Panel I: China's Defense Modernization Objectives and R&D Ecosystem**



**Panel II: Obstacles and Breakthroughs in China's Defense Technological Development**

**Panel III: Policy Tools for the United States and Its Allies and Partners**



QUESTIONS FOR THE RECORD

# HEARING ON CHINA'S PURSUIT OF DEFENSE TECHNOLOGIES: IMPICATIONS FOR U.S. AND MULTILATERAL EXPORT CONTROL AND INVESTMENT SCREENING REGIMES

THURSDAY, APRIL 13, 2023

---

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

*Washington, DC*

The Commission met in Room 419 of Dirksen Senate Office Building, Washington, DC and via videoconference at 9:30 a.m., Chairman Carolyn Bartholomew and Vice Chairman Alex Wong (Hearing Co-Chairs) presiding.

## OPENING STATEMENT OF CHAIRMAN CAROLYN BARTHOLOMEW HEARING CO-CHAIR

CHAIRMAN BARTHOLOMEW: Welcome to the fourth hearing of the U.S.-China Economic and Security Review Commission's 2023 annual report cycle. Thank you all for joining us today. Thank you particularly to our witnesses for sharing your expertise and for the work you have put into your testimonies. I'd also like to thank the Senate Foreign Relations Committee for allowing us the use of this hearing room and the Senate Recording Studio as always for their assistance live streaming this event.

Today's hearing will assess China's pursuit of advanced technologies for its defense modernization and the implications of this pursuit for U.S. interests. China's leaders want the People's Liberation Army, the PLA, to become a modern and innovative force that can contest U.S. technological superiority and achieve China's strategic goals such as, but certainly not limited, to the unification of Taiwan with the mainland. Responding to these calls, China's defense industry has made technological progress over the past two to three decades narrowing the capabilities gap between the PLA and the U.S. military in a number of warfighting domains. Major developments include the development of a diverse modern arsenal of missile systems, including what many experts say is the most advanced hypersonic missile program in the world, the successful deployment of space-based situational awareness systems, ongoing research on counterspace weapons, manned space flight, and planned scientific missions to outer space, improvements to China's systems for hunting enemy submarines, and rapid progress in the field of artificial intelligence, including military applications such as autonomous aerial and underwater vehicles.

China's leaders aim not just to achieve parity with the United States in these domains, but rather to surpass the United States where possible. Doing so is essential to achieving General Secretary Xi's stated ambition of China becoming a world class military by mid-century, a goal the Commission has previously assessed entails direct competition with the U.S. for global military superiority.

U.S. export controls and other restrictions on technology transfer to China have appeared to be stymy some aspects of PLA modernization to date in spite of widespread efforts by Chinese entities to acquire these technologies. In particular, China's defense industry still struggles to produce high performance engines for its fighter aircraft and propulsion technologies for its submarines. But as Chinese leaders have made abundantly clear in various five-year plans, China will continue to work steadily to close these technological gaps and to develop weapons systems targeting perceived U.S. vulnerabilities.

Moreover, the United States is increasingly at risk from defense applications of dual-use technology developed in the commercial sphere, especially in emerging technologies like AI. Our witnesses today will assess how we can reform our current export control system to better monitor and prevent potential adversaries from acquiring these technologies. Additionally, they will consider whether and where expanded investment screening may prevent the flow of capital and transfer of know-how to Chinese entities of concern.

We look forward to discussing actionable policy recommendations for Congress. Our witness today -- witnesses today have deep and diverse expertise on these issues. And I welcome the fact that five of our ten witnesses have not appeared before the Commission and bring valuable perspectives to these challenges. Of course, there are people we are always pleased to see a second time.

I will now turn the floor over to my colleague and Co-Chair for this hearing, Vice Chairman Alex Wong.

**PREPARED STATEMENT OF CHAIRMAN CAROLYN BARTHOLOMEW**
**HEARING CO-CHAIR**

**Hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"**

**April 13, 2023**

**Opening Statement of Chairman Carolyn Bartholomew**

Good morning, and welcome to the fourth hearing of the U.S.-China Economic and Security Review Commission's 2023 Annual Report cycle. Thank you all for joining us today. Thank you to our witnesses for sharing your expertise and for the work you have put into your testimonies. I would also like to thank the Senate Foreign Relations Committee for allowing us the use of their hearing room and the Senate Recording Studio for their assistance livestreaming this event.

Today's hearing will assess China's pursuit of advanced technologies for its defense modernization and the implications of this pursuit for U.S. interests.

China's leaders want the People's Liberation Army (PLA) to become a modern and innovative force that can contest U.S. technological superiority and achieve China's strategic goals, such as – but certainly not limited to – the unification of Taiwan with the Mainland. Responding to these calls, China's defense industry has made technological progress over the past two to three decades, narrowing the capabilities gap between the PLA and the U.S. military in a number of warfighting domains. Major developments include:

- The development of a diverse, modern arsenal of missile systems, including what many experts say is the most advanced hypersonic missile program in the world;
- The successful deployment of space-based situational awareness systems, ongoing research on counterspace weapons, manned spaceflight, and planned scientific missions to outer space;
- Improvements to China's systems for hunting enemy submarines; and
- Rapid progress in the field of artificial intelligence, including military applications such as autonomous aerial and underwater vehicles.

Chinese leaders aim *not just to achieve parity* with the United States in these domains, but *rather to surpass* the United States where possible. Doing so is essential to achieving General Secretary Xi's stated ambition of China becoming a "world-class military" by mid-century, a goal the Commission has previously assessed entails direct competition with the United States for global military superiority.

U.S. export controls and other restrictions on technology transfer to China have appeared to stymie some aspects of PLA modernization to date, in spite of widespread efforts by Chinese entities to acquire these technologies. In particular, China's defense industry still struggles to produce high-performance engines for its fighter aircraft and propulsion technologies for its submarines. But as Chinese leaders have made abundantly clear in various five-year plans, China will continue to work steadily to close these technological gaps and to develop weapons systems targeting perceived U.S. vulnerabilities. Moreover, the United States is increasingly at risk from defense applications of dual-use technology developed in the commercial sphere, especially in emerging technologies like artificial intelligence. Our witnesses today will assess how we can reform our current export control system to better monitor and prevent potential adversaries from acquiring

these technologies. Additionally, they will consider whether and where expanded investment screening may prevent the flow of capital and transfer of knowhow to Chinese entities of concern.

We look forward to discussing actionable policy recommendations for Congress. Our witnesses today have deep and diverse expertise on these issues, and I welcome the fact that five of our ten witnesses have not appeared before the Commission and bring valuable perspectives to these challenges.

I will now turn the floor over to my colleague and co-chair for this hearing, Vice Chairman Alex Wong.

**OPENING STATEMENT OF VICE CHAIRMAN ALEX WONG**
**HEARING CO-CHAIR**

VICE CHAIRMAN WONG: Thank you, Chairman Bartholomew and thank you as well for partnering with me on this hearing. It is important as you say. I'd like to thank our witnesses for the effort and expertise that they're contributing today. And I want to express appreciation to the Commission staff for pulling today's hearing together.

And make no mistake, this is an important hearing. The Commission and the witnesses will explore the question I believe is the most -- most key to determining whether the United States will be able to maintain its leadership of the free world and its ability to foster the peace in the Indo-Pacific region and beyond. And that's the question of hard military power.

More specifically, which country will yield the preponderance of it in the Indo-Pacific in the coming decades? Which country will have the edge and capabilities crucial to cutting-edge warfare? And which country will be able to scale these defense technologies to win wars? There are only two reasonable answers to this question. It will either be the United States or it will be China. And if it's China, that will raise grave uncertainties about possible conflict, regional upheaval, and the ability of the constituent nations of the Indo-Pacific to make sovereign choices about their ways of life.

Our Commission routinely explores facets of our economic competition with China, our political competition, our soft power competition. Those are all exceedingly important areas of inquiry. But I believe throughout history, the most significant determinant of a country's ability to maintain a favorable balance of power is its ability or inability to innovate and invest in the military realm and assert clear military superiority over its main rivals.

China's leaders understand this and they're seeking to seize the military edge from the United States. Therefore the task of the United States, one that this Commission hopes to contribute to today, is to understand China's quest for military parity at minimum and superiority where possible. What defense technologies is China pursuing to fill the gaps in its arsenal? What inputs and conditions does China need to obtain these technologies in a relevant timeframe? And where in that innovation and procurement process can the United States and our friends and allies place prudent and effective pressure?

The answers to these questions will be vital if the United States is to adopt the right policies to hamper China's defense innovation as we boost our own for the benefit and the betterment of the world. Carolyn.

**PREPARED STATEMENT OF VICE CHAIRMAN ALEX WONG**
**HEARING CO-CHAIR**

**Hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"**

**April 13, 2023**

**Opening Statement of Vice Chairman Alex Wong**

Thank you, Chairman Bartholomew, and thank you as well for partnering with me on this hearing. I'd also like to thank our witnesses for the effort and expertise they're contributing today. And I want to express appreciation to the Commission's staff for pulling this hearing together.

And make no mistake—this is an important hearing. The Commission and the witnesses will explore the question I believe is the most key to determining whether the United States will be able to maintain its leadership of the Free World and its ability to foster the peace in the Indo-Pacific region and beyond.

And that's the question of hard military power. More specifically, which country will wield the preponderance of it in the Indo-Pacific in the coming decades? Which country will have the edge in capabilities crucial to cutting-edge warfare? And which country will be able to scale these defense technologies to win wars?

There are only two reasonable answers to those questions. It'll either be the United States or it'll be China. And if it's China, that will raise grave uncertainties about possible conflict, regional upheaval, and the ability of the constituent nations of the Indo-Pacific to make sovereign choices about their ways of life.

Our Commission routinely explores facets of our economic competition, political competition, and soft-power competition with China. Those are all exceedingly important areas of inquiry. But I believe throughout history, the most significant determinant of a country's ability to maintain a favorable balance of power is its ability—or inability—to innovate and invest in the military realm and assert clear military superiority over its main rivals.

China's leaders understand this. And they're seeking to seize the military edge from the United States.

Therefore, the task for the United States—one this Commission hopes to contribute to today—is to understand China's quest for military parity at minimum, and superiority where possible. What defense technologies is China pursuing to fill gaps in its arsenal? What inputs and conditions does China need to obtain those technologies in a relevant time frame? And where in that innovation and procurement process can the United States and our friends and allies place prudent and effective pressure?

The answers to these questions will be vital if the United States is to adopt the right policies to hamper China's defense innovation as we boost our own for the betterment of the world.

## PANEL I INTRODUCTION BY CHAIRMAN CAROLYN BARTHOLOMEW

CHAIRMAN BARTHOLOMEW: Thanks very much. We'll move forward into our first panel. Our first panel will start by examining China's motivations and policies for defense modernization, including overviews of its military procurement process and military-civil fusion strategy.

First, we'll hear from Dr. Tai Ming Cheung, a professor at the University of California. We thank him particularly for being up at this early hour out on the West Coast. He's also the Director of the UC Institute on Global Conflict and Cooperation. Dr. Cheung will discuss the key actors making decisions about China's defense needs, the policy framework guiding China's defense modernization efforts, and funding for weapons-related research and development. Welcome back.

Next, we'll hear from Christian Curriden, a defense analyst at the RAND Corporation and a new voice for the Commission. Mr. Curriden will survey the processes and problems of China's military procurement process.

Finally, we will hear from Elsa Kania, an adjunct senior fellow at The Center for New American Securities Technology and National Security Program. Ms. Kania will examine how China's military-civil fusion strategy advances its defense modernization efforts. We welcome you back also.

Thank you all very much for your testimony. I'd like to remind you to keep your remarks to seven minutes. Dr. Cheung, we'll begin with you.

## OPENING STATEMENT OF TAI MING CHEUNG, PROFESSOR AT UNIVERSITY OF CALIFORNIA, SAN DIEGO AND DIRECTOR OF THE UC INSTITUTE ON GLOBAL CONFLICT AND COOPERATION

DR. CHEUNG: Okay. Thank you, Commissioner and to the Commission for inviting me to talk again at this Commission. I think the -- I can't remember the first time I did it, but it was back in the mists of time. As you rightly pointed out, this is -- It's 6:30 here. I'm on my second cup of tea, but I still don't know how articulate I'm going to be, but I'm going to try and be as succinct as possible.

So I was asked a number of questions related to the development of China's weapons development capabilities. Beginning from the decisions that are taken, based on threat assessments and how that goes through the system to the structure, processes, and resource allocations for carrying out these weapon developments.

In my written testimony, I offer general descriptions of China's approach to this weapons development identifying sort of key approaches and key processes such as the relationship between the Chinese military strategy, the military strategic guidelines, and key strategies such as the weapons and equipment development strategy and its implementation plan, as well as the importance of the five-year planning cycle.

In my oral remarks, I'm not going to go into a great deal of detail. But I wanted to offer a few broader characteristics to provide context to my written narrative. The first is I would say that the Chinese weapons development system as we know it today is relatively new. It only came of age since the late 1990s when the armaments development process came to be recognized within the PLA to be at the same level of other parts of the military system, like the General Department, the Joint Staff Department, or the Logistics or the Political departments.

So what we're seeing in this sort of quarter century since this coming of age has been sort of a remarkable and a very strong performance. But there's lots of problems. A lot of sort of the weapons development process that the Chinese have was inherited from the Soviet Union. It was all central planning. So there's a lot of sort of like historical baggage.

They're building a lot of new processes and new approaches. And so what we're still trying to work out is what are the positives and the negatives of their sort of relatively new system? Is it better suited, especially for sort of new technological developments, emerging technologies?

It doesn't have a lot of the other baggage that we see like in the U.S. with a lot of red tape with the acquisition system.

So the newness of this makes for fascination through like sort of debate over the next decade.

A second key characteristic is the organizational approach of the system. The system is very much of a top down, highly vertically integrated, which is not that dissimilar to the U.S. and other armament development systems around the world. But this top down approach is particularly important for the development of what we sort of consider to be sort of high-value strategic deterrence systems where there's a need of a concentration of resources, the ability to mobilize across their system.

And a key feature of this top down system is a very hands-on role played by Xi Jinping, who since he's come to power in 2012 has paid a very, very sort of great deal of attention to weapons development in his role as Chairman of the Central Military Commission and also as the head of the 995 Leading Small Group.

A third characteristic is that much of that rapid progress made in China's weapons development activities, especially since the turn of the century, is what we would sort of define as an absorption-based model of development. It's a catching up. The ability to absorb foreign technologies and know-how from abroad and improve upon that. And sort of turn that into sort of like systems reverse engineering and turn that into a system with Chinese characteristics. That's been very, very good and that's allowed the Chinese to catch up and narrow in a fairly rapid manner.

But what we're seeing, especially in the last few years is that this absorption-based model is now being sort of like, sort of appears to be important. But a more important approach is a development of an original home-based innovation system where because of sort of like on China's rapid economic growth, technological development, and also the concerns about sort of being what the Chinese call being "strangled" from export controls and sanctions. Not being able to access these capabilities.

They're developing sort of a home grown, sort of innovation system focusing on basic research of the research and development system. This is particularly important going forward and we see this in the last few years with a 14th five-year plan and other long-term plans. And so this shift from absorption to original innovation is going to be one of the key drivers over the next sort of decade to 15 years.

And one last point before I end is that the weapons development process is amply resourced. Unfortunately we don't know how much. And one of the questions that was asked is what the proportion that the Chinese spend on their defense research and development compared to the rest of the defense budget? The only things that we know is that it's not in -- research and development is primarily not in the defense budget. It's in other parts of the state budget.

And moreover, in recent years, we've seen a large part of sort of like research and development and production coming from what we would define as military-civil fusion by tapping into the capital markets. So it's not always dependent on the state budget. There's other sources of funding. And sort of the best guess is that the ratio that Chinese spend on research and development is sort of similar to what the U.S. spends. And I know I'm out of time, so I'll stop my remarks here. Thank you.

CHAIRMAN BARTHOLOMEW: Thank you very much. Mr. Curriden.

**PREPARED STATEMENT OF TAI MING CHEUNG, PROFESSOR AT UNIVERSITY OF CALIFORNIA, SAN DIEGO AND DIRECTOR OF THE UC INSTITUTE ON GLOBAL CONFLICT AND COOPERATION**

**Testimony Before the U.S.-China Economic and Security Commission**
**Hearing on China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes**
**Panel I: China's Defense Modernization Objectives and R&D Ecosystem**

# Priorities, Policies, and Budgets for China's Defense Modernization

**Tai Ming Cheung, University of California San Diego and University of California Institute on Global Conflict and Cooperation**

**13 April 2023**

**Explain how Chinese leaders' perceptions of threats they face in the international environment drive decisions about required future capabilities and military procurement programs.**

The transmission belt of how threat perceptions of the external security environment held by China's governing leadership elite are turned into the development and procurement of military capabilities for the People's Liberation Army (PLA) runs through the formulation of the country's Military Strategic Guidelines (MSG), which constitutes the PLA's "programs and principles for planning and guiding the overall situation of war in a given period."[1]

The formulation of the MSG is overseen by the Central Military Commission (CMC) and carried out in coordination with numerous PLA units.[2] The MSG addresses a multiplicity of factors including external threat perceptions, likely contingencies, geostrategic assessments, and domestic concerns, and identifies tasks crucial for determining the likely nature of future wars.

Four factors are especially relevant to the examination of the relationship between threat perceptions and the development of war-fighting capabilities. The first is the identification of the Strategic Opponent (战略对手). This is based on an assessment of the international security environment and consideration of threats to China's national interests. The United States was the principal enemy between the 1950s and early 1960s, followed by the Soviet Union from the mid-late 1960s to the end of the 1970s. Chinese military authorities have not publicly identified their principal strategic opponent since the 1980s, but some internal PLA writings suggest that the United States became China's principal strategic opponent (not enemy) beginning in the 2000s.

A second concept is the Main Strategic Direction (MSD; 主要战略方向), which refers to the geographic focal point for potential conflict and provides the basis for the prioritization of resource allocations. The MSD is a contingency-based assessment that informs wartime

[1] Taylor Fravel, ***Active Defense: China's Military Strategy Since 1949*** (Princeton: Princeton University Press, 2019), 28. See also David M. Finkelstein, "China's National Military Strategy: An Overview of the 'Military Strategic Guidelines'", Roy Kamphausen and Andrew Scobell (Eds), ***Right Sizing the People's Liberation Army: Exploring the Contours of China's Military,*** ( Carlisle, P.A.: Army War College, 2007), 67–140.
[2] Zhang Wannian Writing Team (张万年传写作组), ***Biography of Zhang Wannian (张三并伀).*** (Beijing: Liberation Army Press (北京; 解放军出版社), 2011), 59−72.

operations and peacetime war planning for "worst case" scenarios to develop forces and capabilities and make deployment decisions. Only one MSD is permitted at any time, although multiple secondary strategic directions are allowed. The MSD has shifted extensively over the course of the history of the People's Republic of China, initially focused on threats from its east between the early 1950s and early 1960s in the direction of the United States and regional allies such as Japan and Taiwan. The MSD pivoted to China's north and northwest from the mid-1960s to the mid-1980s to face off against the Soviet Union. There was a lull between the mid-1980s and early 1990s when there was no major state-based threat, but Taiwan became the MSD from the early 1990s and has continued to occupy this position at the beginning of the 2020s, although the threat aperture has likely widened to include the role of the United States in any Taiwan contingency.

The third component is the "Basis of Preparations for Military Struggle" (军事斗争准备的基点), which is concerned with the nature and form of future war (total, local, conventional, or nuclear) that China will need to fight and the patterns of operations that will need to be conducted.

The fourth component is Army Construction and Development (军队建设发展) that is concerned with all aspects of the PLA's modernization, development, and reform efforts. The MSG guidance on construction and development provides the broad priorities and parameters for the detailed formulation of near-, medium-, and long-term implementation plans. One of the most important of these programs is the "Outline of the Five-Year Plan for PLA Construction and Development" (军队建设发展规划纲要), which comes out at the same time as the national five-year development plan. The Outline of the 13th Five-Year Plan for PLA Construction and Development was the first to be prepared and issued during Xi's rule in 2016 and reflects the priorities and goals of the MSG.[3] An extensive array of construction, development, and reform tasks are covered that include (1) ideological and political work; (2) force structure; (3) weapons and equipment; (4) logistics; (5) information infrastructure; (6) military training; (7) defense mobilization; (8) international military cooperation; (9) defense technological innovation; (10) military theory and regulations; (11) battlefield support; (12) and military civil fusion (MCF). The outline emphasizes that priority should be placed on military struggle preparations.

While the MSG provides broad strategic principles and general guidelines on weapons requirements and acquisition issues, the detailed nuts and bolts of programmatic management, strategic design, planning, and implementation is the responsibility of the Weapons and Equipment Development Strategy (WEDS; 武器装备发展战略) and attendant Weapons and Equipment Construction Plans (WECPs). These planning documents represent the near-, medium-, and long-term visions and roadmap for implementation of the Chinese defense establishment's science and technology (S&T) development for its weapons and equipment capabilities, and have witnessed profound changes over the last several decades.

[3] "Central Military Commission Issues 13th Five-Year Plan for Army Construction and Development", ***Xinhua News Age*ncy (新华社),** 12 May 2016, http://www.xinhuanet.com/mil/2016-05/12/c_1118855988.htm.

The WEDS and WECP are classified, and there are only occasional references to their role and importance in guiding the PLA's technological modernization. However, in an article marking the reorganization of the General Armament Department (GAD) into the CMC Equipment Development Department (EDD) as part of the restructuring of the PLA high command in 2016, *China Military Industry News*, the GAD's official news mouthpiece, disclosed for the first time that one of its accomplishments was to establish "scientific planning of long-term defense science and technology and weapons and equipment development through a twenty-year development strategy, ten-year construction outline, and three five-year plans."[4]

The WEDS provides the overall strategic rationale for the country's armament development. It offers long-term planning stability and provides an integrated approach involving input from across the entire defense establishment. Moreover, it is a rigorous assessment that looks at regional and global strategic, military, and technological trends, and the nature of future war and compares these dynamics with China's national, military, economic, industrial, and technological capabilities to support armament research and development. As one PLA study noted, "in the formulation of military equipment development plans, it is necessary to use a military equipment development strategy as their foundation. Chiefly, this means considering the country's situation for a relatively long period of time in the future, and the country's military strategic policies, as well as analyzing and making predictions for the international strategic environment, the security environment on the country's periphery, and the military equipment needs of the country's troops in future military conflicts."[5]

The WEDS comes in two categories: a national-level version and service-level variants. The national-level WEDS is produced by the EDD and is a comprehensive and integrated strategy for the PLA and defense S&T establishment. The WEDS is described as "subordinate to and serves" the MSG and also takes into account the country's national development strategy and S&T plans.[6]

**Identify the key people and organizations with China's Party-state and People's Liberation Army (PLA) that make decisions about the future capabilities China requires as well as how particular weapons systems or platforms enable those capabilities. If possible, illustrate this decision-making process with an example.**

Chart 1 (at the end of this statement) identifies key Chinese state, party, and military institutions affiliated with the country's defense research, development, and acquisition system and are involved in providing inputs and/or making decisions about future armament capabilities:

[4] "For Seventeen Years, We Walked Together", ***China Military Industry News (*** 31 December 2015, http://news.hit.edu.cn/zgjgb/list.htm

[5] Yu Gaoda and Zhao Lusheng (余高达,和赵潞生), ***The Study of Military Equipment (*** (Beijing: National Defense University Press (国防大学出版社), 2000), Chapter 9.

[6] Fu Guangming and Ji Hongtao (傅光明和吉洪涛), "Exploration of Hu Jintao's Strategic Thinking on Strengthening Military with Science and Technology", ***China Military Science (*** No. 5 (2011).

The most important of these organizations are:

- 995 Project Leading Small Group, which is responsible for overseeing the development of major, especially strategic deterrent, capabilities and was established in response to the U.S. bombing of the Chinese embassy in Belgrade in 1999.

- Central Military Commission (CMC) Science and Technology Commission: This organization's responsibilities include the strategic management of defense scientific research, promoting indigenous home-grown innovation, and promoting military-civil fusion. It has been compared to the U.S. Defense Advanced Research Projects Agency (DARPA).

- CMC Equipment Development Department: This is the military's principal organization for armaments research, development, testing, and procurement.

- State Administration for Science, Technology, and Industry for National Defense (SASTIND): This state entity manages the country's defense industrial apparatus and falls under the Ministry of Industry and Information Technology.

Key officials that hold influential decision-making authority include the heads of the 995 Project Leading Small Group, CMC Science and Technology Commission, CMC Equipment Development Department and its service arm counterparts, SASTIND, and the Executive Vice Chairman of the CMC.

**Describe the policy framework that guides China's defense modernization efforts. What are the foundational policies, plans, and programs? Which agencies develop it and implement it? Are there any overlapping functions that cause friction, or any clear gaps in jurisdiction?**

The primary policy framework that guides China's defense modernization efforts, especially over the medium to long-term, is the five-year planning cycle. These five year plans (FYP) are drawn up and implemented at the same time as counterpart plans in the civilian arena. Besides the PLA-wide Construction and Development FYP, the armament apparatus at the CMC and service and specialized arms levels, and defense science, technology, and industry systems all have their own FYPs. The PLA armament system has the five-year Medium-Term Weapons and Equipment Construction Plan, which is a core component of the PLA Construction and Development FYP. The defense industry has its five-year defense S&T development plan that has numerous specialized five-year sub-plans for specific sectors and technologies. The 995 Program also has a five-year planning cycle.

There is little open information on how the defense-related FYPs are drafted, but if the process resembles how civilian FYPs are drawn up, then special working groups are formed with broad representation from across the sector that the plan covers. For the PLA Construction and

Development Plan, the working group would likely be led by the CMC chairman, who will delegate detailed oversight to the Executive CMC Vice-Chairman. Members of the working group will also likely include senior representatives of relevant CMC departments, commissions, and offices such as the Joint Staff Department, Strategic Planning Office, Equipment Development Department, and CSTC, along with service and specialized arms, joint theater commands, SASTIND, key educational and policy think tanks such as the National Defense University and Academy of Military Sciences.

The current five year planning cycle began in 2021 with the launch of the 14th Five Year Plan. The national level FYP, officially called the 2021-2025 People's Republic of China 14th Five-Year Plan for National Economic and Social Development (中华人民共和国国民经济和社会发展第十四个五年规划), contains short descriptions of military, defense industrial, and dual-use military-civil fusion (MCF) objectives. The plan highlights the need to accelerate the pace and scale of defense modernization, especially with the goal of "improving the strategic ability to defend national sovereignty, national security, and development interests" by the 100th anniversary of the founding of the PLA in 2027.[7]

This centennial target was first disclosed at the 5th Plenum meeting of the 19th Party Congress Central Committee in November 2020, which reviewed an earlier draft of the 14th FYP and was the first time that such a target date had been publicly disclosed. Neither the 14th FYP nor the 5th Plenum communiqué provided any specific details of what is meant by the 2027 target date, however. The FYP emphasizes the need to "strengthen strategic forces and new combat forces in new domains as well as creating high-level strategic deterrence and joint combat systems."[8]

Several other military modernization objectives are detailed in the 14th FYP. One is accelerating the integration of mechanization, informatization, and intelligenization. Mechanization refers to industrial-age warfare that is predominantly fought by large-scale, low-tech, ground-based forces, which constitutes a large majority of PLA units. Informatization involves network-centric, highly mobile, and smaller-sized forces that are set up for information warfare. Intelligenization refers to future warfare in which emerging technologies such as AI, quantum information, big data, cloud computing, and the IoT will play a central role, which means a growing emphasis on autonomous and unmanned military capabilities.

The plan also calls for optimizing the layout of the defense industry. A top priority is promoting advanced high-end defense science, technology, and innovation along with high-quality defense production. Reforms are taking place to improve the structure and process of the defense innovation system and to reinvigorate the defense industrial base by allowing competition and addressing obstacles such as monopolies and corruption.

[7] Xinhua News Agency, ***14th Five-Year Plan (2021-2025) and the Long-Range Objectives Through the Year 2035 for National Economic and Social Development,*** 12 May 2021, Section 16, Introduction.
[8] 14th Five-Year Plan, Chapter 56.

The 14th FYP also discusses the pursuit of the convergence between the civilian and defense economies, although the MCF term is no longer employed.[9] The general objective outlined in the plan is to build an overarching integrated strategic system in which the civilian, defense, and national security sectors are closely aligned and coordinated. An extensive list of goals includes the following:

- Expand efforts to share resources, which means allowing the defense industrial sector to increase its access to the financial markets.
- Encourage the coordinated civil-military development of key regions. A top priority of the 14th FYP is regional and infrastructure development, especially the construction of high-speed transportation networks and the building of major urban clusters around the country. Military requirements will feature prominently in these projects.
- Deepen civil-military R&D collaboration. The civilian S&T R&D system will be increasingly leveraged for defense requirements.[10]
- Strengthen military-civil joint development (军民统筹发展) in maritime, space, cyber, biotechnology, new energy, AI, and quantum technology.
- Promote spin-on (civilian to military) and spin-off (military to civilian) applications in research, development, and production activities.
- Improve the development of the national defense mobilization system to ensure that the national economy can be rapidly and effectively repurposed for defense and national security uses in crisis and wartime conditions. The coronavirus pandemic in 2020 is a prime example of activating the defense mobilization system to deal with a health crisis.
- Guarantee the national security of critical economic capabilities and beef up of early warning, risk prevention, and control mechanisms of the economy. Sectors explicitly pointed out in the plan include the grain, food, infrastructure, energy, and financial industries.[11]

In parallel, the state defense industrial bureaucracy formulates the Defense Science, Technology, and Industry Five-Year Plan (DSTI FYP 国防科技工业五年规划). There is no information so far as to the contents of the 14th DSTI FYP, but its predecessor 13th FYP had a number of key objectives. First was the task of achieving "leapfrog" development in weapons and military equipment. Second was the enhancement of innovation capabilities in turnkey areas. Third was the optimization of the structure of the defense industry and the vigorous promotion of MCF. Fourth was the stepping up of weapons exports efforts.[12]

[9] 14th Five-Year Plan, Section 16, Chapter 57.
[10] Liu, Xiaobing (刘小兵), "Promote the Simultaneous Improvement of National Defense Strength and Economic Strength" (促进国防实力和经济实力同步提升), ***Guangming Daily,*** 14 March 2021, https://news.gmw.cn/2021-03/14/content_34683946.htm.
[11] 14th Five-Year Plan, Chapter 53. See also Dong, Yu (董煜), "The Correct Way to Open the 'Outline' of the 14th Five-Year Plan" ("十四五"规划"纲要"的正确打开方式), ***Diyi Caijing (笫乁贤绑),*** 15 March 2021, https://www.yicai.com/news/100986328.html.
[12] "2016 National Defense Science, Technology and Industry Work Conference was held in Beijing", ***SASTIND (圊阴枝巧层),*** 9 January 2016, http://www.gov.cn/xinwen/2016-01/09/content_5031770.htm.

As FYPs are a key policy instrument for securing financial resources and commitments for extended periods of time, there is almost certainly intensive bureaucratic rivalry among competing constituencies to get their priorities funded.

**What information is available about the budget for research and development of new weapons technology? Where do the monies in this budget come from? How often is funding authorized or appropriated, and by what bodies within the Chinese party-state? Is the budget for R&D distinct from the PLA's own budget?**

The Chinese government do not publish any openly available information on official budgetary allocations for defense research and development. While military authorities do provide a high-level breakdown of the official defense budget that is divided into three categories (personnel, training and maintenance, and equipment), most research and development-related funding allocations are excluded. Defense R&D expenditures, which are officially termed defense scientific research and experiment funds (国防科研试验经费), are assigned to other parts of the government budget that goes to SASTIND, dedicated S&T development plans such as the 995 program, and subsidies for defense industrial firms.

An analysis by academics Sun Yutao and Cong Cao of Chinese S&T financial data from 71 central government agencies for 2011 show they accounted for 44 percent of central government S&T expenditures.[13] The study also found that eight national security-related agencies (SASTIND, China Atomic Energy Agency, National Nuclear Security Administration, National Space Administration, Ministry of State Security, Ministry of National Defense (proxy for PLA), National Administration for Protection of State Secrets, and State Encryption Administration) did not disclose their S&T expenditures, which suggests they accounted for the remaining 56% of central S&T outlays, or around Renminbi (Rmb) 110 billion ($17 billion) in 2011. The PLA and SASTIND would account for most of the non-disclosed central S&T expenditures. As China's defense budget in 2011 totaled Rmb 601 billion ($91 billion), the non-disclosed central S&T expenditures would be equivalent to 18 percent of the defense outlays. This rough calculation would suggest that Chinese state allocations for defense-related R&D activities would be around the mid-10s as a percentage of the official defense budget, which would be a little higher than what the U.S. Defense Department allocates for its R&D enterprise.

It should also be pointed out that Chinese defense industrial firms have been able to tap into investment assets from China's capital markets since the early 2010s through government guidance funds, asset securitization deals, bond issues, and bank loans. This has provided a significant financial boost to China's investment in defense and dual use-related research, development, and production.

**What constraints or trade-offs do Chinese leaders and defense contractors face when deciding how much of their budget to allocate to R&D for weapons technology?**

[13] Sun Yutao and Cong Cao, "Demystifying Central Government R&D Spending in China", ***Science,*** Vol. 345, Issue 1006, 29 August 2014, https://www.science.org/doi/10.1126/science.1253479

One of the biggest fundamental issues for Chinese policy-makers and the defense R&D community when it comes to determining R&D allocations is the balance between basic research and applied research and development. China and the Chinese defense community more specifically have benefited greatly from an absorption-based approach to S&T development, which is to absorb foreign technology and research know-how and convert this into output. This has meant that the overwhelming allocation of research and development funding has been in the development category. Chinese basic research spending is well below the level invested by advanced industrial economies.

In recent years, and especially since the beginning of the 2020s as detailed in the 14th FYP and other long-term S&T planning efforts, the focus is shifting to emphasizing original innovation that means greater emphasis and nurturing of basic research capabilities. The 14th FYP, for example, calls for a significant boost in basic national research spending from around 6 percent at the end of the 13th FYP to 8 percent by 2025. This is still around half of what advanced economies such as the United States (17 percent in 2017), France (21 percent in 2016), and Japan (13 percent in 2017) spends on basic research,[14] but in absolute terms could see a doubling in the size of Chinese basic research outlays by the mid-2020s. Moreover, the plan calls for increasing annual R&D expenditures by 7 percent.

The defense R&D enterprise has likely been investing more heavily in basic research and focusing on original innovation much earlier than the civilian sector because it has been subject to Western sanctions and export control measures since the end of the 1980s. But the shift of the national innovation system from absorption-oriented to original innovation-based development will help to significantly bolster the expansion of the basic research capabilities of the defense R&D system. This will require defense policy makers and defense contractors to make trade-offs between how much should be allocated between basic research vs. applied research and development.

**The Commission is mandated to make policy recommendations to Congress based on its hearings and other research. What are your recommendations for Congressional action related to the topic of your testimony?**

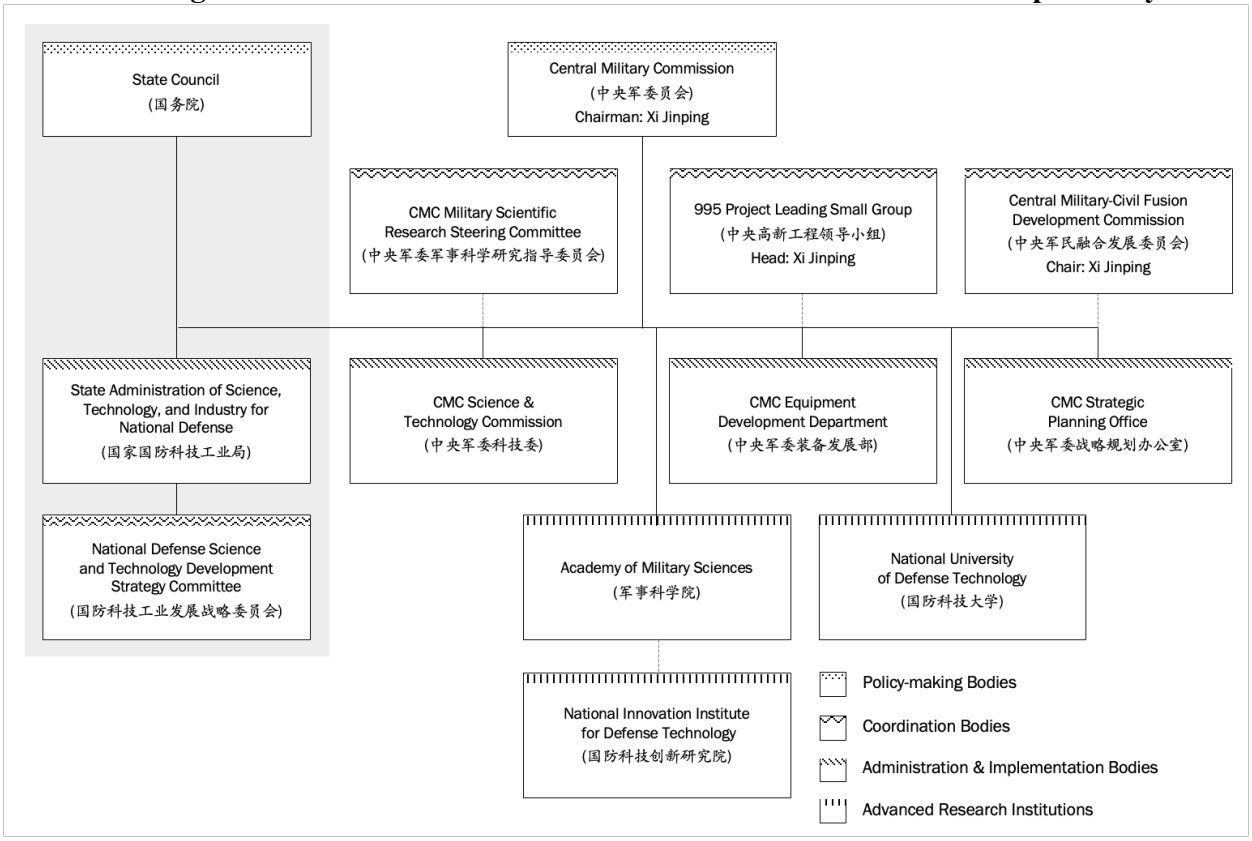
One observation is that the U.S. defense community as well as the broader U.S. S&T community has very little expertise on the issues covered in my testimony. Chinese defense-related research, development, and industrial affairs is poorly researched and covered by both the policy and scholarly communities. Much more effort needs to be invested in this area given that technology-security competition is at the heart of U.S.-China great power competition.

One recommendation is that while the U.S. service arms have set up China-dedicated research entities such as the Center for the Study of Chinese Military Affairs at National Defense University, China Maritime Studies Center at the U.S. Naval War College for the U.S. Navy, and

[14] National Science Board, ***Research and Development: U.S. Trends and International Comparisons (Science and Engineering Indicators 2020),*** (Arlington: National Science Foundation, January 2020), 32, https://ncses.nsf.gov/pubs/nsb20203/.

the China Airpower Studies Institute for the U.S. Air Force, there should be a similar research entity situated in the Pentagon, specifically within the research and engineering portfolio.

**Chart 1: Organization Chart of the Chinese Defense Research and Development System**



## OPENING STATEMENT OF CHRISTIAN CURRIDEN, DEFENSE ANALYST, RAND CORPORATION

MR. CURRIDEN: Thank you. Very happy to be here. It's a privilege to speak to the Commission. So you know, going off of what Professor Cheung has said, I wanted to focus my remarks on sort of the nuts and bolts of the Chinese research development and acquisition system -- the RDA system. It has many inefficiencies. As Professor Cheung has noted, it has really struggled to escape its past as a command economy institution. Xi Jinping and the Chinese Communist Party are aware of these inefficiencies and are working to address them. But they do not seem to be interested in any way in major structural reforms that would address some of the underlying reasons for these inefficiencies.

That being said, it is a system which given sufficient time and money -- and as Professor Cheung noted, it's very good at focusing on particular goals for a very long time -- given sufficient time and money, it is very capable of producing highly sophisticated weapon systems that pose a dire threat to American forces and allied forces throughout the Indo-Pacific.

Like the American RDA system, the Chinese RDA system goes through five basic steps when they want to purchase a new platform. They'll start with a feasibility study and work to establish and assess the requirements and costs for the new platform. They'll then move on to a project design phase where they'll start to do some of the basic R&D and design components in parts of the systems. Do some prototyping there.

They'll then move on to an engineering and development phase -- yeah -- engineering and development phase where they'll go into full scale design of the product and eventually produce some prototypes which they can hand over to the PLA for phase four, which is an experiment and design finalization phase. When the specialized PLA test and evaluation units will use it and possibly tweak the design. And after that, it goes into batch production. This is where it deviates a bit from normal practice in the United States. The Chinese RDA system is very iterative. And very often as soon as they're done with these first four phases, they'll almost immediately start working on the next version of whatever platform it is. You know, the A variant or the B variant or the C variant. And there's even been some cases in which the initial version is so bad, the PLA doesn't really even want that many of them. And so you'll see very limited production runs for the first one. And the PLA seems to be kind of waiting for a better version before they go into larger scale production.

This is a long process. It takes the PLA ten to 15 years in general to go through all of these steps and to produce a -- produce and widely disseminate a new platform to the PLA. A lot of the differences between the Chinese and American RDA processes stem from the nature of the Chinese defense industrial base.

The defense industrial base in China is dominated by a small number of state-owned conglomerates. And these are general monopolies for most sectors. For example if China wants war ships, the China State Shipbuilding Corporation is pretty much the only game in town. There are a couple of instances in which there are more than one company in an area. But even there, the companies tend to cooperate more than they compete so that, you know, even though there's two missile companies say, if you want a short range tactical missile, there's really only one option versus if you want a liquid fuel missile, there's really only one option. And Xi Jinping does not seem to be in any way interested in changing that monopolistic structure at least for major systems integration.

These companies are important interest groups and actors within the Chinese Communist Party. Their top leaders -- Their top leadership positions are controlled by the Chinese Communist Party Central Committee's Organizational Department. So they don't really have much in the way of market control, but the CCP can -- the Chinese Communist Party can exercise direct administrative control over these companies. Traditionally, they've also lacked accountability to anyone outside of the Chinese Communist Party.

A lot of the contracts between the PLA and the companies have historically been rather vague and not especially enforceable. And they've usually used a cost-plus model by which many of the costs of a weapon system are effectively just transferred back to the military. And so, you know, lacking these sorts of, you know, transparency and lacking market competition, the PLA tends to rely on administrative measures to control the companies and ensure its interests are maintained. And the people who do this often are the PLA's military representatives. These are uniformed PLA officers that are stationed around the country and assigned to particular factories or research institutes. And they monitor those companies. They monitor the weapons they produce. They monitor their tests to make sure they're not, you know, fudging their data for the PLA and that sort of thing.

That being said, this system also is plagued by insufficiency, plagued by lack of education among its members, and plagued by conflicts of interest. That being said, as I said Xi Jinping is aware of these problems. And very recently -- in some cases as recently as last year, there have been major new policies to reform the RDA process. In particular, the PLA seems to be interested in experimenting with different cost structures and possibly with contract reform. That being said, as I noted earlier, there does not seem to be any real desire to increase the overall transparency of the PLA's relationship with these large state-owned corporations or any real interest in changing the monopolistic structure of the market.

Elsa is going to talk a lot more about military-civil fusion. But so far, what we've seen with military-civil fusion at least in terms of competition has introduced some competition for component manufacture and for providing services to the PLA, but has not really -- does not yet seem to have included much competition at the higher level in terms of main system integration. That being said, as has been noted, as inefficient as the system can be, ultimately we have to judge an RDA system based on what it produces. And the Chinese have been at this for a long time. For at least a quarter century, they have been very focused on, for example, disrupting American surface forces in the Western Pacific. And you know, they've thrown a lot of money at this problem.

Seven of the 20 largest defense corporations in the world are Chinese and eight are American. So I mean they're still smaller than this in terms of the defense industrial base, but they're getting to be comparable. And as we've seen particularly in the Chinese anti-ship ballistic missile system and hypersonic missile systems, given enough time and enough money, they are capable of producing very sophisticated, innovative, and effective weapon systems. Thank you.

CHAIRMAN BARTHOLOMEW: Thank you very much. Ms. Kania.

**PREPARED STATEMENT OF CHRISTIAN CURRIDEN, DEFENSE ANALYST, RAND CORPORATION**

# The Chinese Acquisition Process

Christian Curriden

CT-A2691-1
Testimony presented before the U.S.-China Economic and Security Review Commission on April 13, 2023.

For more information on this publication, visit www.rand.org/t/CTA2691-1.

Testimonies

RAND testimonies record testimony presented or submitted by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies.

Published by the RAND Corporation, Santa Monica, Calif.


Limited Print and Electronic Distribution Rights



www.rand.org

*The Chinese Acquisition Process*

Testimony of Christian Curriden[1]
The RAND Corporation[2]

Before the U.S.-China Economic and Security Review Commission

April 13, 2023

Given enough time, money, and clear operational tasks, the People's Liberation Army (PLA) research, development, and acquisition (RDA) system is clearly capable of producing innovative and advanced platforms. Over the past 30 years, it has made great progress in a number of very difficult fields, including hypersonic vehicles, carrier-based aviation, and propulsion systems, though jet engines and naval diesel engines seem to present some difficulties.[3] Despite these achievements, it is a system plagued by many inefficiencies.

---

[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of the RAND Corporation or any of the sponsors of its research.

[2] The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest. RAND's mission is enabled through its core values of quality and objectivity and its commitment to integrity and ethical behavior. RAND subjects its research publications to a robust and exacting quality-assurance process; avoids financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursues transparency through the open publication of research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. This testimony is not a research publication, but witnesses affiliated with RAND routinely draw on relevant research conducted in the organization.

[3] Note that, while the Chinese have made great progress in jet engine production, as of March 2023, supply chain efforts continue to impede mass production of military jet engines. Civilian jet engines remain even further behind. That said, China's ability to replace many of its Russian engines with domestic products suggests that, at least for military platforms, it may be close to addressing this problem. Note, too, that, as of 2022, the Chinese struggled with multi-fuel small-watercraft engines. On the diesel-naval-engine front, until at least 2020, Chinese destroyers were being built with German engines license-produced in China. Although domestic alternatives seem to be available, the fact that China continued to purchase these German models despite the country's emphasis on domestic development of weapon systems suggests that the Chinese models may have been deficient in some way. See Minnie Chan, "China's Next-Gen J-20 Stealth Fighter Jettisons Russian Engine in Favor of Home-Grown Technology," *South China Morning Post*, January 8, 2021; Amanda Lee, "China's C919 Jet to Be More Home-Grown with a Domestically Made Engine, But How Long Will It Take?" *South China Morning Post*, October 12, 2022; Amanda Rivkin, "German Technology Found in China's Warships: Report," Deutsche Welle, November 6, 2021; U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China*, 2022, p. 153; and Mike Yeo, "Supply Chain Issues Impede Mass Production of New Chinese Engine," Defense News, March 27, 2023.

PLA oversight over the large, state-owned conglomerates that monopolize the defense sector remains an issue. RDA is also a slow process—generally ten to 15 years to produce new large platforms, and sometimes considerably longer.[4] There may be some exceptional systems that have been developed more rapidly (the DF-17 hypersonic missile may be one such example), and upgrades to existing systems can come more quickly, but most of the aircraft, ships, tanks, and missiles the PLA employs today have been under development since at least the early 2010s, and perhaps even much earlier. This consistent focus on ambitious projects and generous expenditure of resources over time is perhaps the greatest strength of the Chinese RDA process. While the PLA has encountered many difficulties and failures since the turn of the millennium, it has learned from them, has continued to improve, and now produces some of the most effective weapon systems in the world.

It is important to note that this testimony is based entirely on publicly available sources. Given the opacity of China's RDA process, the reliance on publicly available sources has presented some difficulties and led to a certain degree of uncertainty over milestones like program start and end dates. It also necessitates a focus on large platforms, such as aircraft, warships, armored vehicles, and ballistic missiles, which are easier to track in open sources. The conclusions in this testimony might not apply to software, platform upgrades, key components like radar or other sensors, or other smaller-scale acquisition efforts. Given the length of time the PLA RDA system usually takes to produce a new platform, most of the systems examined were begun before Xi Jinping's major military reforms, so it is difficult to see the full impact of those reforms on the entire RDA process from start to finish for a single major platform.

## Xi Jinping and Acquisition Reform

Since taking office in 2012, Xi Jinping has made reforming and modernizing the Chinese military and wider defense industrial base one of his key priorities. From 2012 to 2020, he made as many as 120 visits to sites or events associated with military modernization, far more than his predecessors.[5] These visits included appearances aboard China's new aircraft carrier, at the National University of Defense Technology (the Chinese military's main science and technology university), and at the All-Army Armament Conference in Beijing.[6]

Many of the largest changes that Xi made were reminiscent of the U.S. Goldwater-Nichols reforms of the late 1980s. Most operational control has been shifted from the PLA service branches to newly formed joint theater commands, leaving the services responsible for

[4] U.S. timelines can also take well over a decade.

[5] Tai Ming Cheung, "Keeping Up with the *Jundui*: Reforming the Chinese Defense Acquisition, Technology, and Industrial System," in Phillip C. Saunders, Arthur S. Ding, Andrew Scobell, Andrew N. D. Yang, and Joel Wuthnow, eds., *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms*, National Defense University Press, 2019, pp. 589–591; Tai Ming Cheung, *Innovate to Dominate: The Rise of the Chinese Techno-Security State*, Cornell University Press, 2022, p. 144.

[6] Cheung, 2019, pp. 589–591.

organizing, training, and equipping China's military.[7] The PLA's four general departments (staff, political affairs, logistics, and armaments) have been largely dismantled, and many of their responsibilities and institutions have either gone to a new set of 15 offices, commissions, and departments directly under the Central Military Commission or devolved to the services.[8]

One of the bureaucratic losers in this reform was the PLA's General Armaments Department, which lost many of its responsibilities for direct oversight of acquisition programs to the PLA service branches (especially the PLA Army, or ground forces).[9] It also lost its oversight of the Science and Technology Committee, which now operates directly under the Central Military Commission.[10] The General Armaments Department's successor, the Equipment Development Department (EDD), remains responsible for "centralized unified management" of the PLA armament system and joint issues affecting the entire military.[11] Along with the State Administration of Science, Technology, and Industry for National Defense (SASTIND), it is also in charge of licensing processes and regulations for firms in the defense industry.[12] The PLA service branches each have their own equipment development departments, which seem to be in charge of managing the military representative systems and overseeing weapon tests for their services, while the EDD seems responsible for overall design and regulation of the testing and evaluation process, as well as establishment of military-wide standards.[13] The EDD is also responsible for developing an overall Weapons Equipment Development Strategy, which lays out the basic assumptions about geostrategic trends, technological developments, and future conflicts that underpin the PLA's weapon development.[14] This strategy serves as the basis for

---

[7] Some services may retain some operational control, but these are the exception rather than the rule (Joel Wuthnow and Phillip C. Saunders, "Introduction," in Phillip C. Saunders, Arthur S. Ding, Andrew Scobell, Andrew N. D. Yang, and Joel Wuthnow eds., *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms*, National Defense University Press, 2019, pp. 7–8).

[8] Wuthnow and Saunders, 2019, pp. 6–7.

[9] Cheung, 2019, p. 592.

[10] Mark Ashby, Caolionn O'Connell, Edward Geist, Jair Aguirre, Christian Curriden, and Jonathan Fujiwara, *Defense Acquisition in Russia and China*, RAND Corporation, RR-A113-1, 2021, pp. 16–17, https://www.rand.org/pubs/research_reports/RRA113-1.html.

[11] Cheung, 2019, p. 592; Cheung, 2022, p. 163.

[12] Cheung, 2022, p. 114.

[13] It is possible that the EDD is more directly responsible for overseeing some tests (Cheung, 2022, p. 164; Hu Kaibing [胡锴冰] and Jin Yongchan [金永昌], "Navy Equipment Development Department Builds Cross-Service Military Representative Contract Oversight System" ["海军装备部坚持质量至上以战领建原则 探索构建跨军兵种军代表合同监管体系"], China Military Online [中国军网], October 29, 2019, http://www.81.cn/jpdbfy2019/ywyl_206455/9663060.html; Hu Kaibing [胡锴冰], Lei Zhu [雷柱], and Wang Haofan [王皓凡], "Taking a Closer Look at a Navy Military Representative Office and Getting a Feel for the 'Battlefield Perspective' of the New Age" ["让我们走进海军某军代室，感受新时代监造官们的"战位观"], China Military Online [中国军网], April 21, 2021, http://www.81.cn/yw_208727/10026068.html.

[14] Cheung, 2022, pp. 151–154.

ten-, five-, and one-year Weapon Equipment Construction Plans, which translate its general principles into concrete weapon programs and requirements.[15]

Xi's attention has also resulted in changes in the defense industry more broadly. He has accelerated the consolidation of the major state-owned firms that act as prime contractors for military platforms and moved to strengthen these firms.[16] In particular, he has overseen a reform of their many scientific institutes, addressing many of the ownership, classification, and personnel issues that had hampered their research in the past.[17]

More broadly, Xi has repeatedly emphasized the importance of scientific and technological research in both the military and civilian sectors. In particular, he has called on the PLA to shift from a primarily absorptive model of innovation (in which most technological progress is made by buying or stealing foreign technology and incorporating it into the Chinese military) to one based on original innovation.[18] This is not to say that Chinese leaders are opposed to the purchase or outright theft of foreign technology, but they have expressed the need for more of the PLA's systems to be based on indigenous innovation. This drive for domestic technology may be based in part on fears of remaining reliant on foreign sources for components or know-how, as well as the belief that domestic innovation will help China's economy and the PLA remain internationally competitive.[19]

## Similarities to the U.S. Acquisition Process

Many aspects of China's RDA process are broadly similar to that of the United States. Like the United States, the PLA seems to have five broad steps to its acquisition process. First is a feasibility study to establish requirements and assess the possible costs of a new program. Next comes a project design phase, in which models and prototypes are built and assessed. Third is an engineering and development phase, during which the PLA undertakes full-scale design of the new platform. The program then enters an experiment and design finalization phase, in which the system is subjected to specialized testing by PLA testing-and-evaluation units. Finally, if the system has successfully passed all of these stages, it proceeds to batch production, although, as will be discussed in the following section, this might not mean immediate mass production.[20]

Chinese acquisition programs generally seem to take between ten and 15 years, with some exceptions. This is broadly in line with the timescale of major U.S. acquisition programs, which generally take more than a decade, though, here again, there are exceptions.[21] The Y-20 airlifter,

---

[15] Cheung, 2022, pp. 151–156.

[16] Cheung, 2019, p. 598.

[17] Cheung, 2019, pp. 603–604.

[18] Cheung, 2019, pp. 593–594.

[19] Cheung, 2019, pp. 594–595.

[20] Ashby et al., 2021, pp. 17–18.

[21] There is not enough information in open sources to say whether the Chinese system or the U.S. system is faster. It may depend on the type of weapon system involved. Available information suggests that both systems operate on

for example, underwent about 17 years of research and development before reaching something like initial operational capability.[22] Even the carrier-borne J-15 took 11 to 13 years, despite the fact that it was a very high-priority program.[23] In some cases, the PLA has been known to rush the early research and development phases, but this has generally led to lengthy technology, engineering, and demonstration processes and low initial production rates, as seen with the J-15 and the Type 052 destroyer.[24] A lack of transparency regarding the earlier stages of the development process can make these timelines difficult to track, and there may be some exceptional programs that were able to proceed with greater speed. The PLA's hypersonic DF-17 missile might be one such exception, though this is far from obvious, as I will discuss later. It should also be reiterated that this testimony is based on research focused on large weapon platforms, not components or upgrades. By and large, however, the PLA and U.S. RDA processes seem to be operating on similar timescales, with most major programs taking more than a decade.[25]

The U.S. and Chinese defense industrial bases are also similar in terms of the overall size of defense firms. While U.S. defense firms remain the largest in the world in terms of defense revenue, their Chinese counterparts are catching up. As of 2022, eight of the top 20 global defense firms in terms of defense-related revenue were from the United States, and seven were in China.[26] It is also worth noting that the Chinese defense state-owned enterprises (SOEs) are significantly larger than their defense revenue would suggest, as about two-thirds of the revenues of most Chinese defense firms comes from non–defense-related activities, such as automobiles or white goods production.[27]

---

broadly similar timescales for the development of large weapon platforms ("20 Years of Assessing DOD's Weapon Programs Shows the Importance of Having the Right Information Before Making Investment Decisions," *WatchBlog*, Government Accountability Office, July 7, 2022, https://www.gao.gov/blog/20-years-assessing-dods-weapon-programs-shows-importance-having-right-information-making-investment-decisions).

[22] Ashby et al., 2021, pp. 18–19.

[23] Ashby et al., 2021, pp. 18–19.

[24] Ashby et al., 2021, p. 19; Tai Ming Cheung, "Strengths and Weaknesses of China's Defense Industry and Acquisition System and Implications for the United States," in *Proceedings of the Fourteenth Annual Acquisition Research Symposium*, Vol. II, Naval Postgraduate School, March 31, 2017, p. 343.

[25] Of course, there are some U.S. programs that take considerably longer, and the lack of specificity in open sources makes it difficult to determine exactly whether the U.S. system or the Chinese system operates more rapidly. In terms of major platform development, both systems seem to be operating within broadly similar timescales ("20 Years of Assessing DOD's Weapon Programs Shows the Importance of Having the Right Information Before Making Investment Decisions," 2022; Ashby et al., 2021, p. 19).

[26] Note that defense revenues at Lockheed Martin and Boeing remain the largest by a sizable margin. Note, too, that the Chinese defense conglomerates are quite large, but much of their revenue comes from non–defense-related subsidiaries (Defense News, "Defense News Top 100," webpage, undated, https://people.defensenews.com/top-100/; see also Ashby et al., 2021, pp. 19–20).

[27] Cheung, 2022, p. 170.

## Differences from the U.S. Acquisition System

Many of the differences between the U.S. and Chinese RDA processes stem from the relationships that Chinese defense firms share with the PLA and the Chinese Communist Party (CCP), which are significantly different from the relations between the U.S. Department of Defense and its suppliers. Almost all major Chinese military platforms are produced by one of a handful of large SOEs, which, like the PLA, are important interest groups within the CCP. Their chief executives' positions are among those controlled by the nomenklatura system of the Organization Department of the Central Committee of the CCP, and they carry an official rank equivalent to that of a vice minister.[28] These firms were formed in the 1980s and 1990s as the CCP carved the carcass of its old Stalinist command economy into distinct enterprises, and they continue to be subject to the regulations of SASTIND, a civilian government agency responsible for overall planning, regulation, and oversight of the defense industry.[29] Thus, there is likely limited legal recourse when disputes arise between PLA officials and their SOE suppliers, as both (as well as the courts themselves) are important political actors within the CCP.[30] Contracts between the PLA and these SOEs have generally been simplistic and perfunctory, without clear technical obligations.[31] Most have traditionally been based on a "cost-plus" model inherited from the old command economy, in which a profit of 5 percent is guaranteed to the enterprise, leaving little incentive to improve efficiency or reduce costs.[32]

The PLA is not unaware of these problems and has made some moves to rectify them. In 2014, the General Armaments Department (now the EDD) sought to reform the PLA pricing structure to allow for other pricing models and to control costs.[33] Such measures have likely been resisted by defense SOEs, and it is unclear how prevalent cost-plus contracts remain.[34] More recently, in late 2021 and 2022, the PLA released several new policies promising a "new system"

---

[28] Top-level SOE executives do form a relatively distinct group within the Chinese elite and often retire or move to different SOEs when their positions end, though some are transferred to other provincial or central government bodies (Wendy Leutert, "The Political Mobility of China's Central State-Owned Enterprise Leaders," *China Quarterly*, Vol. 233, March 2018, pp. 1–2).

[29] Note, for example, the continued ability of SASTIND to regulate how its research institutes are structured. See Ashby et al., 2021, p. 16; and Cheung, 2022, p. 119.

[30] There is limited information available in public sources about how exactly disputes between the PLA and SOEs are resolved. It is not impossible that Xi Jinping's drive to use the law to strengthen the CCP will result in a larger role for judicial institutions in this process. I find this unlikely because of (1) the traditionally underdeveloped state of court oversight in the defense sector; (2) the fact that the PLA and the SOEs are both powerful party bodies and the courts are under party control, leaving any judicial decisionmaking process at the mercy of backroom deals within the CCP; and (3) the fact that Xi's focus on law clearly does not mean making the CCP in general subject to legal review. See Ashby et al., 2021, pp. 22–23; and Cheung, 2022, pp. 96, 176.

[31] Ashby et al., 2021, pp. 22–23; Cheung, 2022, p. 176.

[32] Ashby et al., 2021, p. 23; Cheung, 2022, p. 176.

[33] Cheung, 2022, pp. 176–177.

[34] Cheung, 2022, pp. 176–177.

for military procurement, including contract management.[35] These regulations seem to be classified, and it is currently unclear what effect they will have on the ways the PLA interacts with the SOEs and private firms.

Finally, most of these large SOEs are essentially monopolies for a given set of platforms.[36] While there are two Chinese defense conglomerates in some areas (for example, both the China Aerospace Science and Technology Corporation and the China Aerospace Science and Industry Corporation produce long-range missiles), they often specialize in different types of platforms, so, in general, the PLA has only one option to turn to as the lead system integrator for most major programs.[37]

Often lacking competition or clear contracts to protect its interests vis-à-vis the Chinese defense SOEs, the PLA has traditionally relied on the CCP's administrative control over them and on its own military representative officers.[38] These are active-duty PLA officers stationed at the factories or research institutes that are producing the weapons their service branches will be using. They are meant to protect the interests of the PLA by ensuring production quality and contract execution.[39] In doing so, they have historically been hampered by low education levels; most are recent college graduates with limited technical training. In addition, these officers often experience conflicts of interest. Their salaries have traditionally been paid by the institutions they are charged with monitoring; they tend to stay at a single institution for a long time; and, after retirement, they often find jobs at the institutions they used to monitor.[40]

Articles published after the Xi Jinping reforms of the mid-2010s show that this military representative system remains in place.[41] Recent reforms have included efforts to establish joint military representative offices to avoid duplication of effort and measures instituted to allow military representatives to remotely monitor the institutions over which they have oversight.[42] Military representative offices seem to continue to have close, long-term relationships with the

---

[35] "Central Military Commission Chairman Xi Jinping Signs the 'Military Equipment Purchasing Regulations'" ["中央军委主席习近平签署命令 发布《军队装备订购规定》"], State Council Information Office of China, November 1, 2021, http://www.scio.gov.cn/tt/xjp/Document/1715707/1715707.htm; Li Jiaqi [李佳琦], Ma Zijian [冯子剑], and Ding Tuo [丁拓], "Forging the Sharp Blade of Future Victory, We Need a Breakthrough from '0 to 1'" ["锻造制胜未来的利刃，我们需要更多"从 0 到 1"的突破"], China Military Online [中国军网], April 6, 2022, http://www.81.cn/pl_208541/jdt_208542/10146201.html.

[36] Ashby et al., 2021, p. 23; Cheung, 2022, p. 172; Peter Woods and Alex Stone, *China's Ballistic Missile Industry*, China Aerospace Studies Institute, May 11, 2021, pp. 5–6.

[37] There are exceptions in some areas, such as medium-range ballistic missiles or laser-based air defense systems. See Ashby et al., 2021, p. 23; and Woods and Stone, 2021, pp. 5–6.

[38] Tai Ming Cheung, "An Uncertain Transition: Regulatory Reform and Industrial Innovation in China's Defense Research, Development, and Acquisition System," in Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation*, Johns Hopkins University Press, 2014, pp. 49–52.

[39] Ashby et al., 2021, p. 21.

[40] Ashby et al., 2021, p. 22.

[41] "Central Military Commission Chairman Xi Jinping Signs the 'Military Equipment Purchasing Regulations,'" 2021; Li, Ma, and Ding, 2022.

[42] Hu and Jin, 2019; Hu, Lei, and Wang, 2021.

institutions they monitor.[43] More research would be needed to determine whether their pay structure, education, and employment patterns after retirement from the PLA have changed.

The PLA's RDA system also tends to be highly iterative. Once a new system goes into production, work often begins on a newer, upgraded version, usually designated an A/B/C/D variant.[44] For some platforms, at first, only small numbers of systems are produced and distributed to operational PLA units for further testing, and their input can result in changes in future versions.[45] In some cases (such as the Type 98 tank or the Type 052 destroyer), the first version of the platform has been so unsatisfactory that the PLA has purchased only a relatively small number, waiting for improvements.[46]

The PLA seems to take an especially aggressive approach to buying or stealing foreign technology, and many of its weapon systems are copies of foreign models. There are numerous examples of this. The Chinese J-11 is more or less a copy of the Russian SU-27 with various indigenously produced upgrades, the Chinese CH-4 drone is based largely on the U.S. MQ-9, and China's J-20 borrows heavily from the U.S. fifth-generation fighter programs.[47] The CCP has devised a number of methods to acquire dual-use technologies from the private sector, including joint ventures with foreign firms, purchase of all or parts of foreign technology companies, and theft.[48] Acquiring single-use military technologies can be more difficult, though the PLA has been able to make some progress in this area by reverse-engineering military equipment purchased from foreign (usually Russian) firms and engaging in cyberespionage.[49]

## Weaknesses

As discussed, the Chinese RDA process can produce unsatisfactory products that require multiple iterations, and even its reverse-engineered platforms can be inferior to the originals on which they are based.[50] The major defense conglomerates that dominate most of China's defense sector have produced some significant breakthroughs, but they remain relatively unprofitable and

---

[43] Li Xin [李鑫], "Third Academy 8358 Institute Hosts 2022 PLAAF Military Office Coordination Meeting" ["三院 8358 所召开 2022 年空军军所协调会"], CASIC Third Academy, March 21, 2022, http://www.fhjs.casic.cn/n7160835/n7161156/c23194116/content.html.

[44] Ashby et al., 2021, p. 18.

[45] Ashby et al., 2021, p. 18.

[46] Ashby et al., 2021, p. 18; "Land Warfare Platforms: Armoured Fighting Vehicles - Type 98; Type 99," *Janes Land Warfare Platforms: Armoured Fighting Vehicles*, March 19, 2021; "China–Navy," *Janes World Navies*, last updated May 19, 2022.

[47] Ashby et al., 2021, p. 23; "China–Air Force," *Jane's World Air Forces*, February 14, 2023.

[48] Ashby et al., 2021, p. vii; Sean O'Connor, *How Chinese Companies Facilitate Technology Transfer from the United States*, U.S.-China Economic and Security Review Commission, May 6, 2019.

[49] David Alexander, "Theft of F-35 Design Data Is Helping U.S. Adversaries – Pentagon," Reuters, June 19, 2013; Ashby et al., 2021, p. 29; Ian Burns McCaslin and Andrew S. Erickson, "The Impact of Xi-Era Reforms on the Chinese Navy," in Phillip C. Saunders, Arthur S. Ding, Andrew Scobell, Andrew N. D. Yang, and Joel Wuthnow, eds., *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms*, National Defense University Press, 2019, pp. 130–131.

[50] Ashby et al., 2021, p. 23.

less innovative than their private-sector counterparts.[51] Oversight over these behemoths has proven difficult. In the old command economy, the CCP enjoyed a large network of administrative offices that it could use to gather information on economic actors and directly control their actions. The end of the command economy saw the dismantling of many of these offices. In theory, competition and market forces were meant to fill some of their functions, forcing SOEs to increase efficiency without needing direct compulsion from the party state.[52] In the defense sector, however, most subsectors remain dominated by a single state-owned conglomerate. Attempts to introduce private actors have borne some fruit, but they have not changed the fact that, for most platforms, the PLA has only one firm to turn to as the lead integrator. Under Xi Jinping, the trend has been for greater consolidation and government control rather than diversification and market forces.[53]

The Chinese RDA process can also be constrained by a lack of skilled personnel.[54] As noted previously, the lack of technical training among military representatives (some of whom must oversee extremely complex systems or research efforts) has been cited as an impediment to their ability to protect PLA interests.[55] In some new fields, such as artificial intelligence, China seems to be especially deficient in senior engineers with a decade or more of experience.[56] SOEs also seem to be having trouble retaining top talent in the face of competition from the private sector. The loss of researchers like Zhang Xiaoping (a key designer of liquid-propelled engines) to jobs in private companies almost certainly slows the PLA's progress in some fields.[57] However, it is difficult to quantify how much of an impact these issues have had. They certainly have not prevented the PLA from producing several very innovative and technically sophisticated weapon systems, including hypersonic missiles, anti-ship ballistic missiles, and aircraft carriers. And Chinese expenditure on research and development is growing rapidly, leading to a growing workforce.[58] Beijing benefits from large numbers of students returning from technical studies in the United States, though it pays for this privilege both by financially subsidizing U.S. research institutes and by losing at least 20 percent of its best and brightest minds annually, as many of

[51] Ashby et al., 2021, pp. 19, 21.

[52] Ashby et al., 2021, p. 21.

[53] While the two aircraft corporations (Aviation Industry Corporation of China I and II) consolidated into a single firm in 2008, before Xi became China's leader, Xi has overseen the consolidation of China's twin nuclear firms and military shipbuilders, as well as cooperation agreements between China's two major missile producers. See Cheung, 2022, p. 172; and Cheung, 2019, p. 598.

[54] Woods and Stone, 2021, p. 2.

[55] Ashby et al., 2021, p. 22.

[56] Jeffrey Ding, *Deciphering China's AI Dream: The Context, Components, Capabilities, and Consequences of China's Strategy to Lead the World in AI*, Future of Humanity Institute, University of Oxford, March 2018, pp. 26–27.

[57] Woods and Stone, 2021, pp. 20–21.

[58] Ashby et al., 2021, p. 24.

these students choose not to return to China.[59] The proportion of Ph.D. graduates who remain in the United States may be significantly larger.[60]

Chinese leaders often express worry that the PLA and the Chinese economy generally are too dependent on foreign-supplied technologies and components and fear that hostile powers could disrupt their access to these components.[61] U.S. measures, such as export controls to reduce Russia's supplies of critical military components, may have had a deleterious impact on Moscow's operations in Ukraine.[62] However, there are reasons to believe that cutting the PLA off from critical components may prove more difficult. Many of the components that Chinese arms manufacturers once imported from abroad, such as helicopter engines, can now be produced domestically, and great progress is being made on jet engines as well.[63] Furthermore, China is the largest trading partner of 120 countries around the globe, and it may be able to buy on the international market whatever it cannot build itself.[64] This is not to say that it would be impossible or not worthwhile to restrict PLA access to advanced technology, but more research may be needed to identify what foreign components the PLA is reliant upon, how their loss would affect its operations, and what its options are for obtaining them.

Finally, while it is easy to identify the myriad problems China faces in its RDA process, it is worth noting that the U.S. RDA system suffers from its own inefficiencies. The United States is also heavily reliant on minerals and components imported from abroad, many of them from China.[65] Like China, the United States struggles with a lack of skilled workers in its defense industrial base.[66] While U.S. defense conglomerates may be more efficient and profitable than their state-owned Chinese counterparts, and while the U.S. defense sector remains more diversified than China's, consolidation in the U.S. defense market has forced the U.S. military to rely on an ever-shrinking pool of large firms to act as its lead system integrators.

---

[59] Zou Shuo, "Overseas Experiences Brought Back to China," *China Daily*, November 25, 2022.

[60] In the early 2010s, as many as 90 percent of Ph.D. students remained in the United States, though this proportion may have fallen since then (Zhang Ruinan, "China Lures PhD Holders," *China Daily*, February 9, 2018).

[61] Cheung, 2022, pp. 143–144; Richard P. Suttmeier, Cong Cao, and Denis Fred Simon, "China's Innovation Challenge and the Remaking of the Chinese Academy of Sciences," *Innovations*, Summer 2006, p. 79; U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China*, 2022, p. 151.

[62] Office of the Spokesperson, "The Impact of Sanctions and Export Controls on the Russian Federation," fact sheet, U.S. Department of State, October 20, 2022.

[63] Peter Wood, Alden Wahlstrom, and Roger Cliff, *China's Aeroengine Industry*, China Aerospace Studies Institute, March 2020, pp. 26–31, 35–37.

[64] Mark A. Green, "China Is the Top Trading Partner to More Than 120 Countries," *Stubborn Things*, blog, Wilson Center, January 17, 2023, https://www.wilsoncenter.org/blog-post/china-top-trading-partner-more-120-countries.

[65] Cortney Weinbaum, Caolionn O'Connell, Steven W. Popper, M. Scott Bond, Hannah Jane Byrne, Christian Curriden, Gregory Weider Fauerbach, Sale Lilly, Jared Mondschein, and Jon Schmid, *Assessing Systemic Strengths and Vulnerabilities of China's Defense Industrial Base: With a Repeatable Methodology for Other Countries*, RAND Corporation, RR-A930-1, 2022, p. 52, https://www.rand.org/pubs/research_reports/RRA930-1.html.

[66] National Defense Industrial Association, *Vital Signs 2023: Posturing the U.S. Defense Industrial Base for Great Power Competition*, February 2023, pp. 18–19; U.S. Department of Defense, "Defense Department Launches Initiative to Boost U.S. Industrial Workforce," press release, November 23, 2020.

## Strengths

Ultimately, the strength of any RDA process must be measured by the quality of the weapon systems it produces. On this count, the Chinese system must be seen as a qualified success. Although it has struggled in many ways and some of its platforms continue to lag behind comparable platforms in the United States and other nations, it has produced a number of unique and highly innovative systems. Its long-range missile force stands out as a particularly great achievement. While China certainly built on some earlier U.S. and Russian technologies, many of the platforms in its Rocket Force have clearly moved far beyond these antecedents to enable innovative and unique concepts of operations.

It must be emphasized that developing these systems was not a quick process. The Chinese have probably been working on building extremely long-range anti-ship missiles since at least the 1995–1996 Taiwan Strait Crisis.[67] China's RDA system operates on plans that go out as far as 20 years, and many of China's modern weapons date back to Jiang Zemin's decision in 1999 that the PLA needed to be able to deter or defeat U.S. intervention in East Asia.[68] When major programs have failed or encountered setbacks, Chinese producers have continued to patiently iterate until they produce a satisfactory product.[69] Many of the PLA's platforms that now worry U.S. planners date back to the 1990s or early 2000s. For example, the J-20 stealth fighter has been in development since around 1998, the 052C/D guided-missile destroyer since around 1997–1998, the J-15 fighter since around 2005, and the Y-20 strategic airlifter since around 2000.[70] Xi Jinping has certainly left an indelible mark on the PLA, but the physical platforms that have become operational under his leadership are largely an inheritance from his predecessors. Given enough time, money, and clear and consistent operational problems to solve, the Chinese RDA system is clearly capable of producing innovative and highly lethal systems. Its willingness to continue to devote significant resources to these programs over decades, even in the face of failures and setbacks, is one of the system's greatest strengths.

The Chinese long-range missile program in particular stands out as a singular achievement. Unlike in many other areas, in which the PLA seems to be seeking to catch up with the U.S. military and copy U.S. capabilities, China's Rocket Force has pioneered new capabilities and concepts of operations quite beyond those of any other military.[71] In its hypersonics program, the PLA may have even begun to produce new platforms in under ten years, though this is difficult to verify. While the origins and development phase of China's DF-ZF hypersonic glide vehicle

---

[67] Mark Stokes, "China's Evolving Space and Missile Industry: Seeking Innovation in Long-Range Precision Strike," in Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation*, Johns Hopkins University Press, 2014, p. 260.

[68] Cheung, 2022, pp. 151, 181.

[69] Ashby et al., 2021, p. 18; "China–Navy," 2022; "Land Warfare Platforms: Armoured Fighting Vehicles - Type 98; Type 99," 2021.

[70] Cheung, 2017, p. 344.

[71] Note, in particular, the PLA Rocket Force's anti-ship ballistic missile strike capabilities. See Andrew S. Erickson, *Chinese Anti-Ship Ballistic Missile (ASBM) Development: Drivers, Trajectories and Strategic Implications*, Brookings Institution Press, 2013, p. 1.

and DF-17 hypersonic weapon remain somewhat murky,[72] their flight test phase alone seems to have begun in 2014, and the system reached initial operational capability sometime between 2019 and 2022 (five to eight years; sources differ).[73] It is not impossible that this would result in a total development timeline of less than ten years, but that would require an exceptionally short design and ground-testing process. For reference, the J-15 fighter had been under development for about four years before its maiden flight, the J-20 stealth fighter for 12 years, and the Y-20 transport for about 12 years.[74] China could also have other hypersonic programs that are proceeding more quickly.[75]

## Policy Insights

The research on which this testimony is based offers the following policy insights to keep in mind as Congress considers the Chinese and U.S. RDA processes:

- The Chinese RDA process has a number of inefficiencies, many of which stem from the basic structure of the Chinese defense industrial base. While Xi Jinping's anti-corruption reforms may help alleviate these inefficiencies, he has shown little interest in fundamental structural reform to increase market competition among defense companies or to change their relationship to the CCP and the major defense SOEs.
- Given sufficient time and money, the Chinese RDA system is capable of producing innovative and sophisticated weapons. It is capable of devoting massive resources toward ambitious, priority projects over very long periods, resulting in incremental progress and eventual achievement of its goals. The Chinese hypersonic missile program suggests that long-range missiles may be a particular area of excellence.

[72] The DF-17 is a DF-ZF derived vehicle atop a standard PLA Rocket Force missile.

[73] "DF-17," *Jane's Offensive Weapons: Strategic*, September 15, 2022; Richard D. Fisher, Jr., "US Officials Confirm Sixth Chinese Hypersonic Manoeuvring Strike Vehicle Test," *Jane's Defense Weekly*, November 26, 2015; Peter Wood and Roger Cliff, *A Case Study of the PRC's Hypersonic Systems Development*, China Aerospace Studies Institute, 2020, pp. 22–23.

[74] Cheung, 2017, p. 344.

[75] Researchers working for the China Aerospace Studies Institute have claimed that China is working on at least two hypersonic programs, at least one of which is scramjet powered (Wood and Cliff, 2020, pp. 20–23).

## OPENING STATEMENT OF ELSA KANIA, ADJUNCT SENIOR FELLOW, TECHNOLOGY AND NATIONAL SECURITY PROGRAM AT THE CENTER FOR A NEW AMERICAN SECURITY

MS. KANIA: Good morning and thank you so much to the Commission. I'm happy to be here and looking forward to continuing the conversation. I want to start by saying my views are only my own and I'm participating in a personal capacity based on ongoing research leveraging open sources.

There's a lot to examine and look at when we're considering China's pursuit of defense technologies. And I will as mentioned be emphasizing today China's strategy of military-civil fusion, which we have to recognize as an incredibly consequential component of Beijing's agenda to catch up with and surpass the United States, especially when it comes to new frontiers or domains such as space, cyberspace, the deep seas, and in strategic technologies like artificial intelligence and quantum information science as well. And I want to say up-front to emphasize on these fronts, American advantage, the military technological dominance we've previously enjoyed and many of the decisive military technologies is neither assured, nor unassailable.

I'm honored to be building on the research and findings of many esteemed colleagues in this space, including those on this panel. And I want to highlight in particular a couple of trends and aspects of China's approach to military-civil fusion that are unique as it pertains to the PLA's drive to become a truly world class military with the intent to be a pioneer at the forefront of technologies that are defining a new revolution in military affairs, setting the terms for future warfare.

And when we talk about military-civil fusion, we have to recognize that this is truly a grand strategy for China in its scope and reach. It's intended to integrate and to synchronize Beijing's economic, military, and ultimately strategic objectives to ensure that these aims are mutually reinforcing. The complexity and systemic character of this agenda is distinctive even though we also know that certain elements of it emulate an attempt to recreate aspects of the U.S. defense innovation ecosystem that have been traditionally advantageous.

DARPA certainly has many admirers in Beijing and many who are seeking to replicate elements of its efforts. And in particular, Beijing recognizes the imperative of leveraging China's dynamic and highly competitive technology ecosystem and starting to bring in new companies that may not yet be starting to challenge the monopolies of the traditional defense industry, but at least that the margins are starting to have real impact, especially when it comes to new domains and emerging capabilities where the traditional defense industry is not as actively engaged.

While we're focusing today very much on technology development and weapon systems, I also wanted to emphasize that military-civil fusion is more expansive and includes logistic support, taking advantage of talent and expanding education, as well as national defense mobilization, among other lines of effort. We've seen military-civil fusion beyond prior efforts and civil-military integration be elevated under Xi Jinping to the level of strategy. And this elevation and emphasis reflects the urgency of efforts to overcome some of the previous impediments and obstacles and monopolies that my co-panelists have previously discussed.

Certainly the barriers for start-ups for high technology enterprises beyond the traditional defense industry remains deep and it remains challenging for new entrants to come into this defense economy, but some of those barriers are starting to be broken down. And the objective going forward is to build an integrated national strategic system to create a framework for

military-civil fusion for which the optimal end stage would be all factor, multi-domain, and highly effective.

As we've already discussed in the course of this panel, there can be certain inefficiencies, yet nonetheless, overall systems and processes that are effective in producing outcomes. And certainly while the dilemmas that we've discussed so far, including redundancy, difficulties in oversight and corruption are unlikely to be overcome in this new context, military-civil fusion is starting to gain traction. And we can also look at some of the robust constellation of institutions overseeing it. Whether that's the Central Military-Civil Fusion Development Commission, Military-Civil Fusion-focused Office within SASTIND (State Administration of Science Technology and Industry for National Defense), as well as multiple elements of Central Military Commission responsible for implementing military-civil fusion. And in the aggregate, these institutions are trying to overcome the previous lack of top-level oversight and design.

While I don't have time this morning to speak to the full scope and extent of efforts under military-civil fusion, we've seen within the past couple of years, new platforms and funding mechanisms trying to give commercial and academic enterprises opportunities to participate in military programs and receive funding for dual-use research. We've seen new research institutes and laboratories established that focus on dual purpose technologies, and a number of funds dedicated to military-civil fusion related investments that have reached tens of billions in scale and started to bring into play venture capital beyond simply state funding, which highlights the degree to which China's traditional defense budget doesn't capture the full extent of resourcing that has been dedicated to these programs.

And we can also look to see, although the PLA traditionally has not been known for its creativity, multiple elements have been combining DARPA-like challenges and competitions and trying to really bring together academia and commercial enterprises with military customers and end-users. And this is also an agenda that is truly nationwide in scope and scale with just about every province and every major city in China having some initiatives they're pursing under the auspices and umbrella of military-civil fusion.

I'm pointing in particular for instance to the partnership between the Chinese Academy of Sciences and the Academy of Military Sciences, local efforts focused on military-civil fusion and AI development such as have been established in Tianjin in partnership with AMS. And the Agile Innovation Defense Unit seems to be an admirer perhaps of the Defense Innovation Unit and similarly named that is focused -- initially established in Shenzhen that's focused on bringing commercial technologies into -- into the military sphere with a much tighter turnaround for projects, working on everything from COVID response to drone swarming in recent years. I can't provide a definitive answer today as to the exact scope and scale of this agenda or what the long-term prospects for success will look like. But at a certain point, the quantity and amount of resources behind these efforts do start to produce quality and produce more tangible results across every service of the PLA and across every domain.

And I'd point in particular in the time remaining to a couple of efforts that I think are somewhat unique and impactful, whether that is in the world of war gaming, working with commercial technologies and for training and simulations, efforts to achieve an advantage in undersea domain awareness in the South China Sea and beyond with the Smart Ocean Initiative focused on deep sea technologies including undersea cables that have closely integrated military and civil undersea infrastructure development.

And in closing, while looking at the scope and expansive military-civil fusion, the competitive challenges are urgent and apparent. The PLA has feared and is now trying to create technology surprise. Military-civil fusion could allow the PLA to deploy new weapon systems with lower costs and higher velocity in ways that could enable operational advantage, and features of military-civil fusion including in mobilization could erode indicators and warning in a future crisis or conflict. And moreover, in a scenario of protracted conflict, the capacity that military-civil fusion brings to bear in bringing the civilian economy to support defense purposes could enable a long-term advantage in terms of sustainment.

I have much more to discuss when it comes to military-civil fusion and I very much look forward to continuing the conversation in the hearing today. Thank you again.

**PREPARED STATEMENT OF ELSA KANIA, ADJUNCT SENIOR FELLOW, TECHNOLOGY AND NATIONAL SECURITY PROGRAM AT THE CENTER FOR A NEW AMERICAN SECURITY**

# The Competitive Challenge of Military-Civil Fusion

## Testimony to the U.S.-China Economic Security Commission for Hearing on "China's Pursuit of Defense Technologies"

Elsa B. Kania*

13 April 2023

As the United States and its allies continue to reckon with China's rise, military-civil fusion must be recognized as a consequential component of Beijing's strategy to catch up with and ultimately surpass the United States. This agenda has particularly concentrated on new frontiers and emerging technologies, where American advantage is neither assured nor unassailable. The pursuit of military-civil fusion may be especially impactful in new domains, such as space, cyberspace, and the deep seas, and in strategic technologies, including robotics, artificial intelligence, and quantum computing. Looking forward, while military-civil fusion is unlikely to provide the truly seamless integration that the CCP aspires to achieve, this initiative is nonetheless a critical enabler of China's rise as a global military power.

The PLA today, while untested, has continued consistently exceeding expectations and outpacing previous predictions on the trajectory of its military modernization. Once, a not uncommon assumption in U.S. defense circles was that the PLA was unlikely to be creative or truly innovative, whether in its development of new generations of weapons systems or introduction of new concepts of operations. However, China's efforts in military-civil fusion raises the risks of technological surprise, even as this agenda remains incomplete and aspirational, likely falling short of achieving the true fusion that the CCP seeks to create. While China's military-civil fusion initiatives are sometimes surprisingly transparent, including because of the need to release publicly available information to implement a strategy of such complexity with multiple stakeholders, there are nonetheless a number of gaps in information, as well as a trend toward increased controls on information by the CCP, that can impede analysis. This agenda will continue to raise complex issues and competitive challenges for U.S. policy.

The scope and scale of military-civil fusion is probably on track to exceed comparable American initiatives, based on the available indicators. There is no definitive answer at this point regarding the current magnitude of this agenda, nor obvious assessments of the prospects for success on various fronts, and direct comparisons between the U.S. and Chinese defense economies and innovation ecosystems are challenging at best. However, the CCP's capacity to mobilize resources to pursue a systemic approach may be unique and has been enabled by centralized guidance that creates incentives and direction for a range of local initiatives. Ultimately, military-civil fusion is likely to remain at the core of the PLA's drive to become a "world-class" military that aspires to achieve military-technological advantage on the future battlefield.[1] This testimony seeks to highlight several salient trends and issues in the current trajectory of military-civil fusion for the Commission's consideration.

### Imperatives for Military-Civil Fusion

* Elsa Kania is an Adjunct Senior Fellow with the Center for a New American Security and a PhD candidate in Harvard University's Department of Government. Her views are her own. This testimony builds upon previous research and ongoing analysis, based entirely on open sources.

For China, military-civil fusion is framed as a grand strategy that seeks to create and leverage synergies between economic development and military modernization.[2] The objective has been to create an "integrated national strategic system and capabilities," as articulated by Xi Jinping on multiple occasions.[3] That is, military-civil fusion is intended to promote a deeper integration of China's civilian and defense economies, along with their respective technological ecosystems, such that resources will be combined and advances will be mutually reinforcing. While aspects of military-civil fusion have been inspired by or even explicitly emulate U.S. initiatives, this strategy is more ambitious by far and more far-reaching in taking a systemic approach. The enablers of military-civil fusion include not only equipment and technology but also data, capital, and personnel. Beyond defense technology, this approach is also applied in such contexts as emergency response and national defense mobilization, such as for a conflict scenario, which highlights the strategic relevance.[4]

China's pursuit of military-civil fusion is intended to bolster national security and development and to enable competitive advantage in strategic competition.[5] At the same time, this strategy is aimed at overcoming previously persistent challenges within its military research, development, and acquisition ecosystem. Beyond the usual players in the Chinese defense industry, including the state-owned enterprises that have been dominant traditionally, a new ecosystem of technology companies has emerged, ranging from national champions with global reach to newer start-ups, of which a number have prioritized participating in military-civil fusion as core elements of their business models. In this regard, PRC policies that have aimed to lower barriers to entry for emerging enterprises, along with a range of initiatives and incentives for companies to contribute to defense, have the potential to be impactful. Beyond the efforts of military research institutions, military-civil fusion initiatives sought to expand academic partnerships, aiming at cutting-edge research and development in new frontiers of technological development.

Beijing's decision to pursue military-civil fusion is inherently a reaction to changing technological circumstances. With the progression of the latest industrial revolution, which is also believed to be catalyzing a Revolution in Military Affairs (RMA), operationalizing emerging technologies with dual-use potential is regarded as a strategic imperative for the PLA to contest future military advantage. Increasingly, the center of gravity for innovation has shifted from states towards commercial enterprises that have become leaders in technological development, increasingly pioneering advances that states are seeking to capitalize upon. China's dynamic, competitive, and expanding ecosystem of technology companies has become globally unique and has the potential to prove distinctively advantageous. However, the proportion of Chinese technology companies that are actively engaged with the PLA is likely to remain limited in the near term. The potential for Chinese companies to be coerced to transfer technologies to the PLA, a possibility often raised in U.S. policy debates, is relevant and certainly feasible considering the Party-state's coercive capacity.[6] However, such a practice is unlikely to be a systemic or scalable solution, and PRC policies have primarily concentrated on incentives and systemic reforms.

For China, the underlying objectives of military-civil fusion are to challenge and ultimately undermine American military-technological advantage. To date, the achievements of military-civil fusion have been uneven across various lines of efforts with more headway achieved in

emerging industries and less traction in more traditional defense sectors. The urgency of this agenda will likely continue to be heightened, as strategic competition intensifies and as U.S. policies come into play that Beijing regards at attempts at technological containment. The PRC's emphasis on "self-reliance and self-strengthening" (自立自强) has been elevated under the 14th Five-Year Plan and reiterated in Xi's remarks on multiple occasions. Chinese leaders have been especially concerned with U.S. efforts to restrict access to sensitive "chokepoint" technologies, especially semiconductors.[7] For instance, at the "Two Sessions" in March 2023, Xi also emphasized the need to "strengthen the direction on defense science and technology industry in the service of strengthening the military and winning wars."[8]

Beyond military-civil fusion, the CCP has also invoked the concept of "military-civil unity" (军民团结), which Xi Jinping has characterized as an "important magic weapon" to overcome grave national security challenges.[9] As the CCP has started to regard the international environment as more hostile and contentious, the aphorism has been invoked: "If the military and the people are united as one, who under heaven can try to resist" (军民团结如一人，试看天下谁能敌), a sentiment that can be traced back to the time of Mao Zedong. The idea of military-civil unity also implies the solidarity such as was required previously in times of crisis or conflict and could be necessary mobilization and national preparations for a future conflict scenario.

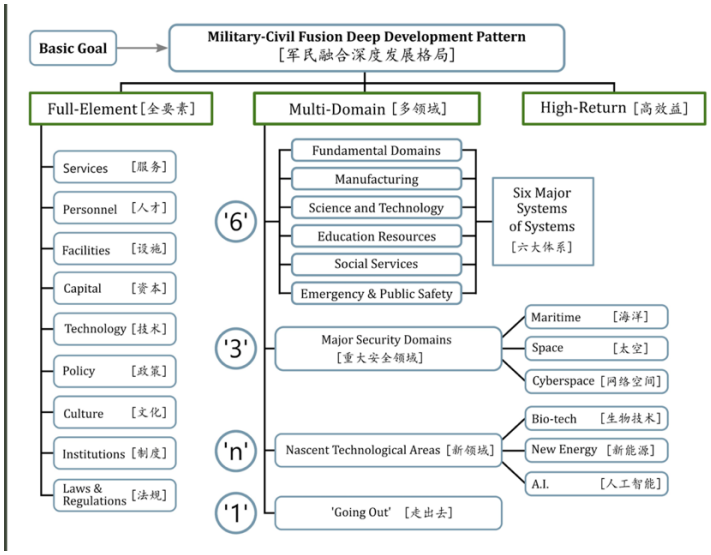
While the potential that military-civil fusion could be successful as a strategy cannot be discounted, the prospects remain uncertain, and future progress will likely remain uneven across various domains. To some extent, Xi Jinping's emphasis on and elevation of military-civil fusion reflected the urgency and severity of issues that had plagued China's defense innovation ecosystem previously, which have yet to be fully resolved. There can be a gap between ambition and reality; to be sure, CCP discussion of military-civil fusion or propaganda narratives about the importance of military-civil fusion and unity can outpace or precede demonstrable progression. However, to the extent that results may fall short of the ambition articulated, that is unlikely to be due to a lack of resourcing, given the tens of billions reportedly dedicated to this agenda based on ample evidence of extensive funding and investments.[10]

**Progression of Military-Civil Fusion**

The CCP's decision under Xi Jinping's leadership to elevate military-civil fusion to the level of national strategy was likely intended to accelerate the advancement of this initiative. Xi's repeated exhortations to advance military-civil fusion are also indicative of the perceived imperative to catalyze progress and overcome prior inertia. The PRC's previous attempts to improve levels of military-civil integration (军民结合) had seemingly stalled without achieving the full effects desired.[11] Among the recurrent problems for military-civil fusion had been insufficient top-level coordination, limited opening of military industry to new entrants, and inadequate sharing of resources, among other factors.[12] However, since 2013, Xi has overseen what might be considered a new era of military-civil fusion, through introducing of an array of plans and policies. Through newer and traditional stakeholders participating in this national program, military-civil fusion has been increasingly institutionalized with its reach and national importance reinforced over time.

The emphasis on military-civil fusion has played out through a series of central policies that have catalyzed local initiatives.† In 2016, SASTIND (国防科工局, the State Administration of Science, Technology and Industry for National Defense) issued the "Opinion on Accelerating and Advancing S&T Collaborative Innovation in National Defense S&T Industry" (关于加快推进国防科技工业科技协同创新的意见).[13] This directive called for China to establish national defense laboratories and industry innovation centers, seeking to improve the overall defense science and technology enterprise with military-civil fusion as a core feature. The CCP Central Committee, State Council, and Central Military Commission also jointly released the "Opinion on the Integrated Development of Economic Construction and National Defense Construction (关于经济建设和国防建设融合发展的意见) in 2016.[14] The opinion highlighted the importance of creating a "full-factor, multi-domain, highly effective" plan for the development of military-civil fusion" with primary objective to ensure "economic construction provides a more solid material foundation for national defense construction, and national defense construction provides more powerful security assurance for economic construction."[15]

In practice, this model of development seeks to leverage all relevant resources to enable progress across a series of priorities. These range from core functions, such as national emergency response, to key domains and emerging technologies.




*Source: Alex Stone and Peter Wood, "China's Military-Civil Fusion Strategy: A View from Chinese Strategists"*

The CCP has since consistently reinforced and enhanced the implementation of military-civil fusion. The Central Commission for the Development of Military-Civil Fusion (中央军民融合发展委员会) was established and initially convened in 2017, with Xi Jinping serving personally as the director.[16] This new committee was intended to provide an organizational framework to coordinate economic and defense developments at the highest levels, in an endeavor that has often been characterized as possessing the complexity of systems engineering.[17] When the 19th

† This is not intended to provide a comprehensive discussion of military-civil fusion, recognizing a more detailed description of the range of policies and initiatives relating to military-civil fusion is beyond the scope of this testimony.

CCP National Congress approved an update to the Party constitution in October 2017, this revision clearly enshrined Xi's priorities, to include military-civil fusion as a major strategy for development, among other state strategies.[18] In 2018, the Military-Civil Fusion Development Strategy Outline (军民融合发展战略纲要) reportedly introduced a formal framework for the development of military-civil fusion as a national strategy, yet only limited information is available, since the strategy in full has not been released publicly.[19]

Across the 13th and 14th Five-Year Plans, military-civil fusion has been an evident emphasis for the CCP. As of August 2017, the 13th Five-Year S&T Military-Civil Fusion Special Projects Plan (科技军民融合发展专项规划) highlighted the extent to which military-civil fusion is emphasizing the pursuit of emerging technologies, including intelligent unmanned systems, quantum computing and communications, and brain-inspired intelligence.[20] The 14th Five-Year Plan reaffirmed these priorities, declaring, "We will deepen military-civil S&T collaboration and innovation, strengthen military-civil overall development planning for maritime, aerospace, cyberspace, biotechnology, new energy, artificial intelligence, quantum technology, and other fields."[21] The focus on these critical technologies has been reflected in partnerships and local or regional programming that has concentrated on these technologies through leveraging local strengths and clusters of expertise.[22]

**Stakeholders for Military Civil Fusion**

The implementation of military-civil fusion extends from central guidance to local initiatives with multiple organizations involve in guidance, oversight, and implementation. The Central Military-Civil Fusion Development Committee oversees and provides the high-level coordination for this agenda.[23] This role and structure are replicated across provinces; even municipalities have established their own mechanisms. At the central level, SASTIND has also introduced guidance and overseen specific programming, such a series of "special action plans."[24] The Ministry of Industry and Information Technology has established a Military-Civil Fusion Promotion Department (军民融合推进司).[25] The degree to which there is effective coordination among these varied organizations and stakeholders is difficult to ascertain.

Within the PLA, the Central Military Commission (CMC) provides guidance and leadership for Chinese military, to include defense science and weapons development and acquisitions. The CMC Strategic Planning Department has established a Military-Civil Fusion Bureau (军民融合局) that is likely responsible for long-term planning and strategic design.[26] The CMC Equipment Development Department has created a new website to facilitate procurement that opens up the process to new companies and also oversees the EDD Military-Civil Fusion Joint Fund, about which limited information is available.[27] The CMC Science and Technology Commission has established a Military-Civil Fusion and Achievement Transformations Office (军民融合与成果转化办公室).[28] There are also multiple examples of initiatives and outreach occurring at the level of services and theater commands, such as the PLA Rocket Force engagement with civilian technical experts.[29]

PLA scientific institutions have also facilitated research and program focused on military-civil fusion in emerging technologies. In 2018, the Chinese Academy of Sciences and Academy of

Military Sciences signed a strategic cooperation agreement for joint research projects, including in energy and new materials, and collaboration on talent training.[30] Notably, the PLA's AMS established a new National Defense S&T Innovation Research Institute (国防科技创新研究院),[31] which encompasses an Artificial Intelligence Research Center, Unmanned Systems Research Center, and Frontier Cross-Domain Technology Research Center, which has actively recruited new personnel, including a growing unumber civilians.[32] In Tianjin, the new AI Military-Civil Fusion Innovation Center (人工智能军民融合创新中心), associated with the National Supercomputing Center, was established by the local government and maintains a partnership with the Academy of Military Science.[33] There are many instances of such initiatives and emerging partnerships that have been announced, but the results so far are more difficult to evaluate.

## Mechanisms for Military-Civil Fusion

Across China within the past decade, there has been a surge in efforts to promote military-civil fusion through multiple modalities. These include: new platforms and funding mechanisms to open up military contracts to commercial enterprises; research institutes and joint laboratories focused on military partnerships with academic or commercial enterprises for dual-use research; a range of funds dedicated to military-civil fusion that can combine or coordinate governmental and commercial investments; local initiatives across multiple cities and provinces military-civil fusion bases for innovation and demonstration that bring in private companies and facilitate their relationships with military stakeholders; and PLA convening/sponsorship of challenges and competitions, among other elements.

While a comprehensive discussion of these efforts is beyond the scope of this testimony, a review of several examples of potential interest can highlight the range of these activities.

*Opening Options for Procurement:*

The PLA Equipment Development Department created a new website focused on military armaments requirements in 2015, which publishes notices for procurement and relevant information.[34] The release of requirements and advertisement of opportunities on the website was intended to open up the process and break down barriers on information in order to open up competition, and the advertisements have often highlighted the PLA's interest in acquiring new and emerging capabilities.[35]

*'Agile' Exploitation of Commercial Technologies:*

CMC S&TC notably launched the Agile Innovation Defense Unit (AIDU), the "defense S&T innovation rapid response small group" (国防科技创新快速响应小组), which concentrates on leveraging commercial technologies, in 2017.[36] Not unlike the U.S. Defense Innovation (DIU) that was likely its inspiration and *de facto* namesake, the Agile Innovation Defense Unit (AIDU), which was first stood up in Shenzhen and has since established units in Dalian, Chongqing, and Shaanxi, has released calls for technology solutions, organized competitions, and facilitated partnerships with commercial enterprises.[37]

This new model for rapidly developing and accessing commercial technologies does demonstrate the PLA's capability and willingness to experiment and progress in scaling and implementing with new models. For instance, AIDU has supported efforts ranging from COVID response capabilities to drone swarming and autonomy.[38] Typically, projects focus on a short timeline for delivery of a new technology or capability.

*MCF Funds and Guidance Funds*

The PRC's implementation of military-civil fusion initiatives has drawn upon new sources of funding for scaling and sustainment. In December 2017, State Council opinion released called for policies that were supportive of 'social investment' into military-civil fusion and "expand investment and financing channels" to promote military-civil fusion.[39] In practice, this has involved efforts to establish funds for investments in priority military-civil fusion industries with local governments encouraged to launch their own funds to promote high-tech military industries.

Even as sizable figures are associated with military-civil fusion, the actual allocation of resources is difficult to ascertain. There were ostensibly tens of billions of RMB (or several billion dollars in counting) of funding dedicated to military-civil fusion between ~2016 and ~2020, with funds launched across Sichuan, Shanghai, Hebei, Henan, Guangdong, Zhejiang, Shaanxi, Guizhou, Hunan, Heilongjiang, Liaoning, among other cities and provinces. For instance, one fund for military-civil fusion launched in 2016 reportedly involved ~30.2 billion RMB or ~$4.4 billion in its initial round of funding.[40] The Ministry of Finance established the National Military-Civil Fusion Industry Investment Fund (国家军民融合产业投资基金), which was intended to direct investments to align with central requirements.[41] However, the amounts of funding announced do not necessarily correspond to the amount actually invested, nor are the likely returns on investment clearly identifiable.

*Industry Alliances*

A number of military-civil fusion industry associations have promoted active and ongoing engagement between defense and commercial stakeholders. For instance, the high-tech zone of Zhongguancun has focused on advancing military-civil fusion in emerging technologies. The Zhongguancun Joint Innovation Military-Civil Fusion Industry Alliance has grown to include ~600 members and has reportedly facilitated research sharing and collaborative innovation in critical industries.[42]

*Local Zones and Initiatives*

The central emphasis and strategic guidance for military-civil fusion have provided impetus and created ample incentives for local initiatives. China's numerous industrial parks and "innovation demonstration" zones dedicated to military-civil fusion also help create conditions for 'clustered development' with critical synergies between scientists and enterprises.[43] For instance, Hainan has established a military-civil fusion innovation demonstration zone focused on maritime technologies, especially deep sea technology.[44]

*Competitions*

The PLA has organized a range of challenges and competitions intended to promote creative solutions to operational problems. These competitions integrate involvement of research institutes, private enterprises, and other stakeholders in addition to traditional state-owned enterprises. For example, the PLA Army has organized a series of events known as "Striding Across Obstacles" (跨越险阻), which started in 2016, an annual challenge series intended to promote the development of UGVs organized by the PLAA Equipment Development Department.[45] Similarly, the PLA Navy organized a competition concentrating on the development of unmanned surface vessels.[46] The PLA Strategic Support Force has engaged with space and cyber security companies on talent and training.[47] The PLA Rocket Force has sponsored the "Smart Arrow·Fire Eye" (智箭•火眼") competition focused on AI-enabled image detection and recognition, advances that could facilitate automated targeting.[48] In 2020, the PLA CMC Equipment Development Department organized challenge based on an AI wargaming platform applied to a joint operations. This contest, titled "Stratagem at Heart, Jointness to Win" (谋略方寸•联合制胜), focused on leveraging wargaming as environment in which to develop algorithms capable of enabling future joint operations.[49]

*New-Type Militias and Mobilization*

China's militias have been starting to engage in more active and regular training with the PLA's services and theater commands.[50] As the PLA shifts its focus to new-type forces, militias have looked to leverage local high-tech industries to contribute to force construction. For instance, Shanghai initially established a UAV militia unit as early as 2015, primarily for purposes of reconnaissance.[51]

Future militia and reserve forces construction intend to emphasize new efforts to incorporate "talents from new professions related to wartime requirements," including e-sports players and AI technicians to provide "technical support and talent guarantee" for winning future warfare.[52] Increasingly, "new-type" militia units that have been established that specialize in emerging capabilities, including network protection and "online public opinion struggle."[53] Within several municipalities or provinces, the creation of national defense mobilization alliances looked to prepare high-tech enterprises to contribute to this endeavor.[54]

## Challenges for Military-Civil Fusion

As has been the case for other Chinese initiatives, when military-civil fusion is declared as central priority, actors across the systems are inclined to brand their efforts accordingly, even those that are less relevant or impactful with that moniker. For every success, there will be some failures or, possibly, future corruption investigations. Indeed, the graft that has historically been a problem in the Chinese military and defense industry is unlikely to be truly overcome in this context. Across these varied programs, there is probably a level of waste, inefficiency, and redundancy beyond what would likely be tolerated in a U.S. context. While these issues may reduce the return on military-civil fusion initiatives and investments, the potential for long-term progress is likely to be prioritized over near-term yields.

China's efforts to enable and encourage technology companies to become involved in defense research and development have required reducing the practical obstacles to their participation. In some cases, the results have been ostensibly impactful; reportedly, for China's first domestically developed aircraft carrier, the 'rate' of military-civil fusion was reportedly nearly 80%.[55] However, Chinese scholars of military-civil fusion has raised concerns about the persistence of 'policy issues, institutional obstacles, and structural contradictions,' including because of inadequate top-level coordination and limited institutionalization of rule of law, along with insufficient market opening in the defense economy and inadequate resource sharing.'[56] Moreover, Chinese companies initially didn't understand military requirements or the process of procurement. As such, efforts to mitigate such barriers were important to realize the full potential of military-civil fusion.

The question of how many Chinese companies have been engaged in the defense economy and how impactful their contributions have been remains difficult to evaluate. Only an estimated 1,000 private enterprises held the Weapons and Equipment Research and Production Certificate (武器装备科研生产许可证) as of 2016 data, a certificate that was required to participate in many projects related to advanced weapons systems.[57] As of 2018, an estimated 2,300 private companies had the Equipment Manufacturing Unit Qualification Permit (装备承制单位资格认证), a similar certification.[58] Chinese experts had estimated only 2% of China's private high technology enterprises were involved in defense projects as of 2019, primarily in support roles.[59]

Anecdotally and based on incomplete data/estimates, the proportions of companies that are qualified and actively participating in military initiatives appears to have increased in the years since. Moreover, quantity is not necessarily the primary indicator, as a small number of impactful contributors can have disproportionate influence in some situations. However, it is likely that only a relatively limited proportion of private companies have participated in defense projects, and often enterprises developing technologies relevant to the military have found cutting through the red tape involved in procurement to be cumbersome, not unlike the frustrations of their American counterparts.[60] There have since been efforts to simplify certification requirements and mitigate the impact of previously expensive and burdensome processes.

*Process for Certification*

Previously, the timeline required for approval was too lengthy and time- and resource-intensive relative to the need for progress to keep pace with technological advancements.[61] As one Beijing-based law firm described the previous situation, "the main obstacles to private sector participation in the military sector are found in the relatively high barriers to entry into the market, the intersecting management that exists, lengthy application cycles, and relatively high maintenance costs."[62] This system was later simplified from four to three certificates in order to simplify and streamline the process.[63]

*Efforts in Standardization*

Fundamental to the progression of military-civil fusion has been efforts to synchronize standards to enable seamless transferal of resources across domains. In 2018, the "Overall Plan for

Promoting Standardization of Military-Civil Integration Work"(统筹推进标准化军民融合工作总体方案) was created in order to "eliminate the problem of overlapping and repetitive conflicts between military and civilian standards" and create a compatible system for standards to enhance the implementation of military-civil fusion.[64] The later opinion on strengthening "Opinion on Further Strengthening the Standardization of Military-Civil Fusion" (关于进一步加强标准化军民融合工作的意见), released in 2019, also aimed to synchronize initiatives and avoid conflicting or redundant requirements.[65] Underlying these efforts is likely a recognition that the scope and complexity of military-civil fusion had resulted in efforts that weren't clearly coordinated.

*Issues of 'Integrity'*

The drive for military-civil fusion has likely generated corruption and inefficiencies that official oversight and initiatives have since sought to address. In July 2022, CMC Equipment Development Department and SASTIND the released of "Regulations on the Responsibility of Governance Integrity Supervision in Military Industry Departments" (军队行业部门廉政主管责任规定), the issuance of which corresponded with the launch of a 'joint inspection' of military industry.[66] While reporting on instances of corruption in military-civil fusion initiatives have been limited, these efforts to 'clean up' efforts and promote improved 'integrity' appear to reflect such concerns.

*Lack of Legal Framework*

For military-civil fusion to be effective and sustainable in the long term could eventually necessitate a more formal legalized framework. However, several previous proposals to create a law on military-civil fusion in order to legally institutionalize this initiative appear to have stalled since early drafts and proposals were first raised,[67] initially in 2012 and later in 2018.[68] Whether a law will be introduced to expand authorities, ensure protection of intellectual property to facilitate collaborations, and introduce legal requirements for military-civil fusion beyond the provisions of laws existing that mandate support for the military, remains to be seen.

**Priority Domains for Military-Civil Fusion**

The review of several priority domains for military-civil fusion can highlight the range and diversity of efforts that have been underway. Although comprehensive assessments of each technology or application are beyond the scope of this testimony, these examples are intended to illustrate trends and priorities, as well as several representative enterprises.

*Unmanned Systems*

The PLA's leveraging of unmanned systems is uniquely expansive and uniquely exemplifies military-civil fusion. PRC-made drones, including many sold for primarily commercial applications, that have been found on the battlefield on both sides in Ukraine provides ample illustration of that phenomenon. DJI's 'RoboMaster S1' (机甲大师 S1), a small UGV, has been reportedly employed for by the Eastern Theater Command urban warfare training.[69] Beyond the

UAVs that abound, Zhuhai Yunzhou-Tech (珠海云洲智能科技), which is recognized for its significant contributions to military-civil fusion, have develop a wide array of models and designs of unmanned surface vessels.[70] SUBLUE/DEEPINFAR (深之蓝) makes undersea robotic systems for defense and commercial applications and aspires to become the DJI of the undersea domain. The company has also established a partnership with Tianjin's AI MCF Innovation Center.[71]

*Space*

The expansion of national networks of satellite constellations has taken a typically dual-use approach. China's concern about the capability that StarLink presented had prompted the development of its own national counterpart and competitor. China SatNet (中国卫星网络集团), the newest state-owned enterprise, is involved in the creation of a "national network" (*Guowang*, 国网) satellite internet project, which would be composed of " low Earth orbit (LEO) constellations totaling 12,992 satellites.[72] There are also several companies bringing enhanced analytic capabilities, such as ADASpace (国星宇航科技有限公司), which produces and operates AI-enabled satellites that seek to employ data processing capabilities as a central feature.[73]

*Cyberspace*

Space and cyberspace are domains in which military-civil fusion has been active and successful. Qihoo360 is prominent in cyber security, not only as a leading company but also because of its apparent contributions to Chinese military cyber security and talent cultivation.[74] For instance, Tianmu Data (Fujian) Technology Co. (天目数据科技有限公司是) has focused on big data, cyber security, and artificial intelligence, including in collaboration with the PLA.[75]

*Data Analytics and Artificial Intelligence*

Several companies have positioned themselves as leaders in military applications of data analytics and artificial intelligence. For instance, Tianhe Defense (天和防务) has focused on big data services, as well as advanced electronics equipment, including in 5G.[76] StarSee (摄星智能) has focused on decision support systems that could support battle management applications.[77] DataExa (渊亭科技 or Yuanting S&T) has focused on cognitive decision-making intelligence for defense applications.[78]

*Deep Sea Technology*

Several Chinese companies in the deep sea equipment industry have focused on military-civil fusion. For instance, Baoli (China Poly Group) Tiantong Deep Sea Equipment Technology (保利天同深海技术) Co., Ltd. has specialized in equipment, including underwater acoustic communications, acoustic navigation and positioning, and hydrophones.[79] Poly Tiantong has also participated in the Military-Civil Fusion Deep Sea Science and Technology International Innovation Park supported with Yunnan and Anning city[80]

Chinese companies have expanded partnerships with the PLA with concentration on undersea communications. In 2016, the PLA Naval Engineering University jointly established the Undersea Optical Network Joint Laboratory (水下光网络联合实验室) in conjunction with Hengtong Optoelectronics, Zhongtian S&T Submarine Cable Co., Ltd. and the Beijing University of Posts and Telecommunications.[81] The joint laboratory was intended to concentrate on research and development in optical communications, as well as integrated optical network design.[82]

*Wargaming*

In the world of wargaming, the PLA is actively leveraging commercial partnerships to bring computerized wargaming into training and for national defense education. Increasingly, Chinese companies have become involved in the commercialization and popularization of wargaming, from tactical to more complex campaign scenarios that are variously historical and more contemporary. Huaru Technology (华如科技) specializes in the development of big data platforms and military simulations,[83] and the company has also marketed wargames focused on space and cyber operations.[84] Huashu Defense Technology (华戍防务), located in Beijing, has also designed several wargames for PLA purposes, including those used in recent tournaments and competitions.[85]

Several Chinese companies also supply the PLA with battlefield simulation systems to facilitate training. Realis (瑞立视) is developing VR training rooms equipped with AI that allow for multi-person training, including for scenarios of counter-terrorism operations.[86] Beijing QingCloud S&T (青云科技) reportedly developed an "urban combat digital training environment system platform" integrating three-dimensional situation display, synchronous video display, and synchronous acquisition and storage of combat data.[87] Such systems could facilitate the PLA's capacity to enhance the realism of its training and preparation for future conflict.

## Policy Recommendations and Considerations

In closing, this testimony recognizes that military-civil fusion presents competitive challenges and raises a series of directions for policy recommendations.

***1. Sustain and redouble investment in American science and innovation.***

The increases in investment in academic research and critical technologies that have occurred under the Biden administration are welcome. Going forward, the consistency and sustainment of these efforts over time will be critical to enable long-term progress. So too, America's trajectory and potential to remain a leader in science and technology will also depend, fundamentally, on the cultivation and retention of talent, which hinges upon policies in in education and immigration.

***2. Leverage the depth and capacity of U.S. capital markets to facilitate targeted investments in critical technologies.***

Whereas China has implemented specific government programming to direct venture capital toward dual-use technology development, most such efforts in a U.S. context so far have occurred through private or independent initiatives. The U.S. government can expand efforts to partner more effectively with commercial stakeholders in order to identify available capital and resources to direct to advance the development and commercialization of critical technologies.

***3. Scale up initiatives for flexible acquisitions to facilitate leveraging of commercial technologies.***

The question of how the U.S. Department of Defense can best facilitate flexible partnerships with commercial enterprises and enable more adaptive acquisitions has long been the focus of much debate and concern. These issues take on greater urgency given current competitive challenges. The efforts of the Defense Innovation Unit, which have been impactful in enabling rapid prototyping of commercial technologies, could be further expanded and institutionalized.

***4. Promote technology demonstration and operational experimentation across the joint force.***

American leadership in innovation can only be operationally advantageous when applied and scaled. For instance, within under the auspices of U.S. Naval Forces Central Command (NAVCENT) the unique approach that Task Force 59 has taken to commercial partnerships, including the use of COCO (contractor owned, contractor operated) capabilities, and active operational experimentation, has been effective and provided a model that can be explored and possibly expanded across other fleets. The introduction of similar initiatives in the Indo-Pacific as well—and in conjunction with our allies and partners—could be effective to enhance U.S. agility in innovation adoption.

***5. Enhance capacity for a targeted approach to technology protection.***

When it comes to export controls on sensitive technologies or research integrity measures aimed to increase oversight of academic research, a core concern and debate remains how to strike a balance and to imply measures in a manner that mitigates damage to U.S. academic research and commercial collaborations.

***6. Expand upon and bolster multilateral coordination with allies and partners.***

To be effective, U.S. policy measures must be multilateral and coordinated with allies and partners. For these initiatives to be effective requires information- and intelligence- sharing, as well as the exchange of lessons learned in policy and process.

***7. Enhance efforts to leverage open-source resources to inform research and policymaking.***

Today, there are reasons for urgent concerns about a closing of open-source resources. The increasing restrictions on access to the China National Knowledge Infrastructure (CNKI), the Chinese academic database previously available to universities, are concerning.[88] The availability of information for research is critical to enable understanding and mitigate the risks of misperceptions worsening due to an information vacuum.

Despite several critical and impactful initiatives within and beyond government that concentrate on leveraging or increasing accessibility through the translation of open-source resources, U.S. policymakers are not yet fully leveraging publicly available information. The expansion of successor to the Open Source Enterprise to allow additional resourcing for research and analysis could be impactful.

## Implications for Strategic Competition

China's strategy of military-civil fusion is likely to remain a central concern in a moment when technological competition is a particularly prominent dimension of U.S.-China relations. To the extent that the PLA is able to increase its capacity to leverage commercial technologies, especially in new domains and to enhance emerging capabilities, these initiatives could be impactful in this ongoing rivalry. In crisis, the leveraging of military-civil fusion to facilitate defense mobilization also could erode warning—and also provide an advantage to China in scenario of a protracted conflict given the potential capacity to sustain resources. Looking forward, the policy and analytic challenges of military-civil fusion will merit continued analytic attention.

## Endnotes:

[1] "Xi Jinping: Firmly promote in-depth development of military-civil fusion to provide strong impetus and strategic support for realization of the China Dream and strong military dream" [习近平：扎扎实实推进军民融合深度发展 为实现中国梦强军梦提供强大动力和战略支撑], Xinhua, March 12, 2018.

[2] Alex Stone and Peter Wood, "China's Military-Civil Fusion Strategy," China Aerospace Studies Institute, June 15, 2020, https://www.airuniversity.af.edu/CASI/Display/Article/2217101/chinas-military-civil-fusion-strategy/.

[3] "When attending the plenary meeting of PLA and PAP delegations, Xi Jinping emphasized unifying thinking and understanding, strengthening mission responsibility, paying close attention to work implementation, and striving to create a new situation of integrated national strategic system and capacity building" [习近平在出席解放军和武警 部队代表团全体会议时强调 统一思想认识 强化使命担当 狠抓工作落实 努力开创一体化国家战略体系和能 力建设新局面], Xinhua, March 8, 2023.

[4] "National defense mobilization: keeping pace with the times and taking the express train of military-civil fusion" [国防动员：与时俱进，搭乘军民融合的快车], Xinhua, October 6, 2017.

[5] "Xi Jinping discusses military-civil fusion: related to the overall outlook for national security and development" [习近平谈军民融合：关乎国家安全和发展全局], *Seeking Truth* [求是], October 16, 2018, http://www.qstheory.cn/zhuanqu/rdjj/2018-10/16/c_1123565364.htm.

[6] For more discussion of this concern and dynamic, see "Myths and Realities of Military-Civil Fusion," co-authored with Lorand Laskai.

[7] For previous analysis of PRC concerns about chokepoint technologies, see: Ben Murphy, "China's Self-Identified Strategic Technology Import Dependencies," CSET, May 2022, https://cset.georgetown.edu/publication/chokepoints/

[8] "When attending the plenary meeting of PLA and PAP delegations, Xi Jinping emphasized unifying thinking and understanding, strengthening mission responsibility, paying close attention to work implementation, and striving to create a new situation of integrated national strategic system and capacity building" [习近平在出席解放军和武警 部队代表团全体会议时强调 统一思想认识 强化使命担当 狠抓工作落实 努力开创一体化国家战略体系和能 力建设新局面], Xinhua, March 8, 2023.

[9] "Consolidate and develop military-government (and) military-civil unity in the new era" [巩固发展新时代军政军 民团结], CNR, March 13, 2023.

[10] Our initial estimate of military funds comes from this 2021 report: "Myths and Realities of Military-Civil Fusion," co-authored with Lorand Laskai; additional data/analysis is available on request.

[11] "From "Military-Civil Integration" to "Military-Civil Fusion" —— Adjustment and Improvement of China's National Defense S&T Industry Leadership Management System Since Reform and Opening Up" [从"军民结合"到 "军民融合"——改革开放以来中国国防科技工业领导管理体制的调整与完善], CCP History Network [中共党 史网], August 29, 2019.

[12] "SASTIND interprets opinions on promoting military-civil fusion in national defense S&T industry – reform solves problems, innovation enhances vitality" [国防科工局解读推动国防科技工业军民融合的意见——改革破 解难题 创新增强活力], Economics Daily [经济日报], December 7, 2017.

[13] "SASTIND Issued the Opinion on Accelerating and Advancing S&T Collaborative Innovation of National Defense S&T Industry" [国防科工局出台意见 加快推进国防科技工业协同创新], Xinhua, June 29, 2016.

[14] ""Opinion on the Integrated Development of Economic Construction and National Defense Construction" Proposed" [《关于经济建设和国防建设融合发展的意见》提出], Xinhua, July 28, 2016.

[15] "The Central Military Commission of the Central Committee of the Communist Party of China issued the "Opinions on the Integrated Development of Economic Construction and National Defense Construction" [中共中 央 国务院 中央军委印发《关于经济建设和国防建设融合发展的意见》], Xinhua, July 21, 2016.

[16] See: "Xi Jinping chaired the Central Military-Civil Fusion Development Committee first plenary meeting" [习近 平主持召开中央军民融合发展委员会第一次全体会议], July 20, 2017, Xinhua.

[17] Jin Zhuanglong [金壮龙], "Create a new situation for in-depth development of military-civil fusion in the new era" [开创新时代军民融合深度发展新局面], *Seeking Truth* [求是], July 16, 2018. Jin Zhuanglong (金壮龙) has served as Executive Deputy Director of the Central Military-Civil Fusion Development Committee Office. "Xue

Huifeng: Use Qian Xuesen's system engineering concepts to promote in-depth development of military-civil fusion of cybersecurity and informatization" [薛惠锋：用钱学森系统工程思想，助推网信军民融合深度发展], *People's Daily*, July 5, 2018.

[18] Brenda Goh and John Ruwitch, "Pressure on as Xi's 'Belt and Road' enshrined in Chinese party charter," *Reuters*, October 24, 2017.

[19] "Xi Jinping: Opening up a new era of in-depth development of military-civil integration" [习近平：开创新时代军民融合深度发展新局面], Xinhua, March 2, 2018.

[20] ""13th Five-Year" S&T Military-Civil Fusion Development Special Plan Issued" ["十三五"科技军民融合发展专项规划发布], Xinhua, August 25, 2017.

[21] "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035" [中华人民共和国国民经济和社会发展第十四个五年规划和2035 年远景目标纲要], Xinhua, March 12, 2021.

[22] "Military-civil fusion deep sea S&T international innovation park project investment agreement signed in Anning City" [军民融合深海科技国际创新园项目投资协议在安宁市签署], China National Defense Science and Technology Information Center [中国国防科技信息中心], August 22, 2018.

[23] See: "Xi Jinping chaired the Central Military-Civil Fusion Development Committee first plenary meeting" [习近平主持召开中央军民融合发展委员会第一次全体会议], July 20, 2017, Xinhua.

[24] SASTIND has released several plans and initiatives. "SASTIND released the 2017 Military-Civil Fusion Special Action Plan" [国防科工局发布 2017 年军民融合专项行动计划], June 22, 2017, SASTIND.

[25] "SASTIND interprets opinions on promoting military-civil fusion of national defense S&T industry; reform solves problems, innovates and enhances vitality" [国防科工局解读推动国防科技工业军民融合的意见——改革破解难题 创新增强活力], *Economics Daily* [经济日报], December 7, 2017,.

[26] "Military and civilians gather together to accelerate the construction of a comprehensive public service platform for national military-civil fusion" [军民聚力加快推进国家军民融合综合公共服务平台建设], Xinhua, July 14, 2017.

[27] The references available are incomplete and don't indicate the amount of funding associated.

[28] For an early reference to it, see: "The 9th China Military-Civil Fusion Annual Conference and Achievements Exhibition was successfully convened in Beijing" [第九届中国军民融合年会暨成果展在京成功举办], December 12, 2016, http://military.cctv.com/2016/12/12/ARTIAvVZd4PH6M7sEoCjM6PV161212.shtml

[29] "13 experts from private enterprises entered the Rocket Force "think tank" and gave the national team treatment" [13 名民企专家进火箭军"智库" 给予国家队待遇], *PLA Daily*, October 5, 2018.

[30] "Academy of Military Sciences and Chinese Academy of Sciences signed a strategic cooperation framework agreement" [军事科学院与中国科学院签署战略合作框架协议], *PLA Daily*, March 25, 2018.

[31] "Academy of Military Science National Defense Science and Technology Innovation Research Institute – Exploring the "Matrix" Research Model to Enhance Innovation Capability" [军事科学院国防科技创新研究院——探索"矩阵式"科研模式提升创新能力], April 2, 2018. "Academy of Military Science National Defense Science and Technology Innovation Research Institute has taken measures to gather top talents" [军科院国防科技创新研究院多措并集聚顶尖人才], China Military Network, February 4, 2018.

[32] "The Academy of Military Sciences selects more than 120 urgently needed scientific research personnel from the whole military" [军事科学院面向全军集中选调 120 余名急需科研人才], Xinhua, January 1, 2018.

[33] "Tianjin (Binhai) AI Military-Civil Fusion Innovation Center" [天津（滨海）人工智能军民融合创新中心], October 23, 2018, http://www.yingjiesheng.com/job-003-781-914.html

[34] "PLA launches website for military equipment procurement," *China Daily*, January 4, 2015, https://www.chinadaily.com.cn/china/2015-01/04/content_19232029.htm

[35] Liu Zhen, "Chinese military hints at plans for airborne laser attack weapon," *The South China Morning Post*, January 7, 2020, https://www.scmp.com/news/china/military/article/3045066/chinese-military-hints-plans-airborne-laser-attack-weapon

[36] See: "Notice on the Forwarding of Applications for the CMC S&T Commission Rapid Response Small Group Projects" [关于转发中央军委科技委快响小组项目申报的通知]

[37] "China's first national defense S&T innovation rapid response team was launched in Shenzhen" [全国首个国防科技创新快速响应小组在深圳启动], Sina, March 18, 2018.

[38] "Emergency Operations Drones in Epidemic Areas! National Defense S&T Innovation Rapid Response Small Group (Chongqing) issued an emergency notice on requirements" [疫情区应急作业无人机！国防科技创新快速响应小组（重庆）发布紧急需求通知], February 9, 2020.
[39] "Opinion on Promoting Deeper Development of Military-Civil Fusion in National Defense S&T Industry" [国务院办公厅关于推动国防科技工业军民融合深度发展的意见], December 4, 2017.
[40] "*Guohua* Military-Civil Fusion Industrial Development Fund established" [国华军民融合产业发展基金创立], National Defense Science and Industry Bureau, September 7, 2016.
[41] "Cheng Jibin, chairman of the National Military-Civil Fusion Fund, and his party went to the Changjiang Industry Group for discussions and exchanges" [国家军民融合基金监事长程继斌一行到长江产业集团座谈交流], July 25, 2022.
[42] See: "Introduction to Zhongguancun Joint Innovation Military-civil Fusion Equipment Industry Alliance" [中关村联创军民融合装备产业联盟简介]
[43] See, for instance: "Military-Civil Fusion Innovation Industry Park Will Be Unveiled at Shunde" [军民融合创新产业园将在顺德揭牌], CNR, December 22, 2017.
[44] "Hainan vigorously promotes marine technology innovation to create a new highland for deep-sea technology" [海南大力推动海洋科技创新 打造深海科技新高地], CCTV, February 15, 2023.
[45] Hu Yu [胡宇] and Huo Yihui [火艺卉], "'Crossing Obstacles 2016' Ground Unmanned Systems Challenge Ends Wonderfully" ["跨越险阻 2016"地面无人系统挑战赛精彩落幕], China Military Online, October 19, 2016.
[46] "2019 Navy Unmanned Surface Vessel Challenge Series" [2019年度海军水面无人艇挑战赛系列活动公告], June 13, 2019.
[47] "Notice on Calling for S&T Achievements Exhibition Project of "Frontier S&T into the Military Camp – Entering the Strategic Support Force Information and Communication Base"
[关于征集"前沿科技进军营—走进战略支援部队信息通信基地"科技成果展项目的通知], Chinese Institute for Command and Control, March 11, 2019.
[48] "Rocket Force's "Smart Arrow·*Fire Eye*" Artificial Intelligence Challenge Finals Held in Beijing" [火箭军"智箭•火眼"人工智能挑战赛决赛在京举办], *China Daily*, June 5, 2021.
[49] See, for reference: "The warm up match of the Joint Operations Smart Game Challenge is about to start" [联合作战智能博弈挑战赛热身赛即将打响].
[50] "New-quality militia forces all debut their skills" [新质民兵力量悉数登场显身手], China Military Network, October 10, 2018.
[51] "Shanghai established militia drone reconnaissance sub-unit" [上海成立民兵无人机侦察分队], *Observer*, May 14, 2015.
[52] "Exploring new mobilization power among talents from new professionals" [在新职业人才中挖掘新质动员力量], Sohu, March 29, 2019.
[53] "Winning the online information public opinion war! Shunde established the first militia cyber unit" [打赢网络信息舆论战！ 顺德组建首支民兵网络分队], Sohu, September 28, 2018.
[54] "Expanding the science and technology innovation "circle of friends" for national defense mobilization" [扩大国防动员的科技创新"朋友圈"], *PLA Daily*, November 19, 2018.
[55] How precisely that was calculated or evaluated was not specified. "How private enterprises "join the army" and shine" [民企"参军"如何大放异彩], *S&T Daily* [科技日报], March 16, 2018.
[56] "Xu Dazhe: Promoting in-depth development of military-civil fusion of defense S&T industry" [许达哲：推进国防科技工业军民融合深度发展], *People's Daily*, November 2, 2015.
[57] "Over one thousand private companies receive Weapons and Equipment Research and Production Certificate" [千余民营企业获武器装备科研生产许可证], Guancha, March 15, 2016. However, other indicators support the inference that companies involved in military-civil fusion are not particularly numerous. There is almost certainly overlap between companies holding the two types of licenses.
[58] "MCF S&T equipment industry investment promotion report" [军民融合科技装备产业投资促进报告], Ministry of Commerce, November 2018, https://web.archive.org/web/20200608231930/http://pdf.dfcfw.com/pdf/H3_AP202002211375367494_1.pdf.

[59] "A private enterprise breaks through the "glass door" of military-civil integration [一家民营企业突破军民融合"玻璃门"], *China Youth Daily*, January 9, 2019. For a more detailed discussion of the general challenges, see: Alex Stone and Peter Woods, ""China's Military-Civil Fusion Strategy: A View From Chinese Strategists,"" China Aerospace Studies Institute, June 2020.
[60] "A private enterprise breaks through the "glass door" of military-civil integration [一家民营企业突破军民融合"玻璃门"], *China Youth Daily*, January 9, 2019.
[61] See: "Thoughts on Optimizing Access Mechanism of "Three Military Certificates"" [优化"军工三证"准入机制的思考], October 14, 2020.
[62] See Yang Ming [杨明], "Analysis of China's Legal System for Military-Civil Fusion Development (Part One)" [浅析我国军民融合发展法律制度(一)], China Law Insight, April 17, 2018.
[63] This system is determined by the "Measures for the Implementation of Licensing for Scientific Research and Production of Weaponry and Equipment" (武器装备科研生产许可实施办法).
[64] "The Office of the Central Military-civil Fusion Development Committee held a deployment meeting to coordinate promotion of standardized military-civil fusion" [中央军民融合发展委员会办公室召开统筹推进标准化军民融合工作部署会], Xinhua, August 1, 2018.
[65] "National Standardization Management Committee Central Military Commission Equipment Development Department Notice on Regulating the National Standard Formulation Procedure Common to Military and Civilian" [国家标准化管理委员会 央军委装备发展部关于规范军民通用的国家标准制定程序的通知],
[66] "The CMC Equipment Development Department and SASTIND launched a joint inspection of the entire military's equipment industry to jointly clean up and manage the military and localities" [中央军委装备发展部、国家国防科技工业局启动全军装备行业领域整肃治理军地联合检查], Sohu, July 12, 2022.
[67] For context on debates at the time, see: ""Military-Civil Fusion Law" legislation added to the agenda" [《军民融合促进法》立法提上日程], *PLA Daily*, March 4, 2012.
[68] See: "Improve the level of legalization in deep development of MCF" [提高军民融合深度发展的法治化水].
[69] "A Brigade of the Eastern Theater Command an Urban Offensive and Defensive Drill" [东部战区某旅展开城镇攻防演练], *CCTV*, May 5, 2021.
[70] Kelvin Wong, "IMDEX 2017: China's Yunzhou-Tech showcases latest USVs," IHS Jane's International Defence Review, May 18, 2017.
[71] "Deep Blue signed a strategic cooperation agreement with the Tianjin (Binhai) Artificial Intelligence MCF Innovation Center" [深之蓝与天津（滨海）人工智能军民融合创新中心签订战略合作协议], TEDA, February 22, 2019.
[72] Andrew Jones, "China is developing plans for a 13,000-satellite megaconstellation," Space News, April 21, 2021.
[73] "This young startup will send AI satellites to the sky" [这家年轻的初创企业，将 AI 卫星送上天], Xinhua, November 13, 2018.
[74] "Zhou Hongyi: Military-civil fusion enhances national network security technology level" [周鸿祎：军民融合提升国家网络安全技术水平], China Military Online, August 19, 2016. "SASTIND Information Center and 360 Enterprise Security Sign Strategic Cooperation Agreement" [国防科工局信息中心与 360 企业安全签署战略合作协议], *Global Times*, April 19, 2018, http://www.cnbeta.com/articles/tech/718377.htm
[75] "Tianmu Data was invited to participate in the 2018 National Cyber Security Week" [天目数据受邀参加 2018 年国家网络安全周活动], Tencent, September 2018.
[76] "Tianhe Defense: Concentrate on strategic innovation and transformation of "combination of peacetime and wartime, military-civil fusion" and launch a new "engine" for growth" [天和防务：聚焦"平战结合、军民融合"战略 创新转型启动增长新"引擎"], Sohu, June 17, 2022.
[77] "Starsee opens the first internal domestic military algorithm "Star Intelligence" platform" [摄星智能开放首个内部国产军事算法 "星智"平台].
[78] "About DataExa" [关于渊亭科技].
[79] The company's full name is 保利天同深海技术股份有限公司. "Military-civil fusion deep sea S&T international innovation park project investment agreement signed in Anning City" [军民融合深海科技国际创新园项目投资协

议在安宁市签署], China National Defense Science and Technology Information Center [中国国防科技信息中心], August 22, 2018.

[80] "Military-civil fusion deep sea S&T international innovation park project investment agreement signed in Anning City" [军民融合深海科技国际创新园项目投资协议在安宁市签署], China National Defense Science and Technology Information Center [中国国防科技信息中心], August 22, 2018.

[81] "Hengtong Ocean and BUPT jointly established the "Underwater Optical Network Joint Laboratory"" [亨通海洋与北邮等联合成立"水下光网络联合实验室"], China Quality News [中国质量新闻]

[82] Hengtong Ocean and Beiyou jointly established the "Underwater Optical Network Joint Laboratory"" [亨通海洋与北邮等联合成立"水下光网络联合实验室"], China Quality News [中国质量新闻网].

[83] "Huaru Technology: The advantages of military simulation are obvious" [华如科技：军事仿真优势明显], Security Times Network [证券时报网], June 6, 2022.

[84] "Huaru Technology was invited to participate in the inaugural meeting of the China Military-Civil Fusion Collaborative Innovation Alliance" [华如科技应邀参加中国军民融合协同创新联盟成立大会], Huaru S&T [华如科技], March 22, 2017.

[85] "The national defense popular science war game deduction system jointly created by CICC and Huashu Defense is here!" [由 CICC 与华戍防务联合打造的国防科普兵棋推演系统来了], CICC, June 9, 2019.

[86] "Introduction to the Company" [公司介绍], http://www.realis-e.com/aboutus.html

[87] See, for instance, promotional materials for the company. "Urban special operations digitalization training environment system" [城市特种作战数字化训练环境系统], 81IT.com, June 9, 2020, http://www.81it.com/2020/0609/11480.html.

[88] Lin Yang, "China to Limit Access to Largest Academic Database," March 30, 2023, https://www.voanews.com/a/china-to-limit-access-to-largest-academic-database-/7029581.html.

## PANEL I QUESTION AND ANSWER

CHAIRMAN BARTHOLOMEW: Great. Thank you very much. We'll start at the top of the alphabet at Commissioner Borochoff.

COMMISSIONER BOROCHOFF: First, let me thank our witnesses today. This is not my background. The entire military is something that's somewhat foreign to my background. But there are great references to my background that affect everyone in America. And I want to say I sincerely appreciated Commissioner Wong's comments about history and how the military affects commerce generally.

I have a question for Dr. Cheung. I appreciate everything that you said. One of the -- In your written testimony where you're talking about some policy recommendations, you made the statement that the broader U.S. S&T community has very little expertise on the issues covered in your testimony. And I think I understand that. I was in the manufacturing, what I would call small batch manufacturing business for 40 years.

And I remember in the 70s and 80s when the Chinese would come to big conferences and expos taking pictures of equipment that American titans of industry were manufacturing. And we all thought that was kind of cute and funny. But today, a lot of those companies don't exist anymore that were truly large companies. And the equipment that they manufactured that they were photographing is now being made in China. Some of it I can see direct relationships in military-civil fusion, things like refrigeration, things that would feed an Army, things that we thought were innocuous, no one ever imagined would have anything to do with military.

You mentioned, Dr. Cheung several things that I frankly have never heard of because it's not as I mentioned, part of my background, that the U.S. service arms have various entities such as the Center for the Study of Chinese Military Affairs at the National Defense University, the China Maritime Center of the U.S. Naval War College for the U.S. Navy., the China Air Power Study Institute for the U.S. Air Force. And you're recommending that perhaps there should be a similar research entity situated in the Pentagon.

I wondered if you might elaborate a little on what those various entities do and what the advantage would be to do it as well at the Pentagon. I'd like to understand should it be centralized -- Is that what you're recommending or are you saying there's an additional need?

DR. CHEUNG: I think there's -- Thank you for that excellent question. And I think we need to have sort of like a base -- sort of a centralized level of effort, et cetera. I mean like as the study of military-civil fusion, military acquisition, sort of the relationship between sort of the military development industrialization and innovation in the U.S. that's being primarily done by individual scholars like you see on this panel.

When we look at sort of like the Defense Department, they've been seeing and they've been sort of like helping to develop this study like for the Navy. They have this Maritime Center, they're able to get the economies of scale, get concentrations of expertise, and so the understanding of Chinese Navy and maritime issues has significantly improved because of that. And we see this in the Air Force and in the other services.

But in the Defense Department, we haven't seen this in the research and development and acquisition and sort of like the industrialization and the economic security side of this. And I think that we -- it really needs sort of like some major investment by the -- by the Government because otherwise, this is left to individual scholars and it's really difficult. And we haven't done that itself.

I mean I was fortunate sort of like a decade ago when the Defense Department gave me a Minerva sort of research grant. And I was able to do a lot of convening and a lot of conferences to sort of train some of the younger scholars, et cetera, but that's gone away. And so right now sort of this whole area, it's acquisition, economic, and industrial issues as it relates to military modernization, is one of the most underdeveloped and understudied and poorly known parts of looking at the PLA.

COMMISSIONER BOROCHOFF: Thank you. Great answer.

CHAIRMAN BARTHOLOMEW: All right. Commissioner Friedberg.

COMMISSIONER FRIEDBERG: Thank you very much and thanks to our witnesses for their excellent statements. Ms. Kania, good to see you. I'd like to start with you. And a question about this whole idea of military-civil fusion. It seems that it depends on two things. One is a dynamic private sector from which military could draw ideas and innovations. And the other at least for the time being is continued access to foreign technology.

So I guess the first question is to what extent would you say or what portion of the military-civil fusion concept depends on continuing access to foreign technology, joint ventures between Chinese and foreign companies?

MS. KANIA: That's a great question and a challenging one as well because certainly we've seen military-civil fusion leveraged to access and exploit dual-use technologies. And that has been impactful in a number of different contexts, including some basic research partnerships around artificial intelligence, robotics, undersea acoustic technologies and otherwise. But I think the writing has been on the wall for a while in the sense that this access to foreign technologies and the ability to leverage these partnerships would not be permanent.

So I think we've seen increasingly in recent years, efforts to try to insulate China from the impacts of these measures and to build more genuinely indigenous capacity. So I think certainly the restrictions in particular of late on access to semiconductors are causing a lot of near-term pain. My concern is that in the long-term, making Beijing so acutely aware of these choke points is driving more resourcing towards overcoming those obstacles. And even when we've seen these restrictions come up in a U.S. and allied context starting to deny more of that access, Beijing and Chinese companies that are linked to military-civil fusion can look to the rest of the world and find other conduits or opportunities.

So I think there will be -- certainly there will be adverse impacts on Chinese military modernization and technology development across sectors for some of the restrictions that are coming into play, but the focus on self-reliance and self-strengthening on becoming less of a fast follower, trying to catch up and close the gap and more of a leader, especially in sectors where there is no clear center of gravity or where China does have this dynamism and innovation in its own right.

For instance, if you look at Shenzhen as a center of hardware and commercial technologies, it's no coincidence that the Central Military Commission set up their first Agile Innovation Defense Unit there. In some respects, China's innovation ecosystem has unique features and capacity, especially in manufacturing robotics, drones, and other sectors. So the impacts will continue to be uneven. But I think -- I worry in the long-term that some of these restrictions we're imposing will have limited near-term to mid-term impacts, but could force Beijing to overcome those dependencies in the long-term and they're dedicating the resources to getting there.

COMMISSIONER FRIEDBERG: So this is I realize a speculative question. But it seems like two things are changing now, which may interfere with the PRC's ability to implement this

military-civil fusion strategy. One is increasing constraints on their access to foreign technology as you mentioned. But the other might be that as the regime tries to tap the private sector and draws it more into its military system, it may depress the innovativeness of that part of their economy. It's going to make those nominally private companies increasingly part of the state-directed system, which may reduce their innovative capacity. Do you have any thoughts on that?

MS. KANIA: That is very much a hazard of the Party-State's current approach. And the extent to which they've been willing to accept those potential tradeoffs reflects the degree to which control and security are still prioritized over innovation. I used to think that the Party's objective was to put harnesses on their golden geese in the technology sector without strangling them. But it since has become apparent they're willing to strangle some of those -- some of those golden geese in the interest of scaring the others into being more compliant to Party-State aims and less inclined to challenge centralized authority.

The question is -- to be sure, they'll have a chilling effect on innovation, but will there be enough companies that are still competing, still dynamic, still motivated by the ample incentives coming into play, where they will toe the line and they will continue to compete within this domestic context and seeking out more favorable and friendly international markets as well.

So I think you're right absolutely that the Party is in some respects hindering its own objectives through this crackdown on the tax sector that we've seen evolve over time and might be -- might be stabilizing for the time being now that they've achieved some of their initial objectives there. But I think that's not necessarily going to be completely impeding the dynamism of some of these industries in the long-term. And there are a number of companies that are very eager to support the PLA and eager to position themselves as advancing Party-State objectives. Especially given the benefits and advantages of doing so.

COMMISSIONER FRIEDBERG: Thank you very much.

CHAIRMAN BARTHOLOMEW: Great. Thank you. Welcome back, Commissioner Glas.

COMMISSIONER GLAS: Hi. Thank you. Thank you all for your testimony this morning. And my question is to Mr. Curriden. In your testimony -- First, your testimony talks a lot about research development and acquisition and how while there's still flaws in the Chinese processes, they have been able in a pretty short period of time been able to gain access to critical military technologies and capabilities. And in your testimony you talk about the Chinese leaders have often expressed concerns about their overreliance on imports for component parts, whether that was for jet engines or other components necessary for military technology advancements.

What is the Chinese government doing to enable more of its domestic manufacturing wholly of component parts? And in addition, you note in your testimony that more research should be done to understand what component parts are coming into the Chinese military infrastructure from other areas of the world to better track that. I don't even feel like we have a good handle on that here in the United States for our own military. But who should be doing that work? Who's doing that work? And what would your recommendation for Congress be?

MR. CURRIDEN: So first of all, as for how they reduce their reliance on foreign tech, there does seem to be a very focused effort to identify on their end, what are they still importing? You know, for example, you know, if they can be a jet engine, are there parts of the jet engine they still have to import? And then a very strong focus on, you know, just sort of going down the list. Right? Okay, well we can't make this thing. How do we make this thing? A lot of that frankly is based on stealing foreign technology. And we've seen a very strong effort when it comes to jet engines to frankly steal foreign technology. Much of that effort also is focused on

their own innovation. You know, building their own companies and their own research institutes that can research those things.

So those seem to be the two sort of main lines of effort when it comes to reducing their reliance on foreign components. As for who is doing the work on what components they rely on, I don't know of any single agency or single institute that is working on that. It's certainly something that you could probably find out a lot more if there were a dedicated research program focused on it.

You know, for example if you were to give a research organization or you know, assign someone a certain -- you know, say okay, you have 12 months or eight months. Find out everything you can about what the components the Chinese are still importing, where are they importing them from, and how important are those components to Chinese weapon systems? Right? Like you know, for example are they importing this just because it's cheaper, but they could make it themselves? Or is it something that like if they can't get this, they're not building anymore missiles or whatever it is? I think there's probably information in the open sources on that and probably even more information classified sources on that.

As for who should be doing that work? You know, I don't know. That's a good question. Certainly something that could be, you know, that people in the Pentagon could look at certainly from the high side. Yeah. I don't know -- Yeah. I guess I don't know that I could speculate too much on who specifically should be assigned to that task.

COMMISSIONER GLAS: Just one quick follow up question to both Mr. Curriden and Ms. Kania. Out of the research development and acquisition process, recognizing they use practices like state-owned enterprises and subsidize their industries and steal intellectual property. Is there anything that the Chinese are doing that is more modern or sophisticated in those processes that the U.S. Government should also be considering doing? Ms. Kania, in your testimony you talked about flexible acquisition. I wasn't quite sure what that meant. But I'm assuming that means providing the Department of Defense the ability to acquire new technologies as needed in a timely fashion. So is there anything that we should draw on for the U.S. Government processes?

MS. KANIA: So I'd say to start, the PLA despite its reputation for not being all that creative or innovative is really experimenting with new mechanisms and new initiatives, some of which are an analogous to those we've seen in the United States. DARPA-style challenges or competitions that have a prize and sort of open entrance to competitors to try to develop a -- reach a specific end state.

I had mentioned in my testimony the Agile Innovation Defense Unit that was stood up through the Central Military Commission Science Technology Commission. And their approach has been analogous to that of the Defense Innovation Unit in terms of working closely with companies having sort of shorter timelines, in terms of delivering a specific capability, and trying to bring in commercial technologies.

So I think in some respects, there are ways we could scale up existing initiatives within the U.S. context. And I think what concerns me to some extent is that American leadership in technology and innovation is irrelevant operationally unless we are able to apply and deploy that at scale. So I think what is unique about China's approach is that they have the scale and capacity beyond what we have at this point.

And even when there are some parallel initiatives between both of our systems that are more creative, experimental in terms of bringing commercial technologies and innovations, I think might ultimately determine advantage is who is able to run with that. And not simply being

at the front, but being able to fully leverage these technologies. The idea of batch development or different variants in iterations that Mr. Curriden had mentioned is I think important of not being locked into a single weapon system or a single platform, but being willing to redesign and iterate upon a current program.

So I do think that the scale, the extent, and the ambition of military-civil fusion even though many aspects of it are inspired by what Beijing sees as American-style military civil-fusion is something we can learn from in terms of also trying to engage more of the country in these efforts. Not simply some of the tech hubs like Silicon Valley or Boston that have been more active there, but looking -- looking to new sources and new players. And that's something that China's military-civil fusion system is starting to do more effectively: putting incentives into place and making the PLA a more appealing partner and customer. One of the greatest obstacles for U.S. startups is still the difficulty of doing business with the Department of Defense at this point.

CHAIRMAN BARTHOLOMEW: Thank you very much. Commissioner Goodwin joining us virtually.

COMMISSIONER GOODWIN: Yes. Good morning. And Ms. Kania, that's actually a perfect lead-in to the question that I have about how best to measure the country's scientific and technological capabilities. Obviously measuring innovation capacity new to world innovation is a critical part of evaluating that.

I want to talk a little bit about this notion of diffusion capacity. Commissioners Cleveland and Price actually chaired a fascinating hearing for the Commission earlier this Spring on China's education system. And during that hearing, we heard testimony from Professor Jeffrey Ding at George Washington University where he talked a lot about diffusion capacity being an equally important measure. In his estimation, China's diffusion deficit.

And it's exactly to the point you were just making, which is how -- we also need a way to measure a country's ability to spread, adopt, and actually put into practical practice and use these new innovations after their initial inception. And in his estimation, measures of diffusion capacity are arguably better predictors of long-term growth. And again, those scientific and technological capabilities.

And further in his estimation, China has a gap. A gap between their ability to innovate on the front end and actually spread those innovations and put them into use. And also a gap between their ability to spread them into use and what we have, the infrastructure and ecosystem we have in place in the United States to do that same thing.

Now I'll acknowledge up-front as Professor Ding did that some innovation-centric measures might be more appropriate in certain settings, including in the military setting. But I want to get the Panel's reaction to this notion of China's diffusion deficit and how it impacts China's defense modernization efforts.

CHAIRMAN BARTHOLOMEW: All right. Who wants to --

(Simultaneous speaking.)

DR. CHEUNG: Are you asking a specific person? I could give you my comments on this question.

COMMISSIONER GOODWIN: Sure.

DR. CHEUNG: So one area I've been looking at is on the commercialization rate from innovation. So what I call sort of from innovation to industrialization. So how do you get a lot of the research and development actually into production and actually sort of like out into the market? And the Chinese Defense community, they make it very clear that they have a very, very

poor diffusion rate. Some of the commercialization rates that they've put forward are like -- they say it's like in space or in some of these other sort of technology domains.

The commercialization rate within the Chinese defense apparatus is around 10 to 15 percent in terms of what sort of like the research input gets out in terms of the output. And they can compare that with the U.S. and with advanced industrial countries where they say those commercialization rates are around 60 to 70 percent. What figures they use is questionable. But it shows that the Chinese diffusion or commercialization processes of sort of like there's a lot of problems getting through that valley of death. And they're trying to work out what to do. And the problems as we've pointed out, the acquisition system, a lot of it is still not very good. There's a lot of -- the legal system is poor, so like -- so the structure and process of diffusion commercialization is one of the big Achilles heels of the Chinese system.

MR. CURRIDEN: Yeah. And if I may just going along with that, I mean in terms of what are good ways to measure it? At the end of the day, the best way to measure it is just can it produce weapon systems? Right? Can it produce innovative sophisticated weapon systems? Especially can it produce weapon systems that nobody else has produced or is it still just producing copies?

That being said, in terms of the scientific system itself, there's been some interesting work done by some of my colleagues on bibliometrics. So looking at how many papers they're publishing and also how often those papers are cited -- how often those papers are cited by, you know, people outside of their own institution, that sort of thing. You can also look at patents -- how many patents they're filing. And then obviously you also want to look at what is the revenue from those patents? Right? So not just how many patents there are, but how useful those patents are.

And then just to agree with what Professor Cheung said. Diffusion is key and they seem to have difficulty with it. In an earlier project on artificial intelligence, one of the things that we found was that a lot of the technology is publicly available. Right? I mean a lot of the fundamental technological breakthroughs are being published on in universities. A lot of times the key is who can turn those scientific advances into military capabilities.

MS. KANIA: And I would just add quickly if I may, although I know we're short on time, that certainly diffusion capacity remains a challenge for China, but the results and efficacy really vary a lot across sectors. So for instance if you look at China's development of drone technology commercially and deployment of it militarily, the PLA has very much embraced drones across all domains including small underground vehicles made by DJI that have been explored in urban combat. And so I think diffusion capacity remains challenging, but not universally so.

And if you look at certain of China's strengths whether that is drones or missile technologies, the capacity for missile development and production that the Peoples Liberation Army Rocket Force can draw upon today is immense. And if you look at ship building as well and some of the trends therein capacity, that is quite significant. And I think we're going to continue to see an evolution and progression of these initiatives and sort of combination of strengths and weaknesses, depending on where you're looking in different sectors or technologies.

CHAIRMAN BARTHOLOMEW: Thanks very much. Also joining us virtually, Commissioner Helberg.

COMMISSIONER HELBERG: Thank you and thank you to our witnesses for the incredibly insightful testimonies. My question is if China's military R&D comes in part from its

civil-military fusion doctrine with its commercial companies, would it be -- I'm sure you guys saw recently -- recent reports about Sequoia Capital and other American-based venture firms funding competitors to Open AI, the artificial intelligence start-up base in California.
My question to you is would it be accurate to say that U.S. venture firms like Sequoia Capital are also funding inadvertently China's commercial technology companies, which are indirectly benefitting R&D developments and AI advancements for China's military?

MS. KANIA: I'll say to start, I think there is a need for increased oversight and screening of those kinds of outbound investments, especially in sensitive sectors like artificial intelligence where there is so much dual-use potential in research and development. I can't speak to those specific investments, but I think a lot of it does depend on context in which companies and institutions are receiving that funding.

Certainly we've seen a lot of AI companies, even those that have concentrated primarily on civilian applications also have some engagement with the PLA, including for instance the realm of natural language processing. And going forward having more parameters and mechanisms for oversight with capacity for screening in place will be important to ensure that U.S. flows of funding are not inadvertently undermining U.S. interests.

COMMISSIONER HELBERG: I have a follow up question. So one of the limited partners, which is basically tech speak for one of the investors in firms like Sequoia Capital is the Children's Hospital Corporation Pension Plan. Sequoia China raised $9 billion mostly from U.S. institutional based investors. So if we kind of extend that logic further, is the Children's Hospital Corporation Pension Plan funding China's AI development?

MS. KANIA: So I would say that I think it is important for these kinds of investments to be carefully screened. And I know that some of the policies in place are not all that robust. I won't speak to the specific details of this case, but I think there's certainly opportunities to continue to expand this conversation on -- We've seen traditionally U.S. China economic engagement be a pillar of the relationship.

Now more and more as strategic competition becomes apparent and prominent, commercial activities that might once have been regarded as unobjectionable are receiving increased scrutiny with good reason. And I think going forward as we continue this national conversation on our China policy, it is important to bring in multiple stakeholders, including for the private sector and including from venture capital, including different investors into that conversation to make sure they are fully informed and cognizant going forward of those risks.

And of how even though China's AI sector continues to be seen as a driver of economic development, the potential for spin-off of certain applications into a military context is difficult to monitor or detect. And military-civil fusion is certainly intended to break down those barriers and to make commercial technologies and academic research advances more available to the military even if in practice, there are still some obstacles to -- the PRC realizing the full extent of its ambition.

COMMISSIONER HELBERG: Before I run out of time, I have rapid fire yes or no questions. Is AI a top priority for the Chinese military? And does China's civil military fusion effectively allow it to acquire technologies developed by private companies?

MS. KANIA: Yes and yes. Intelligentization is what the PLA regards as the future of warfare and a priority direction for military development. So AI is an integral element of that agenda. Whether it will deliver the outcomes operationally that the PLA believes and seeks to achieve remains to be seen, however, given some of the immaturity of these technologies at this point, I'd add.

COMMISSIONER HELBERG: And so is it likely impossible that Sequoia Capital's investments in the AI in China will end up benefitting the U.S. military -- the Chinese military?

MS. KANIA: I think there's a risk that any investment in China, unless there is oversight and thought as to the second order effects, has a risk of inadvertently contributing to military modernization.

COMMISSIONER HELBERG: Thank you.

MR. CURRIDEN: Yeah. I guess I'd just like to note that I think it just merits consideration of how much this is helping and where it's helping because a lot of these restrictions also have costs for American companies. And that's not to say that imposing greater controls to try to stymy Chinese military-civil fusion is not a good idea. It just means that we have to carefully consider the costs and benefits of those policies.

CHAIRMAN BARTHOLOMEW: Great. All right. Commissioner Mann.

COMMISSIONER MANN: Thank you and thank you to the witnesses. My question is for Dr. Kania, although I welcome the thoughts also of the other members of the Panel. You made reference to the fact that some of these efforts by China are outside of the formal defense budget. How does that affect our ability to accurately estimate China's defense budget and its budget in comparison to other countries, obviously including the United States?

MS. KANIA: Thank you. I'll say first I'm not yet Dr. Kania. I'm still working on finishing my dissertation.

COMMISSIONER MANN: You'll get there.

MS. KANIA: I have sometime yet. And that is one of the questions I'm hoping to continue to explore in my ongoing academic research because it is -- it is very much a dilemma as we've been discussing that of coming up with accurate answers as to the size of China's defense budget, the returns on investment, the extent of resources being dedicated to military modernization beyond those official figures and channels. And I think there is a risk that if we look at the information that the Chinese Government is releasing, we may underestimate or miscalculate as to the scope and scale of their efforts.

As we've discussed throughout the Panel, there's also I think some perils in being too credulous in reading Chinese sources when the propaganda and narratives presented about the successes of some of these initiatives may not be commensurate yet with the realities of the difficulties they're facing.

So I think this gets back to the importance of having more academic research and analysis leveraging open sources. I was fortunate when I was starting as a student in this space that one of the first projects I did on this topic was with Professor Cheung through the Minerva-supported program he had been overseeing at that time. And I think going forward having more centers of gravity for academic research. And also I'm incredibly concerned about the closing of the open source. That Beijing recognizes we use certain websites, certain sources of data and insight to study the PLA.

The PLA does read our footnotes from time to time and Chinese authorities are trying to improve operational security and trying to ensure that information that they do not intend to reach a foreign audience remains restricted. So we've seen certain websites and certain articles or details that used to escape onto the internet be more closely constrained. And I think that is especially for those of us who are students or independent researchers, or even those at major institutions with more resources to acquire data, that it is a challenge because we are losing access and losing visibility. And that makes it harder to fill some of those gaps.

The fact that CNKI, the China National Knowledge Infrastructure that used to provide a lot of academic and technical publications to university libraries is now no longer accessible to foreign audiences, that is a major blow to academic research and for all of us who are at different stages of that research process. And I think something that does raise the risks of surprise or of misperception or miscalculation when we're trying to make these assessments of China's military modernization and its potential trajectory based on information that is at best incomplete, and also the information available is often intended for consumption in some forum or the information that would be more revealing is less accessible than it used to be in some respects.

So I don't have any great answers there at this point, but I think it is something we have to grapple with as an intellectual community engaged on these issues going forward to try to fully leverage the data that is still available and hopefully get to better answers going forward.

DR. CHEUNG: Can I offer one case study to provide sort of a perspective about sort of like the question about defense budgets and what's not included in the defense budget to sort of give you a sense of how difficult it is to understand what China is invested in defense research and development? And the one area that I've looked at is what I call for like sort of like the defense industry's leveraging of the capital markets.

So they have a couple of processes.

One is called asset securitization where defense firms do initial public offering on the stock market and gets funding for a lot of their production and research and development projects. The other is government guidance funds, especially military-civil fusion whereas as sort of like -- civilian and dual-use companies leverage sort of private investment to invest in some of these start-up areas.

My estimate is from asset securitization and government guidance contributes to like between 20 to 25 percent of the official defense budget. And that's just one category itself. And that's not included in the defense budget, et cetera. So if you look at that and then there's all other sort of -- many other sources of funding in the defense development apparatus of all these specialized programs like the 995 Program or the 14th Five Year Plan or other plans that are probably not in the defense budget.

So by in large, the official defense budget, what the Chinese provide is not a very, very good source and indicator. We need to think about very differently. And it's very different than sort of like comparing with the U.S. defense budget. We're talking about apples and oranges. So a lot of it is like we need to go back to thinking about -- how do we measure sort of Chinese defense investments and the Chinese defense budget? Because the official defense budget is not a good sort of mechanism to talk about this whole issue on this section.

COMMISSIONER MANN: That's extremely helpful. That's what I was wondering about. Thank you.

CHAIRMAN BARTHOLOMEW: Great. Commissioner Price.

COMMISSIONER PRICE: Thank you and you all for your testimony and for your time today. I wanted to use my time to flesh out more about some of the recommendations that either you've put in your written testimony or mentioned already. Several of my colleagues have already asked questions along those lines. But my question to all of you is how would you triage your top recommendations that you would make to help ensure that the U.S. maintains its military edge? Or do you have anything you want to add what's already been said? Thanks.

MR. CURRIDEN: I mean I have to say most of my work has been focused on China and not the U.S. Although if I may plus one, Dr. Cheung's recommendation of having a joint sort of

Pentagon-based organization looking at China, particularly the Chinese defense industrial base more broadly, that might be worth looking into. And such an organization would be very well positioned as I believe it was you, Commissioner Glas had asked earlier. That organization could be very well positioned to do a more comprehensive study for example of how to take advantage of Chinese dependencies on imports on foreign technologies.

MS. KANIA: And I would agree on those points. And I would also add that when it comes to the long-term competitive challenge that China presents, a lot of what we need to do from a perspective of U.S. competitive strategy does require that we invest in our innovation ecosystem. That we continue to sustain funding for critical frontiers of science and technology; that we concentrate on talent and education; that we try to overcome some of the difficulties in our own acquisition system and have more flexible opportunities to allow the U.S. military to leverage technologies that are available commercially and relevant today and to get those to the war fighter.

If you look at initiatives like Task Force 59 that has been engaged in operational experimentation in the NAVCENT area of responsibility, the focus has been on COCO or contractor owned and contractor operated as a model to enable more rapid deployment of technologies in theatre for maritime domain awareness. And I think that's a model that could be relevant beyond that initial effort within the Indo-Pacific. And as we engage with our allies and partners as well, just especially considering that if we think about the timelines for some of the potential worse case scenarios, time is not on our side.

And in terms of being able to bring in technologies and capabilities that could be essential or advantageous, having faster ways to leverage what is available commercially from American companies and in conjunction with our allies and partners will be critical going forward as well. While of course, continuing as we've also discussed in the Panel to think about ways to protect our innovation ecosystem in a way that mitigates risks, but also doesn't cause undue damage to our own -- our own companies in the academic sector. And focusing on a targeted and nuanced approach to technology protection that's informed by research and analysis.

DR. CHEUNG: So I wanted to add sort of in my recommendation, I was talking about of sort of one step, which is having essential gravity in the Pentagon to practice especially under the Office of Research and Engineering. And that's particularly good for looking at the defense issues. But as we've sort of talked about, a lot of what we're seeing and trying to understand where China is going in terms of innovation on competitive -- economic competitiveness. A lot of this situated outside of the defense sector, whether it's military-civil fusion on the high technology or on the research areas.

So sort of a two-step is that one is focused in the Pentagon Center. Another should be in another part of the Government where it looks at more in the economic and the commercial side. Whether it's the Commerce Department or elsewhere, this should be a more open perspective that looks at other issues that are related to more military-civil fusion or do use where it's more from a civilian perspective, rather than a military perspective.

So this dual track approach would be really, really good to understand. Because as we -- as we talked at the opening, it's this sort of like this fusion between technology and military security and economic development, which is at the heart of this great power competition and China's rise. And what you need to understand is very holistically, rather than just on the military side.

COMMISSIONER PRICE: Thank you all.

CHAIRMAN BARTHOLOMEW: Commissioner Schriver.

COMMISSIONER SCHRIVER: Thank you, Madam Chair and thank you to our witnesses. I'm interested in all of this. And I think my fellow commissioners have asked excellent questions, so let me just try to find a couple things that I don't think have been addressed yet.

Mr. Curriden, you described the whole processes in many ways mirroring ours starting with requirements and research and development to fielding batches and so on and so forth. When I think about our system, it can break down in any of those phases, but one of the worst places to break down is requirements because if you identify the wrong -- you can build a really good piece of gear at the end of the day, but if it's not fit for purpose, it's not terribly helpful.

So what you described from the requirements standpoint, it sounded like a very top-down kind of process. So I'm wondering do you have any assessment of how good they are in identifying the right requirements? This is not a military that does not have recent combat experience, doesn't train in high complex environments. How confident are you in their requirements process, and how rigid is that? They're presumably learning lessons from Ukraine, watching us in our various operations. Is it flexible and adaptable as they learn new things?

MR. CURRIDEN: Honestly thus far, it's kind of hard to say because in most cases, the Chinese requirements are, they look at our military and they say we'll have what he's having. I mean Fifth generation fighters is a great example. Right? The Chinese, even if they had never stolen any of our technology, which they have, but even if they hadn't, they already know that a fifth generation fighter should be stealthy. They know it should have supercruise. They know it should have some degree of thrust vectoring. Right? They have the requirements for Fifth generation fighters because we figured them out.

And so in most areas, that is in some ways the easiest -- in most areas, that part of the problem is not very difficult for the Chinese. It's figuring out how to build a system that meets all those requirements, which I think is possibly one of the reasons why their system is so iterative. They can afford to just keep on iterate and making progressively better versions because they have in their minds what the final product looks like. All they have to do is just across the Pacific at the one we're building.

There are a few areas in which the Chinese have gone beyond us. Again, most notably in hypersonic and anti-ship ballistic missiles. But in these cases, the requirements are guided by very clear operational imperatives. As I said for at least a quarter century, China has been very focused on disrupting American Navy surface operations in the Indo-Pacific. And so for that, the requirements are very straightforward and very consistent.

I think it remains to be seen whether or not the Chinese can continue to have that sort of success in sort of establishing requirements as they reach sort of the frontier of what America has achieved and have to start stepping into the dark. So far, they've done relatively well with anti-ship ballistic missiles and hypersonic missiles, but there again, in that case they had a pretty straight forward operational problem.

DR. CHEUNG: Can I add on this -- bring in my academic hat. So there's sort of two types of requirements that the PLA has to figure out. One is the mission's requirements, which is like as we mentioned -- it's like that's fairly straight forward because that's based on threats and that's based on sort of what is operationally available. And the Chinese -- the PLA apparatus -- the requirements apparatus, they do a pretty good job.

The big problem is the other part, which is the inventions requirements, especially as the focus on innovation on emerging technologies. A lot of like, they don't know sort of where that

is going. And that's where I think -- that's the big issue that the Chinese have to face. What is the invention requirement that then eventually turns into the mission's requirement. The Chinese are good on the applied side. They're not as good on the basic research side of defining what they're going to do for the long-term. And as they move from what I call the absorption-based model to a much more rich innovation model, the inventions requirements are going to become even more important. And it's not just about the missions requirements.

CHAIRMAN BARTHOLOMEW: Anything else? Great. Commissioner Wessel.

COMMISSIONER WESSEL: Thank you all. This has been a fascinating panel. And I want to just do a brief history lesson around the Commission because we originally were created as the U.S. National Security Review Commission. And Congress shortly after our -- the creation merged it and called it the Economic National Security Review Commission. So in their wisdom many years ago, saw that economic and national security were becoming increasingly fused as the Chinese have now identified in the MCF approach.

I'd also say that our first project was trying to assess China's defense budget. We quickly came to understand that was somewhat not to disparage those who are still researching it, somewhat of a worthless approach because since they fused the two concepts, one must look broadly at how they assess what national security means. It's economic security as well.

I want to turn though to a question, Mr. Curriden, you just made a comment a moment ago as to the Chinese want to have what we have. You know, I think about ten years ago or so, you know, the research was looking more at China as focusing on asymmetric warfare -- space-based, the electronic spectrum, et cetera. While they are still seeking to field systems in many ways that are comparable, you know, Fifth generation, Sixth generation fighters, et cetera, it seems that they are still leveraging -- and this is for all the witnesses -- leveraging the adjacencies. How can AI be a force multiplier? We've seen that in terms of Ukraine and the response to the drones, et cetera by the Ukrainians.

Can you help in terms of those adjacencies, all of you as to where you think we have -- our system is exposed? AI, we're still publishing research on basic AI engines that are available. In genomic research, we are still expressing publicly for the medical commons to advance world health, you know, advances, et cetera. China seems to be harvesting those.

So the discussion here is how do we restrict access as the Chinese are restricting access to their open source, et cetera? It seems to me that the threat is much greater, not only to the U.S., but the world from China's practices. So how do we confront those asymmetrics and those research gaps for the Chinese without undermining the benefits to the world? Mr. Curriden, do you want to start?

MR. CURRIDEN: Yeah. So first of all, when the Chinese first started many of these programs, like their missile programs, they were very asymmetric. More recently in perhaps the last decade, decade and a half or so, we've seen a much greater sort of broadening of Chinese focus. And some of that might just be a result of them having all the money that they have now. I mean it used to be they kind of had to pick and choose because they could only do a couple programs. Now they can build a long-range strategic bomber and a stealth bomber and a anti-ship ballistic missile all at the same time.

And so yeah, they absolutely still have a lot of those legacy, more asymmetric program even as they're developing a lot of symmetric programs as well. That being said, these symmetric programs themselves carry vulnerabilities. And I don't know if the Chinese are entirely cognizant of what those vulnerabilities are as they continue to develop those systems.

In terms of research and development, that's a huge question and honestly I don't know that I have a specific answer. I think what you can do is obviously you want to try to slow down the development of the PLA if you can. We also need to be careful, you know, to borrow an analogy. You don't want to kill the goose that laid the golden eggs. Right? I don't want China stealing technology from the United States for the PLA. That being said, I'd much rather have them steal technology from the United States because they're behind than us having to steal stuff from them because we're behind.

And so you'd have to ask yourself at what point in time do say publication restrictions for example become some onerous that they are -- they're more trouble than they're worth. And I think there's some ways you can tailor those. For example, there's some militarily specific technologies that we probably should be restricting. You know, things like stealth technologies that have zero civilian use at all. There's some other dual-use technologies for which it's a harder question.

COMMISSIONER WESSEL: Ms. Kania.

MS. KANIA: I think that the openness of the U.S. innovation ecosystem has been and continues to be a tremendous advantage in many respects. And that our academic and scientific research shouldn't be subject to undue restrictions, especially at early stages. I think we still live in a world where very much innovation is a global system and dynamic where we do see free flows of knowledge.

And I think for some of these priority technologies like artificial intelligence, like aspects of quantum information science, a lot of what is being published primarily is still some of the basic science at earlier stages in the research process where the harms or damages to our own system that could come with putting excessive restrictions in place could outweigh the benefits.

And I think that gets to the reality that in a world where so much of the critical technologies are driven by academic and commercial endeavors, it's inherently more difficult to put those restrictions in place. And we have to assume that some amount of technology is going to diffuse almost inevitably.

That goes go back to the question of how do we strike a balance and how do we sustain our own advantages while also recognizing that certain research collaborations with certain entities in China or research or commercial partnerships at certain stages of maturity or on especially sensitive technologies. For instance, a lot of what China has been doing in the realm of deep sea technologies, including for undersea surveillance, some of that does have legitimate scientific applications that is very clearly in China's system, intended for dual-purpose efforts and undersea surveillance and trying to erode for instance U.S. advantages in undersea warfare and anti-submarine welfare going forward as well.

So I think we have to -- So I don't have a satisfactory answer, I'm afraid. But I think we have to look very closely at different contexts, different technologies, different applications. And ensure that in attempting to compete with China, we don't make some of the mistakes we've seen Beijing make where they have overstepped and caused some chilling effects in their system. I think going forward, we can continue to expect that China will look in a truly global manner to find sources of innovation even as they're building up their own capacity domestically, which does bring us back to the question of how best to engage with allies and partners because doing -- pursuing some of these measures unilaterally won't have the intended effects if Beijing can find other countries or other alternatives as to sources of technology in some cases.

And I do think there are reasons for concern that beyond -- beyond emulation, beyond some of the catching up and trying to build what the U.S. system has, Beijing is also starting to

look to new approaches, new technologies and capabilities that we don't have where we haven't perhaps pursued those same systems or gone quite as far. Whether that is counterspace capabilities or the extent of their use of unmanned systems across the PLA as a joint force. So I think certainly no shortage of challenges at this point, but hopefully still options for creative and targeted solutions to mitigate those risks.

CHAIRMAN BARTHOLOMEW: Great, thank you. Commissioner Cleveland.

COMMISSIONER CLEVELAND: Thank you. Dr. Cheung, I'm interested in just very briefly, you state in your testimony that Chinese military authorities -- and I apologize if I'm repeating anything. I had another thing that I had to do. Chinese military authorities have not publicly identified the principle strategic component since the 1980s. But some internal PLA writing suggests that the U.S. became China's principal strategic component, not enemy beginning in the 2000s. Can you tell me why this designation is or is not important as we think about the relationship?

DR. CHEUNG: Because if you identify the enemy, that's basically -- it's like that's all adversarial and you sort of like focus much more in terms of developing war fighting capabilities and sort of all those aspects are preparing for war. If you're sort of an opponent or potential adversary, it's not as like so threatening itself. And then you don't sort of like scare off your opponent because you still find ways to be able to sort of work with them. So it's not just terminology, it has a very significant impact.

And we have seen, especially in the last year and Xi Jinping in recent months has pretty much identified the U.S. as it's adversary. And when they set that tone, it percolates down and it becomes sort of like a driving norm. And so when you move from being an opponent to an enemy, that really sort of makes the type of competition much more adversarial, much more moving sort of from just peace time to potentially war time environment. So designations matter.

COMMISSIONER CLEVELAND: I think I'll follow up on the record because I'd really like to have you amplify in some detail how that shift in designation to adversary has been manifested in spending or military equipment. But I don't want to take the time right this minute. Mr. Curriden, you focused some of your testimony on Europe. And again, I apologize if I'm repeating other questions. I was reading the other day how the Germans are increasingly reliant on car manufacturing and of course we have the purchase of KUKA by the Chinese. Macron's comments this week come as from my perspective, somewhat unwelcome in terms of at this moment in history the relationship between France and China.

Mr. Curriden, could you describe -- I think on your testimony on Page 8, you talk about methods to acquire dual-use technology from the private sector including joint ventures from firms, purchased in all or part of tech companies, and then actual outright theft. Would you provide some examples -- This is to Mr. Curriden -- of European companies that have been the target of these efforts? And then perhaps contextualize why it is that we're seeing this ongoing overture from Germany and France, notwithstanding the fact that their economies are also being hollowed out.

MR. CURRIDEN: You know for specific examples from European companies, I would want to double check my notes just to make sure I'm giving you the right examples and the right information.

COMMISSIONER CLEVELAND: That's fine.

MR. CURRIDEN: Yeah. Thank you. Sorry.

COMMISSIONER CLEVELAND: No, I appreciate that answer in terms of accuracy for the record. So the next question is also for you. On Page 9 you mention education is a theme and

that there's a deficiency in senior engineers. We had an entire hearing a month or so ago on the role of education in ensuring that the Chinese economy continues to grow. Can you talk a little bit more about this sentence in your testimony that there is this deficiency in senior engineers? And you also talk about how they essentially work for the companies they're supposed to be overseeing and don't have this independence that the PLA would hope for. But could you talk a little bit more about that? It's on Page 9 of your testimony.

MR. CURRIDEN: Sure. So in terms of education -- Oh, sorry. Was there something else?

COMMISSIONER CLEVELAND: What I'm curious about is if there is this deficiency in scientific capability, what role does that play in ensuring that the Chinese stamen and weapons base is competent.

MR. CURRIDEN: I mean that is a multi-billion dollar question. And it's hard to say. I mean there's at least one example in which a Chinese state-owned corporation lost a prominent liquid fuel rocket engineer, which may have delayed some of their developments in that field. It's a problem the Chinese complain about. It's a problem we have and we complain about.

It's really difficult to quantify though just how much it impacts the Chinese military industrial base. I mean with the possible exception of the liquid rocket fuel scientist, I have trouble finding any clear examples of when the Chinese wanted to do something, wanted to build a certain platform. And there is a clear case in which a lack of trained professionals either prevented them from building it all together or delayed them. And so, while this is a problem for them, it does not seem to be an insurmountable problem for them.

CHAIRMAN BARTHOLOMEW: All right. Thank you very much. Vice Chairman Wong.

VICE CHAIRMAN WONG: Thank you.

Dr. Cheung, I want to talk a little bit about the concept of the main strategic direction some more. You indicate that under this concept, there's one permitted at a time. And for the past 30 years, it's been focused on Taiwan or it's been Taiwan.

My question is what are the secondary directions, that's the first question. And second, under China's concept, under this concept in their doctrines, can they fight in two directions or two fronts at the same time? Are they holding and fighting?

What I'm trying to get at is, I guess, the corollary in the American doctrine it used to be two-front capability. Now, I think it's hold and fight. Is there a similar doctrine or a similar concept in Chinese thinking?

DR. CHEUNG: All right. Thank you, Commissioner Wong. I mean, fundamentally, it is. But the main strategic direction is that it is the foremost threat, and the Chinese military needs to conservate their resources on that threat itself.

As I said, in the past between the U.S., the Soviet Union and more recently it's been Taiwan. It's expanded from just Taiwan now to Taiwan including the U.S. and Japan. So the main strategic direction is critical because you cannot weaken what is at the very top.

But in terms of secondary strategic direction, you can have more than one. You can have sort of multiple. And what we've seen with China, they have a lot of secondary strategic direction, the South China Sea, dealing with India, even on the Korean Peninsula, et cetera.

So the secondary strategic direction is to deal with whether they can fight sort of limited wars or it's a holding off operation. It's unclear, but I think it's like -- but in terms of our terminology, it's about dealing with fighting a total war.

The secondary strategic direction, it's to do with a very limited or sort of like campaigns that you don't need the entire military, but you can have a theater command or a particular regional fleet to deal with that.

VICE CHAIRMAN WONG: I guess it's hard to speak in the abstract about it, but if there were two flare-ups at the same time, let's say there's a Korean Peninsula issue contingency that China has to deal with, would that compromise their ability to fight in the main strategic direction?

DR. CHEUNG: I think it would right now. Because when you look at the overall resources, the Chinese, they don't have, I think, critical mass on logistics, on support services, on events of the high command capability sort of because they haven't had very much war fighting experience.

So I think it's like if they had to fight in the South China Sea or on the Sino-Indian border, they would not be able to sort of carry out a major operation across the Taiwan Strait over time.

And we see in terms of the timelines that Xi Jinping has provided is that once they achieve basic defense modernization by the mid-2030, they may be in a better position. But I think right now, they would be very -- have low levels of confidence that they could sort of engage in a secondary operation and also do a primary operation.

VICE CHAIRMAN WONG: Thank you. I have a little bit of time left.

Mr. Curriden, I think you accurately lay out some of the issues with the Chinese procurement and R&D system. Its inefficiencies, lack of profitability, lack of diversification, but you also say, I think rightly, that the end products are pretty good, and that's still the ultimate measure.

You mentioned that it takes a long time to develop some of these exquisite systems, whether it's the J-20, the J-15, but just to put this in relative terms, though. My understanding is their timeline of development for their fourth and fifth generation fighters as an example, that is faster than what we were able to do with the F-22 and the F-35, correct?

MR. CURRIDEN: You know, honestly, I can't speak to the American timelines. Chinese timelines does seem to be about 10 to 15 years for a final platform. That being said, that does not necessarily apply to a component. So for example, it's possible they're churning out radars faster than that or sensors or things like that.

VICE CHAIRMAN WONG: Thanks. I have some followup for Ms. Kania, but I'll leave it up to the chairman.

CHAIRMAN BARTHOLOMEW: Great. Thanks very much. I'm trying to understand the prioritization process in this.

Dr. Cheung, you mentioned that Xi Jinping is in charge. And as always, I marvel that he's in charge of so much. I have no idea how he can do so much in 24 hours a day. But is there competition between the services, and how are they deciding which are the areas they really need to focus on?

And I'll put one more thing in there, which is I understand that there were a number of people from military organizations that participated in the discussions with the Russians. How does this all fit in in terms of what they're identifying they need, who takes priority in getting those things?

And for example with Russia, who determines what it is that they should be trying to get from the Russians in order to improve their modernization?

DR. CHEUNG: That's a great question. It requires about an hour's response to properly answer that, but I'll try to keep it short.

There is a certain amount of centralization. But as you pointed out, for Xi Jinping who's very much involved in this, he has to be very, very selective. So his particular focus is on sort of critical strategic capabilities that is at the national level.

For the services, they are sort of an ongoing sort of like bureaucratic and resource fights with the other services about their own priorities.

Historically, it's been very much sort of like dominated by the ground forces. But in terms of the restructure of the military high command in the mid-2010s, the air force, the navy, the rocket forces and the other service arms, et cetera, they got a lot more sort of political leverage in this itself.

So at the center, the PLA, especially if Xi Jinping and more importantly also he delegates that to the executive vice chairman of the Central Military Commission, Zhang Youxia, who plays a very, very important role. They focus on a sort of like a limited number of the most critical programs.

And then these services deal more -- especially on the conventional side. And in terms of who leads this with the Russians, there is a special commission that is under the Central Military Commission that's led by the executive vice chairman of the CMC.

They have a special commission that they talk to the Russians, and this has been going on since the early 1990s. So that's led at the Central Military Commission level with representation from all the services, et cetera, and sort of a lot of the defense technological cooperation, the acquisitions, are done through this committee.

CHAIRMAN BARTHOLOMEW: Thank you, and let's fold military-civil fusion in this in terms of prioritization. So we have the services, right, that are sort of competing upwards for resources and everything. We have decisions that are being made at the top that are prioritizing downwards. How does innovation fit into all of this?

DR. CHEUNG: So innovation is a key part. The issue is how do we define innovation. Xi Jinping has made clear in a number of venues, especially the innovation-driven development strategy. That's not just about technology, although technology is very important.

It's about organization innovation. It's about doctrinal innovation. It's about sort of talent pipeline innovation that's important. And it's very, very interesting. It's actually very, very significant.

At the recent National People's Congress that the Communist Party and the state began to undertake a major reform of the innovation system. They set up a new Central Science and Technology Commission, which sort of hops back to the Maoist approach about innovation that is centralized under the Party.

And so what we're seeing is a new approach to what innovation, science and technology and how the Party and how Xi Jinping is engaged. And so the next few years is going to be somewhat different from the last 10, 20 years that we understood how the innovation system performs.

CHAIRMAN BARTHOLOMEW: Ms. Kania, anything to add?

MS. KANIA: Just that we're seeing these high-level institutions providing strategic guidance and direction, identifying technologies that are seen as strategic including artificial intelligence, quantum and biotechnology.

And in the process, the CCP and the PLA are respectively drawing upon scientists, groups of experts, sort of small groups within some of these commissions to provide guidance on strategic direction.

We can look at institutions like the Academy of Military Sciences that has been reinvented since the PLA has reformed to really concentrate on not just military strategy, but science and innovation. Some of its leadership with expertise in supercomputing and artificial intelligence.

So think looking at some of the leading military officers and leading scientists and their backgrounds could be telling as to the inputs and priorities and the demand signal set at the top as to what technologies or what capabilities are most important then influence the system as a whole.

So a lot of the local military-civil fusion innovation demonstration zones and some of their specializations or the guidance funds and the military-civil fusion funding mechanisms that bring in venture capital or responding to these top-level signals and priorities.

And the system as a whole, to some extent, the legacy of central planning are still in play, and those may be a positive or a negative depending on the context.

But there is more flexibility for different elements of the system to respond to what are articulated as priorities, sometimes by Xi Jinping personally, though I share your skepticism about how he manages his time and how much he may take credit for that could attributed to others in his inner circle.

But certainly we've seen very clear telegraphing from the CCP as to the technologies they see as most consequential and the focus on a lot of these new domains and newly strategic technologies. And that is certainly shaping the direction for much of these efforts across this entire ecosystem.

CHAIRMAN BARTHOLOMEW: Mr. Curriden, anything to add?

MR. CURRIDEN: Just that it's interesting to look at the ecosystem for drones versus the ecosystem for missiles. Drones is one of the very few areas, actually, in which private companies seem to be licenses lead system integrators and may actually compete with traditional PLA monopolies.

What's interesting there is we see a lot of this technology seems to coming from the private sector. This seems to be the result of the private sector produced a lot of really cool stuff. The PLA saw it, and they want it, and now they're trying to integrate it in.

Missiles is interesting because it seems almost the opposite. It seems to be much more of a top-down development approach where, again, quarter-century ago, the PLA decided we need -- well, even earlier than that, they decided they needed ballistic missiles for their nuclear program.

And then they decided they needed to disrupt American carrier operations, and ballistic missiles seemed like a good way to do it. They've been throwing money at the problem for multiple decades, and they've gotten some very good results.

I think the existence of both of these programs are interesting in that they suggest the PLA is capable of doing both to some extent. Although as has been noted, it remains to be seen whether or not they will end up killing the goose that lays the golden eggs by trying to introduce too much government control into these tech companies.

CHAIRMAN BARTHOLOMEW: Wonderful, thank you. I'll just note I'm going to have the question for the record about corruption and if we have any idea of how much corruption

there is in this whole process given how much money there is sloshing around. Thank you to all of our witnesses for appearing today. We've learned a lot from your testimony. We appreciate it. Dr. Cheung, we really appreciate you getting up so early in the morning in order to participate with us, but thank you very much and we might have further questions as we go down the road. Thank you.

With that, I think we're going to break for ten minutes. We'll be back in, I'll say, 11:25.

Thank you.

(Whereupon, the above-entitled matter went off the record at 11:14 a.m. and resumed at 11:23 a.m.)

## PANEL II INTRODUCTION BY VICE CHAIRMAN ALEX WONG

VICE CHAIRMAN WONG: We're back from our break. The second panel for today will evaluate how China is pursuing new materials, components and technologies to address long-standing gaps in their space, aviation and undersea warfare capabilities as well as to gain supremacy in new domains such as artificial intelligence.

First, we'll hear from Kevin Pollpeter, a senior research scientist at the Center for Naval Analyses. Dr. Pollpeter will address China's burgeoning missile and space capabilities. Welcome back, Dr. Pollpeter.

Second, we will hear from Chad Ohlandt, a senior engineer at the RAND Corporation. Dr. Ohlandt will discuss China's efforts to overcome longstanding obstacles in military aviation. Welcome back, Dr. Ohlandt.

Third, we will hear from Sarah Kirchberger, head of Asia-Pacific Strategy and Security at the Institute for Security Policy at Kiel University in Germany, and a new voice for the Commission.

Dr. Kirchberger will examine China's efforts to improve its undersea warfare capabilities. Welcome.

Finally, we will hear from Gregory Allen, Director of the Wadhwani Center for AI and Advanced Technologies at the Center for Strategic and International Studies, another first-time witness for the Commission.

Mr. Allen will discuss China's efforts to pursue military applications of artificial intelligence.

Thank you all very much for being here. I'd like to remind you to keep your remarks to seven minutes.

Dr. Pollpeter, we'll begin with you.

**OPENING STATEMENT OF KEVIN POLLPETER, SENIOR RESEARCH SCIENTIST AT THE CENTER FOR NAVAL ANALYSIS**

DR. POLLPETER: Good morning, Chairmen Bartholomew and Wong, and members of the Commission. Thank you for inviting me to speak on this important topic of China's space and missile programs and export controls. The views I present today are strictly my own.

Despite far-reaching U.S. export control restrictions on space and missile technologies, the PRC has become a world leader in these technologies in terms of quantity and quality. China's space and missile programs are not only closing the gap with the United States but are also increasingly innovative.

The U.S. director of National Intelligence assesses that China is developing innovative systems in all space technology areas, and that by 2030 it will achieve world-class status in all but a few.

The PRC has deployed the world's first anti-ship ballistic missile, the DF-21 Delta, giving the PLA the ability to attack ships east of Taiwan as well as the DF-26 that gives it the ability to range targets out to Guam. China has also surpassed the U.S. in hypersonic technologies.

Although determining the exact role and importance of the innovative factors propelling the advancement of China's space and missile program is difficult, it is evident that China's success cannot be attributed to just one factor. Foreign assistance and its many forms has been critical to its success, however.

China's space and missile programs would not have been successful if they have not been well-funded, committed to improving their program management, and attracting a well-educated and competent workforce.

Nevertheless, China's progress in space and missile technologies has several implications for the United States in terms of export control enforcement and military security.

First, efforts to isolate China technologically or to decouple the United States and China may have been effective over the short to medium-term, but have been less effective over the long term.

Although each industrial sector has its own characteristics that influence the effectiveness of export controls, China's ability to access foreign space technology through both legitimate and illegal means indicates that U.S. attempts to restrict space and missile-related technology transfers have been limited by the willingness of other states to share technology with China and the porousness of U.S. export control enforcement.

Second, the next ten years may prove to be telling for the future of PRC space and missile programs. As China closes the gap with the United States, it must increasingly rely on its own internal abilities to advance. As a result, access to foreign technology may become less important for the PRC.

Third, the U.S. may need to place more emphasis on monitoring PRC exports of space and missile technologies. As these technologies become more advanced, the PRC may become more likely to export sensitive technologies and services to countries of concern.

On January 23rd, for example, the U.S. Department of Treasury sanctioned Spacety, a PRC-based manufacturer of small satellites for providing satellite imagery to Russia's Wagner Group.

Fourth, the expansion of the PRC commercial space industry increases the number of PRC actors who may try to acquire export-controlled items and may make monitoring and enforcement of export controls increasingly difficult.

There are also a number of implications for U.S. military security. China's development of long-range cruise and ballistic missiles and hypersonic weapons has the potential to usher in a new stage of warfare in which missile power replaces air power as the determining factor in warfare.

In doing so, missile power places an even greater emphasis on long-range reconnaissance and the role of space technologies. As a result, future maritime warfare could be decided by two main factors, weapon range and C4ISR capabilities.

Second, a PRC expansion of its nuclear arsenal may complicate U.S. nuclear deterrence. According to the Defense Department, the PRC seeks to modernize and expand and diversify its nuclear forces with warheads that range from lower yield precision strike missiles to ICBMs with multi-megaton yields.

The establishment of a more diverse nuclear armed force with precision low-yield warheads could provide the PRC more escalatory options not matched by the U.S. nuclear arsenal with its reliance on larger warheads. This asymmetry in nuclear force employment could complicate the ability of the U.S. to respond proportionally to PRC nuclear provocations.

Third, the potential development of an orbital bombardment system by the PRC may signal the intent to develop its nuclear triad into a nuclear quad based on land-launched and submarine-launched nuclear missiles, aircraft as well as space-launched hypersonic glide vehicles.

The addition of a space launch leg to the PRC nuclear deterrent would appear to give the PRC a potential global first-strike capability capable of evading U.S. missile defenses that could add a destabilizing element into a U.S.-PRC crisis management.

The development of a space-based nuclear bombardment system would also violate the Outer Space Treaty's prohibition against stationing nuclear weapons in space.

Finally, the PRC focus on conventional missiles demonstrates an emphasis on precision and mass that provides the PLA with a multilayered area denial capability out to the second island chain.

China's development of ballistic missiles, cruise missiles and hypersonic weapons presents a number of challenges to the U.S. military. These include the longer ranges of PLA missiles and an inability to defend against supersonic and hypersonic missiles.

Moreover, the Russian war on Ukraine and a recent wargame by the Center for Strategic and International Studies indicate that a conflict with the PRC could be resource intensive, with thousands of precision-guided munitions being used in the first weeks of the war causing significant losses of ships and aircraft.

If accurate, this would appear to make the stockpiling of long-range missiles and weapons platforms and the acceleration of the expansion of defense production top priorities.

Again, thank you, Commissioners, for your time today. I look forward to answering your questions.

VICE CHAIRMAN WONG: Thank you.

Dr. Ohlandt?

**PREPARED STATEMENT OF KEVIN POLLPETER, SENIOR RESEARCH SCIENTIST AT THE CENTER FOR NAVAL ANALYSIS**

## Testimony Prepared for the US-China Economic and Security Review Commission Hearing on "China's Pursuit of Defense Technologies: Implications for US and Multilateral Export Control and Investment Screening Regimes"

## PRC Space and Missile Capabilities

## April 13, 2023

*Kevin Pollpeter*
*Senior Research Scientist, China and Indo-Pacific Security Affairs Division, CNA*

Chairmen Bartholomew and Wong and members of the Commission, thank you for inviting me back to testify before you today on the important topic of People's Republic of China (PRC) space and missile capabilities. Space and missile technologies are central to the PRC's efforts to build strategic deterrent and conventional warfighting capabilities. Since its inception in 1956, the PRC space and missile program has stressed "self-reliance" (自立更生) in developing its space and missile programs. Despite this adherence to relying on its own abilities, foreign assistance has played an instrumental role in advancing China's space and missile program.

In fact, despite far-reaching US export control restrictions on space and missile technologies, the PRC has become a world leader in these technologies in terms of quantity and quality. In 1999, the US Congress passed legislation that prohibited the launch of satellites manufactured with US components on PRC rockets. Additional legislative action was taken in 2011 when Congress voted to restrict bilateral contacts between NASA and China, ending most forms of contact between them.[1]

Multiple factors account for China's success. Its extensive and expanding relationship with Russia has played an instrumental role in advancing know-how and providing technologies. However, these efforts have been necessary but insufficient in accounting for China's progress in space and missile technologies. Just as important to China's success has been a techno-nationalist approach to science and technology that has resulted in long-term planning, ample funding, a commitment to reforming its program management system, and the recruitment of a younger and better-educated workforce. As a result, China's space and missile programs are an example of the limitations of "decoupling" in preventing China's rise as a technological power.

# China's space and missile capabilities

The People's Liberation Army (PLA) has a large inventory of ground-, air-, surface-, and subsurface launched ballistic and cruise missiles (See Table 1). The majority are short-range ballistic missiles (SRBMs) that are most likely for use in a Taiwan contingency but also include an inventory of

[1] "Why NASA and China Don't Collaborate in Space," *Wall Street Journal*, https://www.wsj.com/video/series/wsj-explains/why-nasa-and-china-dont-collaborate-in-space/8C34E693-469B-484E-B4C5-12AEEB6D2B2F.

medium-range ballistic missiles (MRBMs), such as the DF-21 with a range of 1,500–2,000 km, and the DF-26, with a range of 3,000+ km that gives the PLA the ability to strike targets as far as Guam.

The PLA's inventory of ground attack and antiship cruise missiles (ASCMs) includes the DF-10 and DF-100 ground attack cruise missiles with ranges of 1,500 and 2,000 km, respectively. The PLA's ASCM inventory includes the YJ-83, which has a range of 185 km, and the YJ-62, with a range of 277 km, as well as the supersonic, surface-launched Russian SS-N-22/SUNBURN, with a range of over 200 km.[2] The PLA has also deployed the YJ-18 ASCM that was described in 2016 by the Defense Department as a "significant step forward in China's surface anti-surface warfare capability."[3] These missiles can be launched from surface ships and submarines, have a range of 537 nm, and can reach speeds of Mach 3.[4] Additional submarine-launched ASCMs are the Russian SS-N-27, with a range of 222 nm, and the YJ-82, with a range of 37 km. In addition to surface and subsurface launched ASCMs, China has air-launched ASCMs. These include an air-launched version of the YJ-83, as well as the YJ-12, which can deliver a 500 kg warhead at speeds up to Mach 3 and a range of 300 km.[5]

China has also deployed hypersonic weapons that can travel at least five times the speed of sound. The PRC fielded the DF-17 hypersonic glide vehicle in 2020, which the Defense Department assesses as having the potential to transform the PLA's missile force.[6] Although "primarily a conventional platform," the DF-17 "may be equipped with nuclear warheads."[7] In July 2021, the PLA tested a hypersonic glide vehicle and an orbital bombardment system that the Defense Department assesses is probably intended to become an advanced nuclear delivery system.[8]

The PLA's missile inventory presents several challenges to the US military (see Table 2). The most common US antiship missile (ASM), the Harpoon ASCM with a range of 130 km, is out-ranged by most PLA ASMs, allowing PLA Navy ships to fire their ASMs in relative safety from distances well beyond the range of US surface-fired ASMs.[9] Although the air-launched version of the Harpoon can alleviate the range deficit, it places a reliance on US aircraft carriers that are likely a main target for PLA war planners. The range deficit will be ameliorated by the introduction of an antiship version of the land-attack Tomahawk cruise missile and the introduction of larger numbers of the long-range antiship missiles (LRASMs). The Maritime Strike Tomahawk has a range of over 1,600 km, and the LRASM has a range of 560 km, but these ranges are still shorter than the PLA's DF-21D and DF-26 ballistic missiles and the CJ-10 cruise missile. Moreover, the

[2] US-China Economic and Security Review Commission, *2015 Report to Congress*, Nov. 2015, 362-363.
[3] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2016*, 27.
[4] Michael Pilger, *China's New YJ-18 Antiship Cruise Missile: Capabilities and Implications for US Forces in the Western Pacific*, US-China Economic and Security Review Commission, Oct. 28, 2015, 2; US-China Economic and Security Review Commission, *2015 Report to Congress*, Nov. 2015, 356.
[5] "China's Anti-ship Missiles YJ-12 and YJ-100 Revealed," *Missile Threat*, Feb. 4, 2015, http://missilethreat.com/chinas-anti-ship-missiles-yj-12-yj-100-revealed/.
[6] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2022*, 83.
[7] *Military and Security Developments Involving the People's Republic of China 2022*, 65.
[8] *Military and Security Developments Involving the People's Republic of China 2022*, 98.
[9] Vitaliy O. Pradun, "From Bottle Rockets to Lightning Bolts," *Naval War College Review*, Oct. 18, 2010, 25.

LRASM is air launched, which again places a focus on naval aviation and aircraft carriers (see Figure 1).[10]

Similarly, the longer ranges of PLA air-launched ASCMs gives the PLA Air Force and PLA Navy aviation units the ability to launch their missiles from well beyond the defensive ranges of US air defense systems. The US anti-air missiles SM-2 and Sea Sparrow with their ranges of less than 170 km, for example, are out-ranged by PLA ASCMs, which can have ranges of several hundred kilometers.

With a reliance on ballistic and cruise missiles, the PLA has come to realize what the US military has realized for some time: long-range power projection requires space-based command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities. Space-based C4ISR can provide remote sensing to identify targets and conduct battle damage assessments, navigation to guide precision munitions, and communication to connect and integrate the actions of multiple services into joint operations.

With more than 500 operational satellites now in orbit, the PRC has the second-largest fleet of satellites in orbit behind the United States. Over 200 are remote-sensing satellites, including electro-optical, synthetic aperture radar, and signals intelligence satellites. The PRC also has over 60 communication satellites and is planning to build a megaconstellation consisting of nearly 13,000 communication satellites.[11] In 2020, the PRC established Beidou, a global satellite navigation system. When taken together, the elements of this space-based C4ISR architecture, when combined with airborne, maritime, and ground-based C4ISR systems, will form the basis of a system to locate, track, and target US military assets.

China is also developing a wide range of counterspace technologies that are intended to threaten adversary space systems from ground to geosynchronous orbit.[12] These include direct-ascent kinetic-kill vehicles, co-orbital satellites, directed-energy weapons, jammers, and cyber capabilities.[13] In 2007, China destroyed one of its weather satellites with a direct-ascent KKV. According to the Director of National Intelligence, "the PLA has an operational ground-based antisatellite (ASAT) missile intended to target low-Earth-orbit satellites, and China probably intends to pursue additional ASAT weapons capable of destroying satellites up to geosynchronous orbit."[14] The PLA is also expected to deploy a ground-based laser system for use against satellites in low-Earth-orbit by 2020.[15]

[10] Dmitry Filipoff, "Fighting DMO, Pt. 2: Anti-Ship Firepower and the Major Limits of the American Naval Arsenal," CIMSEC, Feb. 27, 2023, https://cimsec.org/fighting-dmo-pt-2-anti-ship-firepower-and-the-major-limits-of-the-american-naval-arsenal/#:~:text=The%20amount%20of%20LRASM%20inventory,for%20the%20Navy%20so%20far.&text=The%20Air%20Force%27s%20inventory%20is,numbers%20slightly%20less%20than%20100.

[11] Andrew Jones, "China to Begin Constructing Its Own Megaconstellation Later This Year," *Space News*, Mar. 28, 2023, https://spacenews.com/china-to-begin-constructing-its-own-megaconstellation-later-this-year/.

[12] Dan R. Coats, *2019 Worldwide Threat Assessment of the U.S. Intelligence Community*, 2019, p. 17.

[13] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2016*, 37.

[14] Coats, *2019 Worldwide Threat Assessment of the U.S. Intelligence Community*, 17.

[15] Patrick M. Shanahan, "Remarks by Acting Secretary Shanahan at the 35th Space Symposium, Colorado Springs, Colorado," Apr. 9, 2019, https://dod.defense.gov/News/Transcripts/Transcript-View/Article/1809882/remarks-by-acting-secretary-shanahan-at-the-35th-space-symposium-colorado-sprin/.

Table 1. PRC missile inventory

| Missile | Type | Deployment Mode | Range (kilometers) | Number of Launchers |
|---|---|---|---|---|
| DF-15 (CSS-6) | SRBM | Road-Mobile | 600-850+ | More than 200 launchers<br>More than 600 missiles |
| DF-11 (CSS-7) | SRBM | Road-Mobile | 300-60 | |
| DF-16 (CSS-11) | SRBM | Road-Mobile | 700+ | |
| DF-21 (CSS-5) | MRBM | Road-Mobile | 1,500-1750+ | Approximately 350 launchers |
| DF-17 (CSS-22) | MRBM | Road-Mobile | 1,000-3,000 | |
| DF-26 (CSS-18) | IRBM | Road-Mobile | 3,000+ | |
| DF-4 (CSS-3) | ICBM | Transportable | 5,500+ | 10 to 15 |
| DF-5A (CSS-4 Mod 2) | ICBM | Silo | 12,000+ | About 20 |
| DF-5B (CSS-4 Mod 3) | ICBM | Silo | 12,000+ | |
| DF-31 (CSS-10) | ICBM | Road-Mobile | 7,000-11,000 | Approximately 20-25+ |
| DF-41 (CSS-20) | ICBM | Road-Mobile | UNK | 16+ |
| JL-2 (CSS-N-14) | SLBM | Submarine and ship Launched | 7,000+ | 48 |
| JL-3 (CSS-NX-20) | SLBM | Submarine and ship Launched | 10,000 | UNK |
| DH-10 (CJ-10) | LACM | Ground | 1,500 | More than 100 launchers<br>More than 300 missiles |
| DF-100 (CJ-100) | LACM | Air | 2,000 | UNK |
| YJ-83 | ASCM | | 180 | UNK |

| | | | | |
|---|---|---|---|---|
| YJ-62 | ASCM | | 400 | UNK |
| YJ-12 | ASCM | | 400 | UNK |
| SS-N-22 | ASCM | | 200+ | UNK |
| SS-N-27b | ASCM | | 220-300 | UNK |

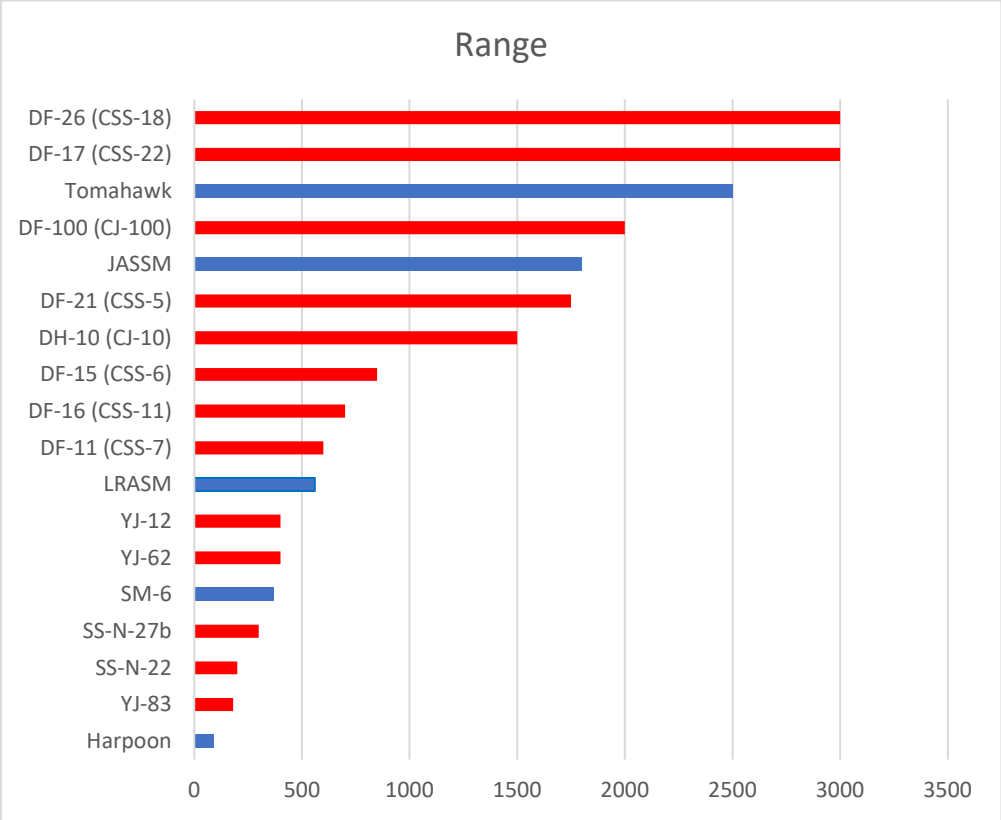
Source: Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2020* and Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2022*, Defense Intelligence Ballistic Missile Analysis Committee, *Ballistic and Cruise Missile Threat*, 2020, https://media.defense.gov/2021/Jan/11/2002563190/-1/-1/1/2020%20BALLISTIC%20AND%20CRUISE%20MISSILE%%2020THREAT_FINAL_2OCT_REDUCEDFILE.PDF; "YJ-12," Missile Defense Advocacy Alliance, Dec. 2022, https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/china/yj-12/; US-China Economic and Security Review Commission, *2015 Report to Congress*, Nov. 2015, 362-363.

**Table 2. US missile force**

| **Missile** | **Type** | **Deployment Mode** | **Range (kilometers)** | **Number** |
|---|---|---|---|---|
| Minuteman III | ICBM | Silo | 13,000 | 400 |
| Trident DF | SLBM | Submarine-launched | 12,000 | UNK |
| Tomahawk | Land attack cruise missile | Sea, submarine-launched | 1,250-2,500 | UNK |
| AGM-158 JASSM | Land attack cruise missile | Air | 370 | ~5,000 |
| AGM-158B JASSM-ER | Land attack cruise missile | Air | 1,000 | UNK |
| LRASM | ASCM | Air | 560 | UNK |
| AGM-84 Harpoon | ASCM | Ship/Air | 92.6-280 km | UNK |
| SM-6 | ASM/Antiair | Ship | 370.4 | UNK |

Source: "Missiles of the United States, Center for Strategic and International Studies, Mar. 3, 2021, https://missilethreat.csis.org/country/united-states/; "LGM-30G" Minuteman III," US Air Force, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104466/lgm-30g-minuteman-iii/; "JASSM/JASSM-ER," July 30, 2021, https://missilethreat.csis.org/missile/jassm/; "Department of Defense Fiscal Year (FY) 2023 Budget Estimates," April 2022, https://www.secnav.navy.mil/fmc/fmb/Documents/23pres/WPN_Book.pdf.

**Figure 1. Comparison of US and PRC missile ranges**




Source: Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2020* and Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2022*, Defense Intelligence Ballistic Missile Analysis Committee, *Ballistic and Cruise Missile Threat*, 2020, "YJ-12," Missile Defense Advocacy Alliance, Dec. 2022, https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/china/yj-12/; US-China Economic and Security Review Commission, *2015 Report to Congress*, 362-363; "Missiles of the United States, Center for Strategic and International Studies; "LGM-30G" Minuteman III;" "JASSM/JASSM-ER," July 30, 2021, "Department of Defense Fiscal Year (FY) 2023 Budget Estimates."

## The PRC space and missile industry

China's space industry is led by two large state-owned enterprises: the China Aerospace Science and Technology Corporation, focused on space and launch vehicle technologies, and the China Aerospace Science and Industry Corporation, focused on missiles. China's strictly top-down approach to space technology innovation is now beginning to change with the rise of a commercial space industry. China has between 120–150 commercial space companies offering a range of products and services, including satellite and rocket manufacturing and launch services. China's

commercial space market is still developing, however, with most companies established since 2014.[16]

The PRC government appears to have encouraged the development of the commercial space industry for several reasons. First, the government intends for private capital to supplement government space efforts.[17] Proponents of commercial space also argue that the efficiencies brought about by market forces better position the private sector to innovate. It does not appear, however, that the PRC government is prepared to allow a commercial space industry to supplant the state-owned sector. PRC regulations characterize the commercial sector as a supplement to, not a replacement for, China's state-owned sector. Nevertheless, commercial space entities could become important players in China's space technology supply chain, even if they are not replacing the state-owned sector's role as the prime contractor.[18]

## The dual-use nature of space technologies

A distinctive feature of space technologies is their dual-use nature. Satellite imagery can be used in both urban planning and to collect intelligence on an adversary. Satellite navigation can be used to navigate city streets as well as to guide missiles. The dual-use aspect of space technologies can make determining a country's true intention for acquiring space technologies difficult and complicates the enforcement of export controls. Technologies exported on the pretext of non-military use can be diverted for defense applications or to organizations conducting defense R&D and manufacturing.[19] Here, I discuss three areas of dual-use space technologies in more depth.

### Space situational awareness

Like air traffic control systems, space situational awareness (SSA) systems provide knowledge of activities in the space domain that can be used to better control spacecraft and ensure their safe operation. SSA, also called space domain awareness (SDA), can also provide militaries with the intelligence to conduct offensive counterspace operations. China has, or is developing, a range of SDA technologies, including domestic, space-based, seaborne, and foreign-based space monitoring stations consisting of optical systems, laser range finders, radio telescopes, and a potential space radar.[20]

[16] "Developments in China's Commercial Space Sector," National Bureau of Asian Research, Aug. 24, 2021, https://www.nbr.org/publication/developments-in-chinas-commercial-space-sector/.
[17] Luo Heng, Zhao Feng, and Liang Tang, "Research on the Development Status of US Commercial Space" (美国商业航天发展态势研究), Aerospace China (中国航天), no. 4 (2017): p. 8.
[18] "Developments in China's Commercial Space Sector."
[19] Cate Cadell and Ellen Nakashima, "American Technology Boosts China's Hypersonic Missile Program," *Washington Post,* Oct. 17, 2022, https://www.washingtonpost.com/national-security/2022/10/17/china-hypersonic-missiles-american-technology/.
[20] Kristin Burke, "China's Space Situational Awareness Capabilities for Beyond GEO," China Aerospace Studies Institute, Sept. 2022, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/CASI%20Articles/2022-09-12%20China%27s%20Space%20Situational%20Awareness%20Capacity%20For%20Beyond%20GEO.pdf.

## Rendezvous and proximity operations

Rendezvous and proximity operations (RPO) refer to "a spacecraft intentionally maneuvering to dock or operate in close proximity to a target space object" and have several peaceful uses.[21] These include the potential to service, repair, and monitor the health of spacecraft. These same technologies can also be used to collect intelligence against spacecraft and to maneuver toward and attack satellites. China has conducted a number of RPO since 2010. According to the Secure World Foundation, the PRC has "not conducted an actual destructive intercept of a target, and there is no proof that [RPO] technologies are definitively being developed for counterspace use as opposed to intelligence gathering or other purposes.[22] However, the dual-use nature of these technologies, coupled with PRC writings on the strategic value of attacking US space assets, strongly indicates that these technologies are militarily relevant.

## Space debris removal and planetary defense

Space debris removal and planetary defense have important dual-use applications, including counterspace and SDA functions. According to China's 2021 space white paper, China will improve its space debris monitoring system, cataloguing database, and early warning services and will "study plans for building a near-Earth object defense system, and increase the capacity of near-Earth object monitoring, cataloguing, early warning, and response."[23]

China is developing space debris removal and planetary defense capabilities that could improve its military capabilities. In a demonstration of potential offensive RPO capabilities, in January 2022, the PRC SJ-21 satellite towed a defunct Beidou-2 satellite into a graveyard orbit to move it out of the way of operational satellites.[24] PRC researchers are also exploring the use of lasers to remove space debris.[25] In terms of SDA, China is building a network of radars that can detect asteroids that could threaten the Earth. The second stage of this radar network is scheduled to be completed in 2025 with a detection range out to 10 million kilometers, which would extend its SDA capabilities well beyond the Moon.[26]

# The PRC approach to space and missile innovation[27]

China's success in space and missile technologies can be attributed to a techno-nationalist approach that treats science and technology as a competition between states and a determiner of

[21] Kaitlyn Johnson, "Key Governance Issues in Space," Center for Strategic and International Studies, Sept. 2020, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/200901_Johnson_GovernanceInSpace_WEB.pdf.
[22] Brian Weeden and Victoria Samson, "Global Counterspace Capabilities," Apr. 2021, https://swfound.org/media/207162/swf_global_counterspace_capabilities_2021.pdf, 1-2.
[23] PRC State Council Information Office, *China's Space Program: A 2021 Perspective*, Jan. 28, 2022, https://english.www.gov.cn/archive/whitepaper/202201/28/content_WS61f35b3dc6d09c94e48a467a.html
[24] Andrew Jones, "China's Shijian-21 Towed Dead Satellite to a High Graveyard Orbit," *Space News*, Jan. 27, 2022, https://spacenews.com/chinas-shijian-21-spacecraft-docked-with-and-towed-a-dead-satellite/.
[25] Matt Williams, "China Has a Plan to Clean Up Space Junk with Lasers," Phys.org, Jan. 17, 2018, https://phys.org/news/2018-01-china-space-junk-lasers.html.
[26] Andrew Jones, "Chinese Asteroid-Detection System Enters New Phase of Construction," Feb. 19, 2023, https://www.space.com/china-asteroid-detection-system-construction-progress.
[27] This section is taken, in part, from Kevin Pollpeter, "Innovation in China's Space Industry: Overcoming Decoupling," *Asian Security*, (forthcoming).

the fates of nations. Reflecting this, China takes outer space as a domain of strategic competition.[28] PRC leader Xi Jinping, for example, has stated that space technologies have become an important representation of a country's technological level and capability,[29] and has called space technology a "sharp weapon" (国之利器) in international competition.[30] A variety of factors, however, are responsible for China's success in space and missile technologies.

## Long-term planning

China manages its space program goals through a series of short-, medium-, and long-term plans that mandate goals—and funding—well beyond the traditional one-year increments of the US budgeting system. Medium-term planning is administered through a series of five-year plans (FYPs). China is currently in the 14th FYP, which covers the period from 2021 to 2025.

Long-term planning governs China's space goals over a 10- to 15-year period. The Medium- and Long-Term Plan for Science and Technology Development that governed overall science and technology work from 2006–2020, for example, established 16 "megaprojects" that set long-term project-based technology objectives across a number of sectors, of which four involved space.[31] The 13th FYP plan extended the megaproject approach, setting objectives to the year 2030.[32] Space also figures prominently in other national industrial strategies. It is one of the 10 "major sectors" for development under the Made in China 2025 plan,[33] one of seven strategic emerging industries,[34] and one of nine sectors listed for priority under the 14th FYP.[35]

## Systems engineering

An often-overlooked factor for the success of China's space and missile programs has been a commitment to establishing a modern program management system. Space programs can be large, complex endeavors that require vast numbers of personnel and organizations working on different systems and whose work must be coordinated, scheduled, and provided with technical data. Beginning in the 1990s, the PRC space program reinvigorated its chief commander and chief designer program management system that entrusted the authority of overall program management to one person. Priority was given to hiring a younger workforce familiar with modern R&D and manufacturing techniques and moving more senior engineers into advisory

[28] The State Council Information Office of the People's Republic of China, *China's National Defense in the New Era*, 2019.
[29] "Make Science and Technology Innovation the Primary Driver of China's Space Development (把科技创新作为中国航天发展第一动力), ScienceNet.cn (科学网), http://news.sciencenet.cn/htmlnews/2020/11/449208.shtm.
[30] "Use a New Era of Space Spirit to Develop a Strong Space Power" (以新时代的航天精神建设航天强国) *Seeking Truth* (求实), May 21, 2018, http://www.qstheory.cn/dukan/hqwg/2018-05/21/c_1122853891.htm.
[31] Sun Laiyan, "China Space Development Strategy and Key Areas" (中国航天的发展战略和重点领域), *Aerospace China* (中国航天), Jan. 2007, 7.
[32] Central Committee of the Communist Party of China, *The 13th Five-Year Plan for Economic and Social Development of the People's Republic of China (2016-2020)*, 2016, http://en.ndrc.gov.cn/newsrelease/201612/P020161207645765233498.pdf.
[33] "State Council Issues 10 Major Areas of "Made in China 2025" (国务院部署 "中国制造2025"10大领域), PRC Central People's Government, Mar. 26, 2015, http://www.gov.cn/zhengce/2015-03/26/content_2838613.htm.
[34] "China Underscores Development of Strategic Emerging Industries,' *China Daily*, Nov. 4, 2020, https://www.chinadaily.com.cn/a/202011/04/WS5fa214d2a31024ad0ba82fe6.html.
[35] "PRC Civilian Economic and Societal Development 14th Five-year Plan and 2035 Long-term Goals (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要), PRC Central People's Government, Mar. 13, 2021, http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm.

roles. A system of quality assurance and testing was established, and a system of standards was enacted to ensure uniformity of the manufacturing process.[36]

## Foreign assistance

The success of China's space and missile technologies raises concerns of the role of foreign technology and know-how in advancing China's space and missile programs. Since its inception in 1956, China's space program has relied heavily on foreign technology and know-how, especially Soviet and later Russian assistance. China continues to leverage foreign technology and know-how to advance its space program through a combination of cooperative activities, technology theft, and foreign inspiration.

***Cooperative activities.*** The space industry's desire for foreign technology is reflected in its international cooperative activities, especially those conducted with Russia and Ukraine. Although the exact nature of China's space relationship with these countries is difficult to determine, their scope and duration indicates the potential for significant transfer of technology and know-how.

*Russia.* China's longest and most substantive space cooperation partner is Russia. After a rupture in relations in 1960, China-Russian space cooperation was restarted in the 1990s. In 1997, the two countries signed an agreement to establish a regular dialogue between their premiers. According to the China National Space Administration, the two countries cooperated on over 100 projects between 2001–2016.[37] Most recently, cooperation was continued with an agreement covering the years 2018–2022. This agreement was described as a significant step forward, covering launch vehicles, rocket engines, space planes, lunar and deep space exploration, Earth remote sensing, space electronic components, satellite navigation, and satellite communications.[38]

*Ukraine.* Ukraine appears to have been a substantial source of foreign technology and know-how for the PRC space program before the Russian invasion of Ukraine in 2022. Ukraine inherited a substantial amount of the former Soviet Union's space industry on which Ukraine based its cooperation with China, especially related to ballistic missiles and launch vehicles. Beginning in 1995, China has cooperated with Ukraine under the Space Cooperation Subcommittee Mechanism of the Sino-Ukrainian Cooperation Commission. China-Ukraine space cooperation is organized around five-year agreements dating at least to 2006.[39] Cooperation involved a variety of topics,

[36] See Kevin Pollpeter, "Organization as Innovation: Instilling a Quality Management System in China's Human Spaceflight Program," in Tai Ming Cheung, ed., Forging China's Military Might: A New Framework for Assessing Innovation, (Bethesda: John Hopkins University Press, 2014), 212–240.

[37] "China-Russia Space Cooperation Has Entered a New Stage of Major Strategic Cooperation" (中俄航天合作已转入重大战略合作新阶段)," *Sputnik News*, Sept. 6, 2016, https://sputniknews.cn/russia_china_relations/201609061020681762/.

[38] Wu Yan, "China-Russia Space Cooperation is Broad (中俄航天领域合作空间广阔)," *People's Daily*, Apr. 17, 2018, http://world.people.com.cn/n1/2018/0417/c1002-29930025.html and "Notice on Soliciting Project Proposals for the 'China-Russia Space Cooperation Program 2018-2022' (关于征集《2018-2022年中俄航天合作大纲》项目建议的通知)," Northwestern Polytechnical University School of Astronautics (西北工业大学航天学院), Mar. 24, 2017, https://hangtian.nwpu.edu.cn/info/1371/10283.htm.

[39] "Ukrainian-Chinese Working Group on Space Cooperation Held Meeting in Yuzhnoye Sdo," Nov. 29, 2019, https://www.yuzhnoye.com/en/press-center/news/copy_news_669.html and "Ukraine, China to Expand Space Cooperation Program Until 2015 With New Large-scale Projects," *Kyiv Post*, Sept. 12, 2013, http://www.kyivpost.com/content/business/ukraine-china-to-expand-space-cooperation-program-until-2015-with-newlarge-scale-projects-329268.html.

including rocket engines, new materials, and additive technologies.[40] Although unknown, it is likely that space cooperation between the two countries was halted with the Russian invasion of Ukraine. It is also possible that China's tacit support given to Russia for its invasion of Ukraine will curtail or stop further cooperative efforts.

***Technology theft.*** A second avenue of approach for China is illegal technology transfer. As the leading space power, the United States is likely a major target for PRC collection efforts. An examination of the US Department of Commerce's Bureau of Industrial Security website reveals a number of space-related export control violation cases involving China. A common item in space-related export control violation cases is radiation-hardened computer chips. This likely reflects not only China's overall challenge with developing high-end computer chips but also its challenges with developing computer chips suitable for use in the space environment. The higher radiation levels of outer space can degrade electronic components and affect the life of spacecraft, and the lack of more effective radiation-hardened chips may be one factor in Chinese spacecraft having had shorter service lives than US spacecraft.[41]

***Foreign inspiration.*** A third category of technology and know-how transfer is "inspiration"—basing designs on the knowledge that something has been done or been done in a certain way. Inspiration allows countries to know the realm of the possible. These similarities have raised accusations that China is leveraging the capabilities of the US commercial sector as a "fast follower" in space innovation.[42] Similar to SpaceX, China's space industry is developing a number of partially reusable space launch vehicles. The Long March 6 and Long March 8 launch vehicles developed by China's state-owned space sector, as well as the Hyperbola 2 and Zhuque 2 launch vehicles being developed by the commercial space launch companies iSpace and Landspace, respectively, are planned to be partially reusable.[43] In November 2022, the China Academy of Launch Technology announced that the Long March 9 super heavy lift rocket would be redesigned to accommodate a reusable first stage.[44] A partially reusable first stage would offer a significant advantage over its US counterpart, the Space Launch System.

[40] "China's CPMIEC to Expand Space Cooperation with Ukraine," Russia & CIS Military Weekly, Aug. 7, 2009, and "Yuriy Boyko, Vice Prime Minister of Ukraine for Ecology, Natural Resources, Energy and Space," Space News, Nov. 25, 2013, http://www.spacenews.com/article/features/38347profile-yuriy-boyko-vice-prime-minister-of-ukraine-for-ecologynatural; and "Ukraine, China to Prepare Space Cooperation in April," China Defense Mashup, Mar. 22, 2012, http://www.chinadefense-mashup.com/ukraine-china-to-prepare-space-cooperation-in-april.html; "Ukraine, China Approve Updated Bilateral Program of Space Cooperation Until 2020," *Interfax-Ukraine*, Nov. 27, 2017; and "Ukrainian-Chinese Working Group on Space Cooperation Held Meeting in Yuzhnoye Sdo," Nov. 29, 2019, https://www.yuzhnoye.com/en/press-center/news/copy_news_669.html.

[41] "Summary Of Major US Export Enforcement, Economic Espionage, and Sanctions-Related Criminal Cases (January 2016 to The Present: Updated November 2019)," US Department of Justice, November 2019 and "Summary of Major US Export Enforcement, Economic Espionage, and Sanctions-Related Criminal Cases (January 2015 to January 19, 2018)," US Department of Justice, Jan. 2018.

[42] "Developments in China's Commercial Space Sector," *National Bureau of Asian Research*, Aug. 24, 2021, https://www.nbr.org/publication/developments-in-chinas-commercial-space-sector/.

[43] Andrew Jones, "China Sets Targets for Smart, Recoverable and Reusable Launch Vehicles," *Space News*, November 26, 2020, https://spacenews.com/china-sets-targets-for-smart-recoverable-and-reusable-launch-vehicles/ and Andrew Jones, "China Rolls Out Long March 8 Rocket for Weekend Test Flight," Space News, December 18, 2020, https://spacenews.com/china-rolls-out-long-march-8-rocket-for-weekend-test-flight/.

[44] Andrew Jones, "China Scraps Expendable Long March 9 Rocket Plan in Favor if Reusable Version," *Space News*, Nov. 9, 2022, https://spacenews.com/china-scraps-expendable-long-march-9-rocket-plan-in-favor-of-reusable-version/.

# Conclusions

China's space and missile programs are a case study in how China has been able to overcome US isolation to become a world-leading technological power. Indeed, the near-total ban on space cooperation between the two countries since the late 1990s demonstrates the ability of the PRC to innovate in this critical area. The recognition of space as an important strategic military capability and an element of national prestige has committed China's leadership to devote attention and funding to the development of its space and missile programs.

Despite this isolation, China's space and missile programs are not only closing the gap with the United States but are also increasingly innovative. The US Director of National Intelligence assesses that "China is developing innovative systems in all space technology areas," and "that by 2030 will achieve world-class status in all but a few."[45] The PRC has deployed the world's first antiship ballistic missile (ASBM), the DF-21D MRBM, with a range of 1,500–2,000 km, giving the PLA the ability to attack ships east of Taiwan, as well as the DF-26 ASBM.[46] China's emphasis on developing hypersonic glide vehicles has resulted in China surpassing the United States. According to Mark Lewis, the Pentagon's former director of defense research and engineering for modernization, "By almost any metric that I can construct, China is certainly moving out ahead of us [in hypersonics]."[47] The development of an orbital bombardment system will provide the PLA with true global strike capabilities.

China's progress in space and missile technologies has several implications for the United States in terms of export control enforcement and military security.

## Implications for export control enforcement

***US export controls have had limited effect on PRC access to space technologies***

Although determining the exact role and importance of the innovative factors propelling the advancement of China's space and missile programs is difficult because of secrecy issues and the inability to physically examine launch vehicles, missiles, and satellites, it is evident that China's success cannot be attributed to just one factor. Foreign assistance in its many forms has been critical to its success; however, China's space and missile programs would not have been successful if they had not also been well-funded, committed to improving their program management, and attracting a well-educated and competent workforce.

As a result, efforts to isolate China technologically or to "decouple" the United States and China may have been effective over the short- to medium-term but have been less effective over the long-term. Although each industrial sector has its own characteristics that influence the effectiveness of export controls, China's ability to access foreign space technology through both

[45] "Chinese Space Activities Will Increasingly Challenge US Interests Through 2030," Office of the Director of National Intelligence, April 2021, https://www.dni.gov/files/ODNI/documents/assessments/NICM-Declassified-Chinese-Space-Activities-through-2030--2022.pdf.
[46] Jordan Wilson, *China's Expanding Ability to Conduct Conventional Missile Strikes on Guam*, US-China Security and Economic Review Commission, May 10, 2016, 4 https://www.uscc.gov/sites/default/files/Research/Staff%20Report_China%27s%20Expanding%20Ability%20to%20Conduct%20Conventional%20Missile%20Strikes%20on%20Guam.pdf and "SinoDefence Air and Space," Sept. 4, 2015, https://sinodefence.com/2015/09/04/pla-missiles-in-3-sept-parade/.
[47] US Defense Department, *Military and Security Developments Involving the People's Republic of China 2020*, p. 56 and Robert Burns, "More security? US vs. China in 'Super-Duper' Missiles Race," *Christian Science Monitor*, May 20, 2020, https://www.csmonitor.com/USA/Military/2020/0520/More-security-US-vs.-China-in-super-duper-missiles-race.

legitimate and illegal means indicates that US attempts to restrict space- and missile-related technology transfers have been limited by the willingness of other states to share technology with China and the porousness of US export control enforcement. US efforts to constrain China's space program have likely only limited the speed of PRC progress rather than halted it.

***PRC role as a leading space power may make it less reliant on foreign technology***

The next 10 years may prove to be telling for the future of the PRC space and missile programs. As they close the technological gap with the United States and approach the technological edge of space and missile technologies, the PRC space and missile programs must increasingly rely on their internal abilities to advance. As a result, access to foreign technology may become less important for the PRC.

***US may need to place more emphasis on monitoring PRC exports of space and missile technologies***

As its space and missile technologies become more advanced, the PRC may become more likely to export sensitive technologies and services to countries of concern. In a reversal of decades-long practice, the PRC is supplying electronic components to the Russian space industry.[48] On January 23, 2023, the US Department of the Treasury sanctioned Spacety, a PRC-based manufacturer of small satellites, for providing satellite imagery to Russia's Wagner Group.[49]

***Expansion of PRC commercial space industry complicates export control enforcement***

On the other hand, the expansion of the PRC commercial space industry increases the number of actors who may try to acquire export-controlled items. The increased number of actors either acquiring foreign technology directly or through their subsidiaries may make monitoring and enforcement of export control laws increasingly difficult.

## Implications for US military security

***PRC emphasis on missiles is ushering in an emerging competition in missiles and space technologies***

China's development of long-range cruise and ballistic missiles and hypersonic weapons has the potential to usher in a new stage of warfare in which missile power replaces air power as the determining factor in warfare. In doing so, missile power places an even greater emphasis on long-range reconnaissance and the role of space technologies. As a result, future maritime warfare will be decided by two main factors: weapon range and C4ISR capabilities.[50] This dynamic is seen in

[48] State Council Information Office, *China's Space Activities in 2016*, Dec. 27, 2006, http://www.scio.gov.cn /zfbps/32832/Document/1537024/1537024.htm; State Council Information Office, "Joint Communique From the 21st Regular Meeting Between the Prime Ministers of China and Russia" (中俄总理第二十一次定期会晤联合公报), *People's Daily*, Nov. 9, 2016, http://politics.people.com.cn/n1/2016/1109/c1001-28845796.html.
[49] Andrew Jones, "U.S. Sanctions Chinese Satellite Firm for Allegedly Supplying SAR Imagery to Russia's Wagner Group," *Space News*, Jan. 27, 2023, https://spacenews.com/u-s-sanctions-chinese-satellite-firm-for-allegedly-supplying-sar-imagery-to-russias-wagner-group/.
[50] Wayne P. Hughes, *Fleet Tactics and Coastal Combat*, (Annapolis: Naval Institute Press, 2000), 721.

an emerging competition in missiles and space technologies, called here the "US-China reconnaissance-strike competition."[51]

***PRC expansion of nuclear arsenal complicates US nuclear deterrence***

The PRC has a relatively small intercontinental ballistic missile (ICBM) force consisting of tens of silo-based and road-mobile missiles. This force will likely grow as the PRC's nuclear arsenal increases to a projected 1,500 warheads by 2035.[52] The PRC's nuclear arsenal presents more challenges than sheer numbers, however. According to the Defense Department, the PRC seeks to modernize, expand, and diversify its nuclear force with warheads that range from "lower-yield precision strike missiles to ICBMs with multi-megaton yields."[53]

The establishment of a more diverse nuclear force armed with precision low-yield warheads could provide the PRC more escalatory options not matched by the US nuclear arsenal with its reliance on larger warheads. This asymmetry in nuclear force employment could complicate the ability of the US to respond proportionally to PRC nuclear provocations.

***Potential PRC development of nuclear "quad" complicates US nuclear deterrence***

The potential development of an orbital bombardment system by the PRC may signal the intent to develop its nuclear triad into a nuclear "quad" based on land-launched nuclear missiles, submarine-launched nuclear missiles, aircraft with nuclear bombs and missiles, and space-launched hypersonic glide vehicles. The addition of a space-launched leg to the PRC nuclear deterrent appears to give the PRC a potential global first-strike capability capable of evading US missile defenses that could add a destabilizing element into US-PRC crisis management. The development of a space-based nuclear bombardment system would also violate the Outer Space Treaty's prohibition against stationing nuclear in space, which the PRC has signed.

***US needs to consider the development and stockpiling of longer-range missiles and delivery systems.***

The PRC focus on conventional missiles demonstrates an emphasis on precision and mass that provides the PLA with a multilayered area denial capability out to the second island chain.[54] China's development of ballistic missiles, cruise missiles, and hypersonic weapons presents a number of challenges to the US military. These include the longer ranges of PLA missiles and an inability to defend against supersonic and hypersonic missiles. Moreover, the Russian war on Ukraine and a recent wargame by the Center for Strategic and International Studies indicate that a conflict with the PRC could be resource intensive, with thousands of precision-guided munitions being used in the first weeks of the war causing significant losses of ships and aircraft.[55] If

[51] For more on the US-PRC reconnaissance-strike competition, see Kevin Pollpeter, "The US-China Reconnaissance-Strike Competition: Missiles, Space, and Counterspace," in Tai Ming Cheung and Thomas Mahnken, eds., *The Gathering Pacific Storm, Emerging US-China Strategic Competition in Defense Technological and Industrial Development*, (Amherst: Cambria Press, 2018).
[52] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2022*, 98.
[53] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2022*, 96.
[54] US-China Economic and Security Review Commission, *2015 Report to Congress*, Nov. 2015, 355-356.
[55] Mark F. Cancian, Matthew Cancian, Eric Heginbotham, *The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan*, Center for Strategic and International Studies, Jan. 2023, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?VersionId=WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ.

accurate, this would appear to make the stockpiling of long-range missiles and weapons platforms and an acceleration of the expansion of defense production priorities.

Approved April 2023: Maryanne Kivlehan-Wise, Research Program Director
China Studies Program/ China and Indo-Pacific Security Affairs Division



CNA is a nonprofit research and analysis organization dedicated to the safety and security of the nation. It operates the Center for Naval Analyses—the only federally funded research and development center serving the Department of the Navy—as well as the Institute for Public Research. CNA is dedicated to developing actionable solutions to complex problems of national importance.

 3003 Washington Boulevard, Arlington, VA 22201 | 703-824-2000 | www.cna.org

## OPENING STATEMENT OF CHAD OHLANDT, SENIOR ENGINEER, RAND CORPORATION

DR. OHLANDT: Thank you, Chairman Bartholomew and Vice Chair Wong and the rest of the commissioners for inviting me to speak today. I am Chad Ohlandt, a senior engineer at the RAND Corporation.

My testimony addresses Chinese aviation technology, and I spend most of the written testimony trying to establish and differentiate between three kinds, military aviation, commercial aviation and general aviation.

And so military aviation is fighter jets, bombers, combat helicopters, transports, military drones, the usual stuff. It uses high performance aviation technology, so advanced engines, radars, stealth technology, stuff that is not used in the other parts of the aviation world. Commercial aviation is both the aircraft construction and the airlines themselves, and they provide -- generally, anything that provides regular daily public air transport mostly of passengers, but then some cargo would be included in commercial aviation.

The vast majority of that on a monetary basis is really a narrow body, single aisle commercial aircraft that the kinds that Boeing and Airbus make. And their focus, they use advanced technology, but their focus is on operational cost efficiency, and of course safety.

Finally, general aviation is basically the grab bag of everything else that doesn't fit in those first two categories. And so private propeller planes, business jets, chartered aircraft, hobbyist drones, as well as other commercial drones for business like for agriculture or pipeline monitoring or many other uses that they are.

And while that all uses aviation technology, and by most people's standards it is high tech, the reality of general aviation is that they're trying to make it affordable to either the individual or small companies to use it. And so usually what they're about is trading away the cutting-edge stuff in order to find what's more affordable.

So those are the three different kinds of aviation but realize that the policy implication are different. So the military tech one is the easiest. Hands down, we need to protect -- first of all, we need to continue to advance our own military technology.

Second of all, we need to protect that from falling in the hands of our adversaries, both because it creates vulnerabilities for our systems and cancels our investments, but also that we don't want them to have it, at least without having to work for it.

Commercial technology is actually quite different. Not only is the technology different, but the policy implications are different because it's a globally competitive market both between the people who build the aircraft, but also as I said, you have to include the airlines, and it's highly regulated.

Every nation regulates their airspace and their runway usage in their own way, and it's a very complicated environment that has existed for many decades. And the key there is that China is unquestionably not playing fair in this area, but the U.S. and Europe have long disagreed on what the ground rules are here, and we still haven't agreed on that.

And so agreeing to that is by hand -- if we're going to hold China accountable to any standard, we have to have a common standard between us and our allies first. And general aviation, on one hand in almost every case -- actually, in every case, it is not significant to national security or to the broad national economy.

However, you shouldn't dismiss it. We've already discussed a little bit small businesses and things like that. It greatly impacts them. Those are the players in the general aviation industry.

And to many degrees, China is more active in what they're trying to do internally as well as what they asserted in terms of investing in the U.S. and throwing their money around than the rest of the world.

Also, commercial drone activity falls into that general aviation category. And there is a difference between military drones and those smaller hobbyist drones, but that leads me right into my next section is that even though these are different technologies and there are different policy implications for both of them, they all have defense aspects to them, right.

The military aspects, I don't need to talk about military aviation. That's quite obvious to everyone. Commercial, in times of war, commercial transport can be used for airlift, and we very much have plans to do that and have used that in all the major wars that we fought over the past few decades. And so that's important.

Also, the commercial industry adds a lot of heft to the industrial base, which provides lots of opportunities for the defense industry to leverage, either on an urgent need, or, even possibly more importantly, over the long term in peacetime, it lowers certain costs because there's this large base or quantity of engineers that are available as needed.

And general aviation, I've mentioned the drones on general aviation, so small hobbyist drones. On one hand, not really a significant national security issue, not a significant national economic issue. However, as we can see in the Ukraine conflict, they can be used tactically in ground warfare.

And so there are issues there, and I would argue those issues are not so much on tech transfer or anything like that. It's more on regulation. It's like what is acceptable. In times of war, people will do whatever they want. But on a daily basis, how does the FAA regulate drones in the U.S. and so on.

To wrap things up, overall, the important thing to realize is that China has made significant progress in all three of these areas. However, the U.S. still has global leadership in all of them with the possible exception of hypersonics and long-range missiles, which are on the periphery of what I consider aviation as the speaker before me actually addressed both of them.

China has invested billions in commercial aircraft. And so they do not yet have a globally competitive product, but nonetheless, they are already distorting the market. Obviously, mostly the Chinese domestic market for aircraft and having impact.

And there is no reason to believe that that investment is going to end any time soon. They continue forward trying to break in and steal market share from Boeing and Airbus.

In general aviation, China actually does very poorly. They have a pretty minimal general aviation, and their society is not well-aligned with having lots of individuals have the freedom of using the airspace. However, they are the largest exporter of drones of the smaller hobbyist sort.

Thank you, and I am happy to address any specific questions the Committee has.

VICE CHAIRMAN WONG: Sorry, I was taking notes. Thank you.

Dr. Kirchberger.

**PREPARED STATEMENT OF CHAD OHLANDT, SENIOR ENGINEER, RAND CORPORATION**

# U.S.-China Aviation Competition

## Military, Commercial, and General Aviation Are Different

Chad J. R. Ohlandt

CT-A2692-1
Testimony presented before the U.S.-China Economic and Security Review Commission on April 13, 2023.

For more information on this publication, visit www.rand.org/t/CTA2692-1.

Testimonies

RAND testimonies record testimony presented or submitted by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies.

Published by the RAND Corporation, Santa Monica, Calif.


Limited Print and Electronic Distribution Rights



www.rand.org

*U.S.-China Aviation Competition: Military, Commercial, and General Aviation Are Different*

Testimony of Chad J.R. Ohlandt[1]
The RAND Corporation[2]

Before the U.S.-China Economic and Security Review Commission

April 13, 2023

Aviation comes in three flavors: military aviation, commercial aviation, and general aviation. Military aviation is driven by performance demands—speed, radars, stealth, short or vertical takeoff. Commercial aviation emphasizes safety, reliability, and efficiency. General aviation places the most importance on lowering the capital costs of aviation to allow small companies and individuals to fly, which requires trade-offs with performance and efficiency. While each is distinct, they all contribute to defense capabilities in different ways.

All three involve aerospace technology and often lead to the discussion of platforms and vehicles. However, each flavor of aviation is also underpinned by complex systems and processes. Militaries need to continuously train, sustain, and innovate in ways that meet their strategic goals. Commercial aircraft manufacturers and commercial airlines are heavily regulated by national safety boards, constrained by the availability of landing slots at key airports and international agreements between nations, and face continuous competition in their markets. General aviation depends on numerous smaller airports and companies to support a myriad of independent actors in ways that do not interfere with military or commercial aviation.

---

[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of the RAND Corporation or any of the sponsors of its research.

[2] The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest. RAND's mission is enabled through its core values of quality and objectivity and its commitment to integrity and ethical behavior. RAND subjects its research publications to a robust and exacting quality-assurance process; avoids financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursues transparency through the open publication of research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. This testimony is not a research publication, but witnesses affiliated with RAND routinely draw on relevant research conducted in the organization.

The RAND Corporation has published research on the broad Chinese aerospace industry;[3] China's commercial aircraft manufacturing sector;[4] the U.S.-China military balance, including aerospace capabilities;[5] and Chinese investment in U.S. aviation.[6] As of early 2023, in each of the three aviation categories, the United States is ahead of China and competitive with or better than the rest of the world. However, China continues to close the gap with the United States, both overall and with the notable progress of the People's Liberation Army (PLA) in military capabilities and in some specific areas, such as hypersonic weapons. Even with the Chinese Communist Party's (CCP's) direction of large investments in domestic commercial aircraft manufacturing and the occasional purchase of overseas general aviation companies, the People's Republic of China (PRC) continues to lag in commercial and general aviation.

## Military Aviation

The PLA aviation capabilities continue to grow. In 2023, more than half of PLA jet fighters are considered modern fourth-generation aircraft, comparable to F-16s, F-15s, and F-18s. The PLA Air Force (PLAAF) has fielded fifth-generation fighters, J-20s, nearly comparable to F-22 and F-35 stealth fighters, in smaller quantities. The PLAAF is also modernizing bomber and airborne early warning and control aircraft, including the anticipated development of a stealth bomber, the H-20. The PLA Navy (PLAN) aviation continues to expand its ability to do carrier operations with two operational aircraft carriers and more under construction. The PLA is also expanding its nuclear strategic forces with both a nuclear-capable bomber platform, H-6N, and new intercontinental ballistic missile fields.[7]

Nonetheless, U.S. global military aviation capabilities still greatly exceed those of the PLA. In 2023, the United States operates hundreds of fifth-generation F-35 stealth fighters with a planned fleet of over 2,000 across the U.S. Air Force, the U.S. Navy, and the U.S. Marine Corps. The F-35 program involves eight nations that partnered in its development and an additional nine nations that are purchasing the aircraft. As of 2023, eight partners and allies of the United States already operate the F-35 in their militaries.[8] The Air Force is also developing a new stealth

---

[3] Roger Cliff, Chad J. R. Ohlandt, and David Yang, *Ready for Takeoff: China's Advancing Aerospace Industry*, RAND Corporation, MG-1100-UCESRC, 2011, https://www.rand.org/pubs/monographs/MG1100.html.

[4] Keith Crane, Jill E. Luoto, Scott Warren Harold, David Yang, Samuel K. Berkowitz, and Xiao Wang, *The Effectiveness of China's Industrial Policies in Commercial Aviation Manufacturing*, RAND Corporation, RR-245, 2014, https://www.rand.org/pubs/research_reports/RR245.html.

[5] Eric Heginbotham, Michael Nixon, Forrest E. Morgan, Jacob L. Heim, Jeff Hagen, Sheng Li, Jeffrey Engstrom, Martin C. Libicki, Paul DeLuca, David A. Shlapak, David R. Frelinger, Burgess Laird, Kyle Brady, and Lyle J. Morris, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND Corporation, RR-392-AF, 2015, https://www.rand.org/pubs/research_reports/RR392.html.

[6] Chad J. R. Ohlandt, Lyle J. Morris, Julia A. Thompson, Arthur Chan, and Andrew Scobell, *Chinese Investment in U.S. Aviation*, RAND Corporation, RR-1755-USCC, 2017, https://www.rand.org/pubs/research_reports/RR1755.html.

[7] Office of the Secretary of Defense (OSD), *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China*, U.S. Department of Defense, 2022.

[8] Lockheed Martin, "F-35 Lightning II Program Status and Fast Facts," infographic, March 1, 2023.

bomber, designated the B-21, and the Next Generation Air Dominance (NGAD) fighter to replace eventually the B-2 and F-22, respectively.[9] The Army is also pursuing the Future Vertical Lift program toward upgrading many of its helicopter capabilities.[10] U.S. naval aviation operates from ten nuclear aircraft carriers and ten conventional amphibious assault ships, including the new *Ford*-class carrier, with the USS *Gerald R. Ford*'s initial deployment in 2022 and the *John F. Kennedy* and *Enterprise* aircraft carriers under construction. However, the United States maintains a global posture, while the CCP's PLA concentrates its military forces in the Pacific, which means that U.S. military overmatch in the region continues to decline. This is true both in the sense that the United States can only deploy a fraction of its aviation forces to that theater and that those forces have to be prepared to operate at much greater distances from U.S. air bases.

In a couple of areas relevant to aviation, China has notable advantages over U.S. military capabilities. As part of a counter-intervention strategy, the PLA has long emphasized a long-range strike missile force under the PLA Rocket Force (PLARF) for force projection and to enable an anti-access and area denial capability. The PLARF has hundreds of ballistic missiles in every class (i.e., short range, medium range, intermediate range, and intercontinental ballistic missiles) and long-range cruise missiles that are both ground and air launched. The PLA continues to expand those capabilities, including testing and deploying hypersonic strike capabilities (e.g., testing a fractional orbital intercontinental hypersonic glide vehicle and deploying the DF-17 medium-range hypersonic glide weapon).[11] The PLAAF also fields a significantly larger ground-based integrated air and missile defense system based on surface-to-air missiles (SAMs) than that of the United States. The system is a combination of systems made up of Russian SAMs and indigenous Chinese SAMs and warning radars. Individually, the systems can be very capable, but the PLA has them deployed in a dense pattern of overlapping zones that would be deadly to anything within line of sight of mainland China, protecting key assets and CCP leadership. The same technologies and systems have been placed on PLAN surface vessels, allowing the PLA to extend the capability out into the Pacific Ocean.[12]

In contrast to often having overmatch in aviation capabilities, the United States does not have clear leadership in hypersonic strike or SAM capabilities. The United States has historically relied on bomber and fighter air-to-ground weapons and long-range subsonic cruise missiles for long-range strike capability. Likewise, global projection of airpower by both the Air Force and Navy provides protection to deployed ground and maritime forces. The United States has committed to a third wave of hypersonic systems development with multiple hypersonic programs across the Army, Navy, and Air Force following the initial Cold War hypersonic development wave for intercontinental ballistic missile and space re-entry systems and a second

---

[9] John R. Hoehn, *Air Force Next-Generation Air Dominance Program*, Congressional Research Service, June 23, 2022; John R. Hoehn, *Air Force B-21 Raider Long-Range Strike Bomber*, Congressional Research Service, September 22, 2021.

[10] John R. Hoehn, *Army Future Vertical Lift (FVL) Program*, Congressional Research Service, July 13, 2021.

[11] OSD, 2022, pp. 64, 83, 98, 149, 167.

[12] OSD, 2022, pp. 53, 61, 82.

wave of development in the 1990s for its national aerospace plane effort.[13] The Army continues to upgrade Patriot SAM systems; the Missile Defense Agency maintains and develops capabilities for intercepting missile threats to the U.S. homeland, allies, and deployed forces; and the Navy operates surface warfare ships capable of air and missile defense. Because of its primarily global military posture, the United States chooses to remain less dependent on those capabilities than China.

## Commercial Aviation

Commercial aviation includes both manufacturers and airlines. Boeing and Airbus continue to dominate the manufacturing of large commercial aircraft, particularly the narrowbody, single-aisle airliner market (e.g., the 737 and A320 series, respectively). Much fewer in number are larger widebody, multi-aisle commercial jets, which are also made by Boeing and Airbus. Regional jets are smaller aircraft that fly shorter ranges and carry fewer passengers. Bombardier of Canada, now Airbus Canada, and Embraer of Brazil are the historical leaders in the regional jet market. Commercial markets also include turboprops with visible propellers and helicopters used for regular passenger or cargo transport, but those are much smaller markets relative to airliners.

For comparison, Boeing and Airbus each assemble roughly 500 narrowbody aircraft annually and one hundred widebody aircraft. The smaller regional jets built annually number less than 200 across all manufacturers. These markets are not exclusive to the companies listed above; most of the markets have multiple competitors trying to expand their limited market share. Because of these limited production numbers, even in the largest narrowbody aircraft market, the global commercial manufacturing markets tend toward duopolies in each aircraft class. The two leading companies achieve the best possible scales of efficiencies, while there are always competitors looking for an opportunity to break in.

Much of commercial aviation revenue is generated by the airlines that operate the aircraft. In contrast to naturally occurring global manufacturing duopolies, the airline industry is structured around state regulation. Every nation controls its sovereign airspace and decides what aircraft are safe to fly and land there, as well as what routes are available. Commercial airports are also public infrastructure with limited numbers of gates and landing slots. As a result, most nations strive to support multiple major domestic carriers for competition and often have multiple smaller low-cost carriers trying to carve out market share in the larger-volume routes. International carriers are generally constrained by agreements between nations where routes and landing spots are typically made available on a roughly equal basis. There are plenty of exceptions to these generalizations, but they are representative of the global airline markets.

In this context, China is roughly a fifth of the global economy and the world's population, which translates to 20 percent of the global aviation market share. This gives the PRC purview over something like a fifth of the future commercial airline market but no historical presence in commercial aircraft manufacturing. China's aerospace sector is primarily state-owned enterprises

[13] Michael E. White, "U.S. and Adversary Hypersonic Programs," statement prepared for the Strategic Forces Subcommittee of the House Armed Services Committee, prepublication version, March 10, 2023.

that are controlled by the CCP, supervised by the PRC, and resourced by the Chinese banking sector. Combined with PRC state plans to develop the aerospace sector and "Made in China" policies, the PRC established the Commercial Aircraft Corporation of China (COMAC) to compete in the global commercial aircraft manufacturing market. Founded in 2008, it is not a public company but a joint venture of two PRC state-administered investment funds and a number of large Chinese state-owned enterprises.[14] COMAC's efforts are detailed in multiple RAND studies, which I will update in this testimony.[15]

COMAC started with the development of a regional jet, ARJ21, to gain experience and to learn how to navigate a system of commercial safety certification. The Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) are each global leaders in aviation safety oversight and certification and both establish global best practices. They typically recognize each other's certifications and most other national aviation safety organizations do as well. Starting with its first test flight in 2008 and initial efforts to work with the FAA and EASA, the Civil Aviation Administration of China (CAAC) certified the ARJ21 in 2014. In 2023, a little over one hundred ARJ21s are in commercial service. The first international delivery of an ARJ21 was to Indonesia in 2022. COMAC delivered a record 30-plus ARJ21 aircraft in 2022.[16]

COMAC has also entered the more lucrative narrowbody market with the C919. In 2022, the C919 received CAAC safety and production certification, and COMAC delivered its first commercial aircraft to China Eastern Airlines.[17] It anticipates commercial operation certification and increased production of the C919 with orders from several Chinese airlines.

Lastly, the China-Russia Commercial Aircraft International Corporation (CRAIC), based in Shanghai, is a joint venture between Russia's United Aircraft Corporation and COMAC to develop a larger widebody aircraft, the C929. Starting in the early 2020s, after ongoing discussions begun in the previous decade, CRAIC hopes for its first flight by 2030. Sanctions related to the Russian invasion of Ukraine, which may restrict access to Western aerospace supply chains, have complicated this effort.

As of early 2023, the PRC and COMAC have not yet captured a significant share of the global commercial market. Nonetheless, COMAC has made significant progress toward that goal. It has a regional jet and a narrowbody commercial airliner safety certified in China. It has been producing and delivering regional jets for a few years to PRC airlines. These airlines are operating ARJ21 aircraft and learning how to efficiently maintain them. Following the 2020 aviation safety agreement between EASA and CAAC, the path for safety certification of COMAC aircraft in Europe is looking more promising.

---

[14] See Commercial Aircraft Corporation of China, "Introduction," webpage, undated, http://english.comac.cc/aboutus/introduction/.

[15] See Ohlandt et al., 2017; Crane et al., 2014; and Cliff, Ohlandt, and Yang, 2011.

[16] "COMAC Delivers the 100th ARJ21 Aircraft, Showing Homegrown Regional Jetliner Entering Mass Production Period," *Global Times*, December 29, 2022.

[17] Zhu Wenqian, "C919 Receives CAAC Production Certificate in Milestone for Homegrown Aviation," *China Daily*, November 29, 2022; Tu Lei and Shen Weiduo, "Domestically Developed First C919 Jet Delivered to China Eastern, 'Marking a Start in Journey Toward Mass Production,'" *Global Times*, December 9, 2022.

COMAC's supply chains for the ARJ21 and C919 are dependent on Western companies for engines, control systems, and other components. So, while every COMAC aircraft delivery to the Chinese domestic market is a loss for Embraer, Airbus, or Boeing, other U.S. and European aerospace companies in the COMAC supply chain do benefit.

It is important to differentiate between military and commercial aviation technology and capabilities. However, commercial aviation can contribute to defense capabilities. First, commercial aviation can be used as a substitute for military airlift. If the PLA wanted to move people and cargo large distances quickly, it could leverage its domestic airlines and their aircraft to do so. Today, those aircraft are dependent on Boeing and Airbus supply chains. Second, a successful commercial aviation industry can provide industrial capacity that can be redirected to military aviation. The PRC has already leveraged its successful shipbuilding industry to expand the PLAN rapidly.

## General Aviation

Any aviation not attributed to military or commercial aviation falls into the category of general aviation. General aviation concerns the individual aviator and private ownership or operation of aircraft for noncommercial purposes. It covers a wide variety of smaller aircraft from simple propeller airplanes to small helicopters to hobbyist drones. On the upper end, business jets for personal or corporate travel are part of general aviation. While quite diverse in nature, general aviation has the common goal of making aviation affordable to the individual private entity. It generally does not involve technology necessary for military performance or commercial efficiency and safety. As such, general aviation usually does not have national security or national economic implications.

It is worth discussing here for two reasons. First, many attempts at purchasing U.S. or other foreign aerospace companies by Chinese entities revolve around general aviation companies because their technology and revenues are less significant compared with military or commercial aviation endeavors in terms of national security or economic implications. Additionally, because PRC policy advocates for the development of aerospace industry in China, the transfer of funds outside China is more likely to be approved given PRC capital controls. While general aviation companies do not, as a rule, have national security or economic significance, there are cases with negative consequences where North American jobs are moved to China following the acquisition or control of overseas general aviation companies assumed by the Chinese entities that are hard to hold accountable in U.S. courts, which raise concerns.[18] For example, in 2011, such concerns were raised with China's Aviation Industry Corporation of China's (AVIC's) acquisition of Cirrus Aircraft, a manufacturer of general aviation aircraft, including single-engine planes and jets, that continues to be based in Duluth, Minnesota, which as of 2018 has established some manufacturing and assembly in Zhuhai, China.[19]

---

[18] Ohlandt et al., 2017.

[19] "Buyers Collect 1st Made-in-China/Zhuhai Cirrus Aircraft," City of Zhuhai, November 12, 2018, http://www.cityofzhuhai.com/2018-11/12/c_290836.htm.

Second, the growing personal drone market and evolving commercial use of drones fall under general aviation. The largest maker of commercial drones, Da Jiang Innovations (DJI), is in China.[20] While DJI does not market military-grade drones, their products are often conflated with such. One of DJI's specialties is drone-based video that can be used to monitor local populations for law enforcement purposes. The 2022 Russian invasion of Ukraine has also further demonstrated the utility of smaller drones for tactical targeting in ground warfare. Business concepts around package delivery by aviation drones are rapidly evolving with the technology and government regulation.

General aviation typically concerns large numbers of independent individuals and entities dispersed geographically using aviation and supported by similarly dispersed small airports and businesses. The United States has a general aviation tradition that dates back to the origins of human flight. It is worth noting that little of this is true for China. The PRC's population is mostly located in dense urban areas. The PLA controls the national airspace. There is no significant historical tradition of general aviation in China. Even while some Chinese elite may desire private jets or planes for convenience, the occasional CCP campaign against waste and privilege tempers that desire. The PRC system run by the CCP is not well aligned with the concept of general aviation that involves numerous independent actors.

## Findings

In each of the three categories of aviation—military, commercial, and general—the United States leads in aviation capability and technology. However, the CCP-led PLA military and PRC government are actively trying to match U.S. and European aviation capabilities. As of early 2023, the PRC continues to make steady progress in closing the aviation technology gap. The PLA has military aviation capabilities, including stealth aircraft, airborne early warning and control, and naval aircraft carrier forces, that are second only to those of the United States, and the PLA combines such capabilities with long-range missile forces and ground-based SAMs that are second to none. PRC state-owned enterprises have spent 15 years and unknown billions of dollars building COMAC to compete with Airbus and Boeing in commercial aircraft, which in 2022 was just starting to deliver narrowbody commercial aircraft to China's domestic airlines. China's DJI exports more small drones than any manufacturer in the world, and AVIC owns U.S.-based Cirrus Aircraft, which builds light aircraft for the general aviation market.

When Congress considers potential policy actions for maintaining U.S. competitive advantages in aviation, it should take into account the three categories of aviation discussed here. If Congress wants the United States to stay ahead of China in military aviation capabilities, it could continue investing in advanced capabilities, such as the B-21, NGAD, unmanned aerial vehicles, vertical lift, hypersonic weapons, and numerous other aviation capabilities, while protecting the technology unique to those capabilities, such as stealth materials, advanced radars, and high-performance super-cruise jet engines. None of this is new in terms of policy, but maintaining a U.S. advantage in military aviation capabilities requires continual attention to

[20] Ness Anwar, "World's Largest Drone Maker Is Unfazed—Even If It's Blacklisted by the U.S.," CNBC, February 7, 2023.

resourcing U.S. efforts while providing oversight of the mechanisms that protect U.S. military technologies, such as cybersecurity, counterintelligence, and Committee on Foreign Investment in the United States operations.

Competing in commercial aviation requires a more nuanced policy. Boeing and its partners benefit from high barriers to entry into its market, which result in a natural duopoly with Airbus. However, Congress cannot ignore that the CCP and PRC are investing billions of dollars toward displacing either Boeing or Airbus, even though, at the same time, U.S. suppliers to COMAC benefit from Chinese investments and COMAC sales. The United States and Europe have long disagreed on what constitutes acceptable government support of their aviation industries, which has led to long-running World Trade Organization disputes between Boeing and Airbus.[21] Rather than focus on short-term impediments to Chinese aviation by restricting non-military aviation technology or by slowing aviation safety approvals, the United States and Europe could agree to a common set of principles for investing in commercial aviation and then together hold China to those standards. If Congress wants to promote a level playing field in commercial aviation on which U.S. companies can continue to win, it could incentivize the U.S. government and industry to adopt a common understanding or agreement with U.S. allies and partners in aviation, particularly Europe.

Lastly, general aviation has less significant economic and national security implications. With many different actors working on a smaller scale, general aviation also has lower barriers to entry for Chinese companies and greater room for competitive responses from U.S. entities. If Congress wants to maintain U.S. competitiveness in general aviation, it could continue to support a healthy general aviation community of small business, small airports, and aviation regulation. For example, the growth of drones and personal air vehicles for short-range transport has created new challenges; Congress could support the efforts of the FAA and the National Aeronautics and Space Administration to address them.

[21] See Crane et al., 2014.

## OPENING STATEMENT OF SARAH KIRCHBERGER, HEAD OF ASIA-PACFIC STRATEGY AND SECURITY AT THE INSTITUTE FOR SECURITY POLICY, KIEL UNIVERSITY

DR. KIRCHBERGER: Good morning, Chairman Bartholomew and Vice Chairman Wong and Commissioners. I'm going to talk about undersea warfare here.

China currently operates one of the largest submarine fleets in the world with at least 70 active boats, both nuclear powered and conventional. The latest types have made market progress in terms of their quieting, endurance range, sensors, and armament, and they have operated at least as far away from China as the Indian Ocean. And the shipbuilding infrastructure that is producing them has been massively upgraded and enlarged. Nonetheless, a gap still exists between China's subsurface warfare capabilities compared with the technical and operational standards that exist within the U.S. Navy and arguably also some of its allies. Due to a rather unfortunate maritime geography for subsurface warfare, China has identified U.S. subsurface warfare as a key threat to China in any military confrontation, whether over Taiwan or in the South China Sea. And China is therefore striving to close the gap.

And it's coming types of nuclear-powered boats, the Type 095 nuclear attack submarine for instance, or the Type 096 ballistic missile submarine are expected to be larger, faster, quieter, equipped with better sensors and weapons, and therefore to be more lethal overall than anything that came before.

Since Xi Jinping has made naval expansion a maritime rights protection, as it's called, a prime goal, China has also begun to focus much more strongly on anti-submarine warfare. The ultimate goal is to gain the ability of being able to deny the use of China's claimed water to adversary submarines.

For that, China has ambitious plans to create a vast, integrated ocean surveillance system, which is already in the works. The goal is to track ocean movement within the water column in near real time, for instance in the South China Sea. While that may as yet be an aspirational goal, it is not in the interest of either the U.S. Navy or the regional allies who depend on the U.S. naval presence there for their own security.

China invests considerable funds into the related production, design, research and development, and educational facilities via a vast and opaque system across shareholdings and state-owned banks' credit lines.

It is very difficult to keep track of all the entities that contribute somehow essential knowledge or technologies to this vast effort of undersea warfare. And some of them only have this as a small part of their overall civilian portfolio. Most of them are, however, subsidiaries of either the shipbuilding building, CSSC, or the defense industry group, CETC.

A lot of research has been done on Chinese technology espionage, and that is an ongoing concern as a recent high-level espionage at the NATO Undersea Research Centre in La Spezia, Italy, has shown.

But by far the most important transfers that have contributed to China's current status of undersea warfare have taken place legally, whether from Western countries or from Russia. Imported systems have then undergone a process of adaptive innovation in China.

As it currently stands, Chinese conventional submarines are powered by German diesel engines, seem to use an originally Swedish Stirling engine technology for air-independent propulsion, equipped with sonars that were developed from originally American, French and Russian models.

And China's anti-submarine warfare had helicopters are based on legally-imported airframes from France and the United States. The necessary seafloor mapping that precedes any submarine operation, expansion into new sea areas, was enabled by legally-imported civilian research equipment, including multibeam sonar technology for serving deep sea geography that came from Norway and the United States.

But the most decisive source of knowledge and technology has, without doubt, been Russia, which also very likely provided active design assistance for the nuclear submarines. And China and Russia are now cooperating also in the development of fiber optic hydrophones. Further Russian support will therefore be a key factor for the quality of any future undersea warfare.

The area of unmanned underwater vehicles is particularly prone for inviting foreign researchers from Western countries for collaboration, who may be sometimes unaware of the dual-use --

(Simultaneous speaking.)

DR. KIRCHBERGER: -- collaboration who may be sometimes unaware of the dual-use characteristics of this field.

Software development and mathematical modeling of underwater robotic systems, for instance, has been a field where cross-national collaboration between Western and Chinese research institutions has taken place.

Oceanographic research in particular, including also on the effects on the climate change, but especially if it contains an element of hydroacoustics research is another area that's very prone to attracting the attention of Chinese submarine warfare experts.

It's one of the few areas where cooperation with China is deemed essential because of the need to combat climate change, despite all dual political tensions. It can be hard in practice to distinguish between research that's purely aimed at gaining knowledge for combating climate change and such activities that may ultimately have a dual-use character.

So what can be done about this? As you can see from the details given in my written testimony, it may not be enough to just place small firms on the entity list.

Rather, I think what we need is critical thinking should be furthered within U.S. and Western industrial and research communities at the grassroots level to make sure that security aspects of potential cooperations with research institutions in China are not being overlooked and due diligence and potential partners in such cooperations should be conducted before such a cooperation even starts.

And this could happen through a system, I think, of cross-sectoral workshops that might be led by members of the intelligence community. Basically, schooling people, conducting postmortems on existing cases and so on.

So the existing tools and knowledge databases that we have that contain data on partners that could be relevant should be strengthened and expanded and made easy to use. And they're certainly not geared towards undersea warfare in particular right now.

Last, the United States, as the leading nation in undersea warfare in the world, should accept the challenge coming from China and continue to innovate at the technological frontier while being very mindful that quality matters more than quantity, but especially if it comes in large numbers.

Thank you.

VICE CHAIRMAN WONG: Thank you, Dr. Kirchberger.

Mr. Allen.

**PREPARED STATEMENT OF SARAH KIRCHBERGER, HEAD OF ASIA-PACFIC STRATEGY AND SECURITY AT THE INSTITUTE FOR SECURITY POLICY, KIEL UNIVERSITY**

April 13, 2023

**Testimony before the U.S.-China Economic and Security Review Commission**

**Hearing on**

***"China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"***

**Panel II: Obstacles and Breakthroughs in China's Defense Technological Development**

# China's Undersea Warfare

Dr Sarah Kirchberger

Head of Asia-Pacific Strategy & Security, Institute for Security Policy at Kiel University (ISPK)

Vice President, German Maritime Institute (DMI)

Nonresident Senior Fellow, Atlantic Council

**A Note on sources**

*Undersea warfare is one of China's most heavily guarded military R&D fields, and publicly accessible information is therefore limited. Where applicable, this testimony reflects this by using language indicating a degree of uncertainty. The sources relied on for the assessments made include published reference works and analyses based e.g. on satellite imagery and other visual evidence, Chinese scientific journal articles, Western, Chinese, and Russian news reports, official websites, job adverts, and the like of Chinese companies and research institutes, industry brochures and presentations shown or collected at arms fairs and conferences on naval weapon systems, as well as published and own anonymized background interviews with undersea warfare experts and practitioners from the industry and military communities. Classified evidence that exists in Western militaries on the performance of Chinese submarines and ASW systems derived from direct encounters, technical measurements as well as other types of intelligence was not accessible to this author, and neither were Chinese internal evaluations of the quality and performance of systems; technical details of existing and planned submarines and ASW systems; and internal comparisons with Western and Russian submarine warfare systems. The resulting knowledge gap is likely considerable and cannot be bridged in a public testimony.*

## 1. Overall comparison of U.S. and Chinese undersea warfare

Undersea warfare depends on a multitude of technologies, systems, and skills, including the production of hydrodynamically optimized submarine hulls; reliable propulsion plants (conventional and nuclear) with adequate sound insulation for quieting, and high-density energy storage systems; various navigation,

communication, and other subsystems; active and passive sonars (bow-mounted and towed) and other sensors; various types of armament; ASW aircraft, sensors deployed on or from other submarines, surface warships, and aircraft (integrated active and passive sonars, dipping sonars, sonobuoys); as well as fixed hydrophone arrays (e.g. to monitor submarine traffic through chokepoints); and so on. Lately, unmanned undersea vehicles (UUVs) are being developed to conduct anti-submarine roles as well, and the latest developments in regional ocean surveillance networks aim to employ a great number anti-submarine warfare technologies that integrate manned and unmanned platforms, floating and fixed installations, using active and passive sonars in addition to gathering oceanographic background data, transmitted in near real-time to data processing facilities for the creation of hitherto unknown levels of undersea domain awareness through networked, multi-static anti-submarine warfare. Though that is still in development, even standard submarine operations require an extensive knowledge of the undersea natural environment, including, but not limited to, exact maps of the seafloor as well as detailed oceanographic data e.g. on salinity levels and temperature layering (for calculating sound propagation channels), as well as on the ocean background noise generated by marine life, seismic activity, and the like. For the latter, there exists a large degree of overlap with civilian oceanographic sciences, as all research that generates datasets on the oceanographic characteristics of any given sea area basically has the potential to become "dual-use", opening attractive research platforms for international collaboration with PLA Navy R&D personnel. Chinese studies openly reflect on this fact.[1]

The technological gap between Chinese and US undersea warfare technologies in quantity and quality has historically been large, but is shrinking thanks to a sustained effort to overcome remaining bottlenecks. This effort is driven by a perceived strategic need to find solutions for alleviating China's geographical disadvantages in undersea warfare, which are due to a unique maritime geography consisting mostly of shallow and crowded littorals on continental shelf without direct access to the open oceans - Chinese submarines must transit through heavily monitored choke points in the First Island Chain to reach oceanic waters. This puts them at a disadvantage when faced with US and allied ASW forces, and negatively impacts China's ability to conduct open ocean nuclear deterrence patrols untrailed. In terms of area defense, however, China's shallow littorals offer good conditions for deploying a force of smaller, hard to detect conventionally powered submarines.

### *Nuclear attack submarines (SSNs)*

Despite having been cut off from international submarine design assistance between the Sino-Soviet Split in the early 1960s and an era of Western technology imports that lasted for a decade from the late 1970s, China managed to build at least 3 hulls of its first (now obsolete) Type 091 "Han"-class nuclear attack submarine (SSN) design, reportedly with support from a Russian design bureau. About 15 years after commissioning the first hull, China began to commission eight or nine of the currently active Type 093 and Type 093A "Shang"-class SSN, the last of these entering service around 2018 (see Figure 1). This compares with a fleet of ca. 26 currently active American Los Angeles-class SSNs (out of a class of 62) that are able to fire Tomahawk missiles in addition to torpedoes; 3 Seawolf-class SSNs, and already 21 commissioned boats of the latest Virginia-class SSNs that are to gradually supplant obsolete Los Angeles hulls and are seeing continuous further upgrades and development. Since two US shipyards share the building of SSNs in comparison with just one yard in China – Bohai Shipbuilding Heavy Industry Company (BSHIC) in Huludao – the US industrial base is broader and more experienced.[2]

From the third boat of the Chinese Type 093-class SSN onwards, Chinese SSNs have been equipped with low frequency towed sonar arrays in addition to integrated active/passive sonar, making them better able to detect adversary submarines than previous boats that were both comparatively noisy [3] and comparatively lacking in anti-submarine warfare capabilities of their own. A next-generation SSN design, dubbed variously the Type 093B or the Type 095, is already in the works, with at least one boat under construction in Huludao. Though no exact specifications are yet available, it is likely to be larger and faster than its predecessor; to be equipped with a vertical launch system for firing cruise missiles, in addition to torpedoes; and to use a pump jet instead of a propeller, which could significantly improve its acoustic signature and thus, reduce detectability.[4] All these as yet speculative features are however already long standard in the USN and would bring the Chinese boats closer to that standard, but it remains to be seen how well the newly developed prototype will ultimately perform. Drawing from experience with China's surface warship fleet, as long as the PLAN continues to produce only small numbers of incrementally improved design variations, this might indicate the presence of remaining design flaws, whereas the beginning of larger-scale production series would indicate satisfaction on the part of the PLAN.

### *Ballistic missile submarines (SSBNs)*

China commissioned its first prototype Type 092 "Xia"-class SSBN only in 1993. It featured a vertical launch system for the relatively short-range JL-1A submarine-launched ballistic missiles (SLBM). This single, now obsolete hull reportedly never conducted a single actual deterrent patrol. China later built at least 2 Type 094-class SSBNs (the first commissioned in 2004) and at least 6 already commissioned 094A "Jin"-class SSBNs, all featuring a vertical launch system for firing the longer-range JL-2 or JL-3 ballistic missiles. The boats suffer from a hull design flaw dubbed the "turtle" back from the missile compartment that creates a relatively noisy hydroacoustic profile. The design has been described as "fundamentally flawed in that the large missile compartment at the rear of the vessel and the flood openings below the missile hatches create a detectable sonar signature" at higher speeds, making the acoustic signature of these boats even worse than that of 1970s era Soviet designs such as the Delta III SSBNs and the Victor III SSN.[5] Chinese commentators are blaming the less than ideal turtle shape on "poor technical strength at the time," and on the need to equip the boats with the JL-2 SLBM (whereas the JL-1 had been smaller). By contrast, the Type 096 SSBN is expected to be much quieter, with military expert Chen Guangwen giving an expected noise value of less than 105 decibels for the Type 096 SSBN.[6]

All Chinese nuclear-powered submarines seem to run on pressurized-water reactors using low-enriched Uranium as fuel, and their submerged maximum speed is estimated to be not less than 26kts. At least one hull of a new, follow-on "Type 096"-class SSBN is currently already under construction at Huludao, with an estimated minimum of at least 3 further units planned. This new design is expected to be significantly larger than its predecessor to accommodate the ballistic missiles without a "turtle" design, and to feature a larger VLS, as well as very likely a pump jet instead of a propeller, which would result in a much improved hydroacoustic stealth profile.[7] Though a great improvement, this would nonetheless not match the US SSBN fleet's overall size and capability level. The USN is currently operating 14 Ohio-class SSBNs as ballistic missiles submarines plus 4 of these boats as cruise missile submarines for firing Tomahawk missiles, and is building the next-generation District of Columbia-class SSBNs. American SSBNs have continuously conducted nuclear deterrent patrols for decades on a worldwide basis, including under the Arctic ice. Their operational practice also in terms of maintenance and training therefore differs significantly from the experience of the PLA Navy, which is still in the process of developing all the associated skills, and for the time being, in regionally far more restricted patrol areas mostly in China's adjacent waters in the South

China Sea. Operating SSBNs in that crowded environment has its own challenges, as an incident in October 2017 showed, when a Type 094 "Jin"-class SSBN surfaced amidst Vietnamese fishing vessels near the Paracel Islands.[8]

The limited range of the Chinese JL-2 missile has so far hindered Chinese SSBNs from holding the entire US mainland at risk from patrol areas near China's coastal waters. This could change either if China's SSBNs gain the ability to transit into the open Pacific patrol areas while evading detection by US and allied anti-submarine warfare sensors when transiting the First Island Chain; or, if an even longer-range SLBM than the JL-3 is developed and deployed in China's coastal waters within defended submarine sanctuaries akin to the "bastion" off Russia's Kola Peninsula in the Arctic. That China is in principle interested in an Arctic basing strategy of its own is indicated by several relatively recent technical journal articles dealing explicitly with the challenges of designing submarine hulls for operations in arctic and ice-covered waters.[9] That would, of course, be contingent on Russian permission and support.

### *Conventional submarines*

Unlike the US Navy, China is also operating a large fleet of smaller diesel-electric submarines for operations in China's shallow littorals, where they can mainly contribute to an area denial strategy (see Figure 2). Advanced models equipped with air-independent propulsion (AIP) systems can prove practically speaking undetectable even to advanced ASW forces within the loud, shallow and complex littoral undersea environment of China's coastal waters, posing significant risk to surface vessels. The USN has not operated diesel-electric submarines for decades, and due to their limited range and speed and a different maritime geography, also has no requirement for them.

After copying early Soviet submarine designs with its first indigenously constructed "Romeo" and Type 035 "Ming"-class submarines that are now technically obsolete, China between 1998 and 2006 imported and commissioned 2 Russian-built "Pr. 877 Kilo" and 10 more advanced "Pr. 636 improved Kilo"-class submarines, including all sensors and armament. The Pr. 636 boats remain in service today, and although not yet equipped with air-independent propulsion which limits their continuous submerged operating time to 2-3 days, are very quiet and hard to detect when submerged. This import happened in parallel to the already ongoing construction of the indigenous Type 039 and Type 039G "Song"-class submarines, which indicates that these Chinese designs were considered inferior to even the older Soviet-era Russian "Kilo" submarines. The Kilos at the time of their transfer reportedly required extensive Russian maintenance assistance, but the sensor technologies obtained through their transfer later informed many Chinese sonar developments.[10]

### *Where is China "ahead" and where "behind"?*

Starting from a relatively low level of proficiency during the Cold War, China has made significant strides in the design of more hydrodynamic hulls and better propulsion systems (conventional and nuclear). In terms of operational practice, Chinese submarine operations have during the past 15-20 years been significantly extended from operating almost exclusively within China's near seas into at least the Northern Indian Ocean area, where Chinese submarines have taken part in anti-piracy patrol missions off the Horn of Africa and conducted port calls, e.g. in Karachi/Pakistan. Some gaps remain when compared with the globally operating US Navy and other advanced Western submarine-operating navies, in particular in command and control system design, quieting, and propulsion. These gaps are openly acknowledged in the Chinese research literature.[11]

The exposure to more advanced Russian technology via imports and consulting services has enabled China to develop its indigenous Type 039A, 039B and 039C "Yuan"-class conventional submarine designs that have successively and incrementally evolved to incorporate better stealth features, sensors, and armament. From the Type 039B "Yuan"-class onward, these submarines have been equipped with a Stirling air-independent propulsion system which significantly enhances the timeframe of maximum fully submerged operation from no more than 2-3 days to more than two weeks.

Several regional US treaty allies that share the maritime space with China, such as South Korea and Japan, operate comparably sized but technically more advanced diesel-electric submarines with air-independent propulsion systems based on fuel cell and lithium-ion (South Korea) or Stirling engine and lithium-ion battery technology (Japan).

In anti-submarine warfare, China is investing heavily into the build-up of extensive ocean surveillance systems, inspired by the Cold War era SOSUS system deployed at the Greenland-Iceland-UK ("GIUK") gap for the monitoring of Soviet submarines.[12] Through creating a vast undersea surveillance network that combines and employs various emerging and disruptive technologies (EDTs) at the reported cost of more than 2bn RMB, China aims to create a real-time or near real-time undersea situational awareness and thereby, turn key parts of adjacent waters (in particular near the SSBN base on Hainan island) in the South China Sea and in the East China Sea "transparent" in an effort to discourage submarine operations of adversary nations in those areas. This ambitious effort is currently ongoing, as numerous research articles and exhibits at defense fairs attest. Next to this, China is heavily engaged in generating the necessary basic oceanographic and hydrological knowledge that is of foundational importance for potentially extending submarine operations into further areas along the Maritime Silk Road. There are indications that the level of ambition also includes the Arctic (see below). A large degree of overlap between civilian (e.g., climate change-related) oceanographic research and military uses of such research for submarine operations is openly acknowledged in Chinese research literature.[13] Based on that, Chinese initiatives to map the sea bottom, to deploy sensors for measuring salinity, temperature levels, or oceanic background noises (whether through fixed hydrophone arrays or gliders), and to gain access to related research databases of other nations have to be seen as potentially contributing to China's undersea domain awareness improvement, which is a key enabling factor for submarine and anti-submarine warfare alike. Given the high degree of interest in Western countries to cooperate with China on environmental research, China will likely be able to make much faster progress than it would be if fending on its own by engaging and conducting joint research projects with oceanographic research communities worldwide.

China invests considerable state funds into related production, design, R&D and educational facilities and is additionally tapping into stock markets to funnel money into the system via cross-shareholdings with private and semi-private entities.

### *How "innovative" is China in this area?*

China is still striving to close technological gaps in hull design, quieting, and particularly, propulsion systems that continue to exist compared with Russian, American and other advanced submarine technology producers that innovate at the technological frontier, whereas China is mostly still in the process of absorbing subsurface warfare technologies and conducting adaptive innovation based on these models.

From the beginning, China's efforts in subsurface warfare have heavily relied on foreign technologies, and in particular Soviet or Russian imports and design assistance for the development of its submarine fleet, both conventional and nuclear.

In such a foundational area as propulsion, China has continued to rely on key imported components, in particular German MTU marine diesel engines that have been built in China under a license agreement for many years. A recent incident in the context of China's submarine export to Thailand revealed that an indigenous Chinese submarine diesel engine that was offered as an alternative to the MTU diesel has apparently not yet been deployed on any Chinese submarines, as the Thai navy rejected it on account of not being a "proven" design (see below). This perhaps surprising weakness in submarine propulsion design mirrors similar situations with naval gas turbines for surface vessels (which China produces under a license agreement from Ukraine) and also in aero-engines.

China was however able to indigenously develop an air-independent propulsion system (AIP) for diesel-electric submarines based on Stirling-engine technology apparently legally imported from Sweden during the 1980s. Notably however, it seems to have taken China about two decades - until 2005 - to develop this into a deployable AIP propulsion system, despite the basic principle of Stirling engines being a legacy technology.

Recent Chinese research articles indicate that China has so far not been able to deploy any of the more advanced AIP technologies on submarines than Stirling engines, e.g. fuel cell technology (as is operational on the latest German, South Korean, or Singaporean submarines) or lithium-ion batteries (such as are already deployed by both Japan and South Korea). Though Chinese R&D in those areas seems to be a particular focus, research articles note that several difficulties need yet to be overcome for these technologies to be safely deployed aboard a submarine.[14] This points to a certain gap in innovativeness compared with the above mentioned leading producers of diesel-electric submarines.

For China's indigenously developed nuclear-powered attack submarines and ballistic missile submarines, the Russian Rubin Design Bureau in particular was reportedly heavily involved in assisting the designers of the Type 093 "Shang" class SNN in the areas of hull design, instrumentation, acoustic stealth improvement, and development of acoustic countermeasure systems.[15] One Russian military commentator points out that "Chinese engineers struggled for a long period with vibration suppression issues from the shock absorption platform that houses the steam turbine along with circulation pumps, turbo charger and other equipment."[16]

A recent book on the Chinese navy by PLA Colonel Ma Hongwei claims that the next-generation SNN – the Type 095 will feature "six world-leading new technologies": a new pump-jet propulsion system; ultra-high-strength steel (presumably allowing for greater diving depths); a single-double hybrid hull structure; new integrated shock-absorbing floating raft for improved quieting; a vertical launch system for cruise missiles; and China's "third-generation submarine reactor".[17] Another Chinese commentator likewise mentions "new generation of reactor technology" of the next-generation submarines, and points out that China has the world's largest 80,000-ton forging hydraulic press" as well as "super steel with a yield strength of 2000 MPa, which is the world's top level" – a precondition for more pressure-resistant hulls and deeper diving depths.[18] Colonel Ma gives the following performance data for the planned Type 095 SNN: A maximum underwater speed of no less than 33kn, silent speed of no less than 18kn, and a maximum diving depth of no less than 600 meters. This would put the new Chinese boat in a different league entirely than its predecessors. He also indicates that on the basis of the Type 095 SNN, China also

intends to develop a cruise missile-armed nuclear submarine carrying multiple integrated cruise missile launchers.[19]

### *How long will it take China to "close the gap" with the United States?*

Several difficult to assess factors influence the timeframe that China will need to catch up with current US standards. Heightened US wariness toward Chinese researchers in dual-use technology fields during the past few years, sharpened export controls and the like are bound to slow down direct technology transfers from the US. One decisive factor would be enhanced Russian design support. So far, Russia had been hesitant to transfer its most advanced nuclear propulsion and quieting technologies. Depending on the overall geopolitical interests of both countries, and given the growing Russian economic and political dependency on China as a result of the Ukraine war, this resistance could begin to melt. Already in 2020, official Russian media had announced that Russia and China were "jointly designing a new generation non-nuclear submarine."[20] And Russian and Chinese researchers have been actively cooperating on sensitive undersea sensor technology for use in the Arctic for a number of years, indicating the potential for further Russian openness to cooperation with China on subsurface technologies even in that sensitive area.[21] Should Russia however decide to withhold its most advanced technologies to keep an edge over China, China's progress would occur more slowly, while American and allied producers all the while will continue to innovate at the technological frontier.

Another key factor concerns the question of continued high-level political support and uninterrupted accessibility of large-scale state funding. As of now, China's government prioritizes the build-up of a world-class nuclear and conventional submarine fleet. Submarines are considered essential for the build-up of a full nuclear triad and contribute significantly to area denial in the context of China's near seas active defense posture. China is furthermore striving to deter foreign submarine incursions into Chinese-claimed waters, including the South China Sea, and wants to neutralize technological advantages of adversaries by quickly catching up in anti-submarine warfare, which includes the creation of extensive ocean surveillance networks in China's near sea areas to increase undersea domain awareness. Related survey activities have also begun in areas beyond the South China Sea and First Island Chain, e.g. the South Pacific and Indian Ocean,[22] and China has also started to export new submarines, so far to Pakistan and Thailand, which has the potential to strengthen strategic relations with submarine customer countries while providing China's submarine designers with valuable customer feedback.

Under the current great-power rivalry, high-level political support for China's undersea warfare development can be expected to persist. The availability of funds, however, depends not only on political will, but also on China's future economic growth and other pressing state spending needs. Here, adverse economic developments in China, e.g. a banking crisis, could potentially disrupt the flow of funding. But in light of the high strategic priority undersea warfare enjoys, cuts can be expected to occur first in other areas, such as surface fleet development.

In anti-submarine warfare, Chinese specialists working in the field have noted that high-level support for this research field is relatively recent and occurred mostly within the past decade. "Professor Tu Liangcheng of the Huazhong University of Science and Technology in Wuhan said in 2016 that funding for submarine detection technology had been increased in the preceding years: "There is a shift in the navy's attitude to submarine warfare". According to him, China previously focused more on enhancing the capability of its submarines rather than focusing on ASW. Tu was also quoted as saying that China was "desperately" striving for the ability to track foreign nuclear submarines, but that it was "30 years behind

the capabilities of the United States" in submarine detection. He indicated that funding was sufficient, and R&D supposedly already "on par with the US and Europe," but noted that "the pressure is high, there is high expectation of a quick breakthrough, and we are short of hands."[23]

## 2. Specific technological obstacles that China has historically faced in its efforts to develop advanced undersea warfare capabilities

China's submarine-developing industries have enjoyed limited degrees of access to more advanced foreign technologies for most of their existence. During 1950 to ca.1960, the Soviet Union was the sole provider of legacy submarine technology. The diesel-electric Type 035A "Ming" boats China produced based on that basis proved relatively accident-prone.[24] During ca. 1980-1989, China gained access to some advanced Western naval technologies, including American and French sonars and ASW helicopters, German diesel propulsion (MTU) and also Swedish technology for Stirling-engines that was later indigenously developed into an AIP system after an arduous R&D process.

After the arms embargo following the Tiananmen massacre in 1989, China again lost access to the Western arms markets except in some dual-use fields. This did not impact the further transfer of naval diesels, and neither did it inhibit transfers of oceanographic and hydrographic research equipment necessary for mapping the sea floor. Following the demise of the Soviet Union, Soviet-era Russian technology became once again available to China, and China imported several batches of Kilo class submarines. These brought significant amounts of hitherto unavailable technologies to China, and modern sonars are mostly based on that imported batch of Soviet era technology. In particular, the Rubin design bureau seemingly assisted China in the design of nuclear-powered submarines.

One area of heightened interest is AIP propulsion technology for conventionally powered submarines. Despite concentrated efforts, just like Russia, China has so far not deployed a fuel-cell AIP on submarines and is still working on lithium-ion battery AIP despite being a leader in electric car manufacture where lithium-ion batteries are already widely used. Chinese technical literature cites safety concerns, in particular the need to securely control the danger of thermal runaway.[25] Nonetheless, China can be expected to master lithium-ion battery AIP at some point and thus likely leap over the technically more complicated to copy stage of fuel cell AIP.

China seems to have only very recently developed an indigenous submarine diesel engine after license-producing the MTU 396 SE84 diesel engine for decades. This became apparent when after China had won a contract in 2017 to export one S26T Yuan class submarine to Thailand, to be delivered in 2023, the deal ran aground in 2022 once the German government would not grant an export license for the MTU engine. After Thailand threatened to cancel the contract, China offered its indigenous CHD620 diesel, but Thailand was as of March 2023 still hesitant to accept an "unproven" engine, which implies it has never been integrated into a submarine before. The inspection and negotiation process remains ongoing as of April 2023 writing.[26] This export contract points to an unexpected bottleneck in what a German submarine design expert interviewed by me considers a "relatively old" technology that is "not too complicated to master" and poses merely a "manageable" technical risk. Asked to speculate what elements of an "unproven" diesel engine might specifically be considered risky from the point of view of a submarine customer, the expert offered that the worries might conceivably be related to the performance of the exhaust back pressure system for discharging diesel exhaust below the surface when operating at

snorkeling depth. Malfunctions in this area would pose a safety hazard for the crew, and reliability is therefore a key concern.[27] The reaction of Thailand also shows that Chinese submarine technology is so far not considered quite on par with leading Western technology on the export market.

## 3. Chinese attempts to address obstacles through greater investment in domestic R&D

As Kevin Pollpeter and Mark Stokes have pointed out, "Chinese defense enterprises approach indigenous innovation in three ways: original innovation, integrated innovation, and technology transfer, or what the Chinese call 'Introduction, digestion, absorption, and re-innovation'", in short: IDAR.[28] In submarine warfare, so far absorption and re-innovation or "IDAR" seems to be frequently employed.

A vast state-led high-tech development plan, ("863 Program") was created in 1986 in an effort to make China technologically more independent. Marine technologies were included from 1996. It seems to have been particularly important for funding R&D activities related e.g. to sonars and unmanned systems development.[29] The latter is a particular focus of current Chinese undersea warfare R&D. As a Chinese security firm's analysis of the undersea technologies market in China proclaims, "we will vigorously develop underwater unmanned submersibles, push forward the deployment of underwater shallow and deep-sea regional monitoring and early warning systems, focus on advanced technologies such as underwater navigation and positioning, communication, and autonomous coordination, and combine manned and unmanned equipment technologies to create a new type of underwater network combat system."[30]

In the context of overall structural reforms in the defense industries, and massive R&D and arms production funding, a vast and opaque system of interlinked shipyards, R&D institutions and subsystem developers has emerged in China that is characterized by cross-shareholdings among each other, with state-owned banks, and with listed private businesses within China and abroad; connects deeply with the academic R&D community worldwide; and is collectively engaged in a vast effort to overcome bottlenecks in critical arms technologies via ingenious methods beyond traditional espionage.[31]

For foreign businesses and research institutions, it can be hard to conduct due diligence on Chinese partners, or even to keep track on the activities of a single firm or entity, due to frequent renamings and asset reorganizations. To give an example, the CSSC China Marine Information Electronics Company Ltd. (a.k.a. China Haiphong 中国海防) is a leader in underwater communication technology, ultra-low power signal processing technology, high efficiency acoustic emission technology, broadband transceiver design and manufacturing technology and underwater system equipment, focusing in particular on the development of "autonomous unmanned underwater vehicles (AUVs), deep-sea vehicles and submarine-specific underwater operational equipment, including underwater phones, underwater information transmission, underwater television, underwater lighting, underwater navigation and positioning, underwater black box, etc." It was originally established in 1993 under the then name Gansu Sanxing Petrochemical, went public in 1996, was renamed "China Electronics Guangtong" in 2004, and in 2017, injected shares into Great Wall Electronics and Sesco. In 2018, it was renamed China Haiphong, and in 2019, purchased 100% of the equity of Haisheng Technology, 100% of Jereh Holdings, 100% of Liaohai Equipment, 62% of Qingdao Jereh, 54% of Jereh Electronics, and a China Ship Yongzhi 49% stake.[32]

The area of unmanned underwater vehicles is particularly prone to invite foreign researchers who may be unaware of the dual-use characteristics of the field. Software development and mathematical modeling of underwater robotic systems has for instance been a field where cross-national collaboration has been conducted between Western and Chinese research institutions. A 2019 study on software architecture for hybrid underwater robotic vehicles had co-authors from Chinese entities that are all listed as "high risk" in the ASPI's Defence Universities Tracker Database, plus one co-author from the department of computer science and electrical engineering at Jacobs University in Bremen, Germany.[33] Another recent anecdotal example concerns a renowned German climate research modeling scientist co-publishing with Chinese hydroacoustics researchers from a „high risk" background, while acknowledging having received state financing from Russia.[34] There are multiple similar cases where Western scientists were likely unaware of the military implications of their research.

The submarine-building shipyards of China in their turn conduct naval and commercial building simultaneously. Shipbuilding joint ventures with advanced shipbuilders, e.g. from Japan, France or South Korea, even in civilian commercial projects have in the past bolstered Chinese naval shipyards' technological and procedural skills, which ultimately led to China's technically upgraded and massively subsidized yards in 2018 surpassing even South Korea as the leading producer of commercial ships. Another factor is likely the goal to close technical bottlenecks in military shipbuilding via Military-Civil Fusion.[35] Bohai Shipbuilding Heavy Industry Company (BSHIC) shipyard in Huludao, the sole build yard for all nuclear-powered submarines, on a no longer accessible website in 2017 described itself as an "official research base" for "localizing (…) important technical equipment".[36]

Furthermore, as CSIS has pointed out, by attracting "billions of dollars of revenue and technology transfers from companies around the world", Chinese naval shipyards have benefited from significant shipbuilding technology upgrades, including modern design software, modular construction techniques, etc., and generated profits that may have been used to balance high costs of naval developments. "Between 2019 and 2021, four key Chinese dual-use shipyards received at least 211 orders for commercial vessels, 64 percent of which were placed by foreign companies—including companies based in Taiwan, France, Japan, and elsewhere".[37]

Table 1 in the appendix contains an inexhaustive listing of some of the most important design, R&D, and production entities engaged in producing systems needed for undersea warfare, many of them dual-use. Western research institutions and industries would likely benefit from a more comprehensive and publicly accessible database of known contributors to Chinese undersea warfare capabilities covering also civilian commercial and dual-use fields that also lists the various aliases of entities, as it can be particularly hard to identify risky partnerships and commercial dealings in such areas.[38] Looking only at entities engaged in the development of autonomous underwater vehicles (AUV), Ryan Fedasiuk reported in 2021 that a listing published in 2019 had 159 AUV projects catalogued at over 40 universities, when only 15 universities had been active in that field four years earlier; and another catalogue by a professor at Hebei University of Science and Technology listed 48 universities and 45 enterprises engaged in research on UUVs and AUVs.[39] According to Elsa Kania, an "Underwater Vehicle Intelligent Equipment Base" was established in Qingdao, "undertaking research and development, as well as the design and manufacture, for a range of marine robotics and engineering equipment, including the white Dolphin (白豚) autonomous underwater vehicle." By April 2018, Qingdao hosted the "first forum on military-civil fusion in the AI industry" convened by Harbin Engineering University, which discussed intelligent underwater robots, high-speed unmanned boats, smart ships, and target recognition."[40]

## 4. Chinese attempts to address obstacles through the acquisition of foreign technology

During the process of restructuring the state-owned defense sector from 1998/99 and subsequent organizational reforms, China has created an non-transparent system of cross-shareholdings between private, semi-private and larger state-owned entities in the defense sector. On the one hand this enables the Chinese government to channel funds from domestic state-owned banks (in the form of credit lines) and from domestic and foreign stockmarkets into the defense industries. The private and semi-private listed subsidiaries of state-owned entities furthermore provide avenues for joint ventures and M&A activities with foreign partners that can contribute technical expertise, technologies, or in some cases also things like procedural knowledge and market access in other countries.

Energy generation and high-density energy storage solutions are an especially critical area of submarine development that has, however, also multiple applications in purely civilian technologies. Chinese firms active in this dual-use field can used M&A to bolster overall Chinese competencies in this field. For instance, the privately-owned Wolong Group: 卧龙集团, China's largest maker of electrical motors, also makes among other products "custom electric motors for nuclear power plants" as well as generators, drives and other electrical systems for "naval and defense vessels" according to its official website, although the exact types of vessels are not elaborated on.[41] Its subsidiary Wolong Electric has taken over a variety of western makers of electrical motors, among them General Electric's small electrical motor section. And in Germany, the medium-sized special electric motor producer ATB Schorsch that also makes special electric motors for submarines,[42] was taken over 100% by Wolong in 2011. The sale was conducted on the German side in the hopes the Chinese buyer would invest into production and R&D facilities within Germany and bolster the firm's business. But instead, contrary to previous affirmations, as the head of the Works Council Olaf Caplan said in an interview in 2019, "Ultimately, it is about know-how transfer and the relocation of components and ultimately complete products to China." As he reports, ATB Schorsch's management in Germany reportedly had no longer any say, as the company became de facto run from China in a time-delayed and non-transparent manner. Caplan also noted quality issues in the now Chinese-produced products which according to him, had the potential to damage the brand's international standing.[43] According to Chinese news reports, Wolong's "production network is strategically located in Asia, Europe and North America. Wolong Electric has established R&D centers for motors and drive controls in Europe, the United States, and Japan, and plans to open a Global R&D Center in Shanghai.[44]

Licensed production within China of some key technologies, such as the above mentioned German MTU diesel engines or the French ASW helicopters has been another legal way to absorb technologies. China's first anti-submarine helicopter, the Z-8, was manufactured under a license agreement following an imported batch of the 12 SA 321 Super Frélon from France in the late 1977s.[45] The latest anti-submarine warfare helicopter, the Z-20F, has been introduced during the past 5 years and was developed based on the American Sikorsky H-60 Black Hawk, which had been legally imported by China before 1989.[46]

As to sonars, after a history of indigenous developments based on older Soviet models, more modern hull-mounted active/passive sonar technology was legally imported by China during the decade before 1989 from the US, via Italy (the Raytheon DE-1160); and hull-mounted passive sonar technology from France (the DSUV-22 and DUUX-5). After 1989, China gained access to a variety of modern Russian sonar technologies through the import of the Kilo class submarines as complete weapon systems. Based on these technologies, indigenous development took off.[47]

A notable case of recent R&D cooperation concerns ongoing and intense research collaboration between Chinese R&D institutions with miliary ties (including Harbin Engineering University) and Russian counterparts on hydroacoustics communication and fibre-optic hydrophone development in Arctic waters for use under the ice. So-called "China-Russia Polar Acoustic Symposiums" have been organized since at least mid-2019, involving over 100 experts from Russia and China from 30 military research facilities and companies, indicating a surprising openness on the part of Russia to collaboration with China in this highly sensitive field.[48] A related high-profile supposed espionage case notwithstanding, this points to an institutionalized rather than ad hoc collaboration.

Illegal methods used by China to obtain underwater warfare technologies include the copying or reverse-engineering of legally imported systems, likely also from Russia. As recently as 2019, the Chief of Russia's defence conglomerate Rostec went public with complaints of massive copyright infringement by China, mostly however concerning the aerospace sector.[49] In how far the same applies to submarine technologies is therefore not entirely clear. A cryptic announcement of a planned joint development of conventional submarines with Russia would point to a new level of mutual trust in this field, but was so far not elaborated further.[50] Previous rounds of direct support from the Russian Rubin design institute point to potentially deeper exchanges also in nuclear submarine design. Nonetheless, there were charges brought in Russia against researchers and officials for transferring sensitive submarine-related knowledge, e.g. in hydroacoustics, or even, particular materials to China in violation of state security regulations as recently as 2021. As one Russian news report from 2021 notes, "last summer in Vladivostok, customs officers noticed four containers prepared for shipment to China. According to the documents, 106 tonnes of ferrous metal scrap were inside. However, it quickly became clear that the bills of lading had been cheated - the containers contained high-strength steel obtained by cutting up the solid hull of a nuclear submarine. It is forbidden to export such metal because, firstly, it can be reused, and secondly, the composition of the metal itself is a secret."[51]

A rather high-level espionage case occurred at the NATO undersea research center in La Spezia (NATO CMRE), which is responsible for research on multistatic and networked anti-submarine warfare, when its deputy director, the Estonian scientist Tarmo Kouts, was recruited by Chinese intelligence in 2018. He was sentenced to 3 years in prison in 2021.[52] Due to a lack of public reporting on the case, no detailed implications can be drawn, other than China paying attention to the individuals leading multilateral efforts among allies in the underwater warfare field.

## 5. Dual-use technologies or research disciplines that overlap with undersea warfare

Ocean environmental monitoring in the context of climate change and other oceanographic research is a field with a lot of overlap to undersea warfare, even though scientists working in it may not even be aware of any military or dual-use implications, while many western governments actively fund related collaborative research projects with China in the interest of combating climate change. Projects like a "cloud platform for big data and artificial intelligence (AI) in ocean science'" that is operated by the Institute of Oceanology at the Chinese Academy of Sciences (IOCAS), however, have obvious usefulness for undersea warfare as well. According to a Chinese news report, the platform "acts as an information pool by integrating updated, wide spatio-temporal coverage range, open and shared oceanographic data" while including an "oceanographic data portal, an interactive analytics platform for large-scale data, an AI development service platform and application products of big data and AI." According to the report, there

are "353 sets of ship-based survey data available on the cloud platform, with 59 sets of moored observation data, six sets of remote sensing satellite data, more than 10 sets of reanalysis data products and internationally shared data, and 500 sets of integrated software for ocean and atmospheric sciences."[53] A 2020 paper by PLA researchers eloquently describes the foundational significance of all foundational oceanographic and marine environmental research for submarine warfare.[54]

In that regard, a related area where exchanges with Western firms may have inadvertently contributed to enhancing Chinese undersea warfare capabilities concerns deliveries of advanced multi-beam sonar equipment for surveying deep-sea geography. A 2021 Chinese research paper particularly lists multi-beam sonar equipment by the Norwegian firm Kongsberg MBS as the main survey instrument. According to the paper, this particular survey was carried out in the northeast and central part of the South China Sea and lead to vastly improved awareness of the geomorphological features of the seafloor in the surveyed area.[55] Another Western maker of comparable multi-beam sonar survey equipment, Teledyne RESON, is also on record as having delivered its most advanced echosounder equipment to Chinese recipients, including the Qingdao Institute of Marine Geology (QIMG) and the Guangzhou Marine Geological Survey (GMGS), who received the ParaSound „Sub-bottom Profiler" P70 3G-Mk2 with „upgraded hardware and updated software".[56] The Norwegian company Norbit, yet another maker of multibeam echosounding technology, has also supplied its equipment (the NORBIT-iWBMS bathymeter) to the First Institute of Oceanography and the Key Laboratory of Ocean Geomatics under the Ministry of Natural Resources in Qingdao, where it was used alongside the Teledyne SeaBat T50-P multibeam echosounder to evaluate seafloor mapping software in a 2022 study.[57] The same echosounder was described its maker in a 2018 news release as a "key component to the (Chinese) Yun Zhou Tech M80B unmanned surface vessel", which was "recently deployed in Antartica on the Chinese Polar Research Vessel Xue Long (Snow Dragon)" where it successfully surveyed 5 square kilometres in the waters of Antartica."[58] This likely refers to the Xue Long's November 2017 Antarctic expedition. The Chinese USV on which Teledyne's multibeam echosounder was deployed, the M80B USV, was jointly developed by the PLA's Naval Surveying and Mapping Research Institute; the State Oceanic Administration's South China Sea Survey Technology Center, and Yunzhou Tech, as per Elsa Kania's testimony before the USCC on June 7, 2019.[59]

## 6. Reliance on foreign sources for the materials and technologies and chokepoints the United States or allies could leverage to degrade the PLA's military capabilities during a conflict

In the openly accessible literature, there is no sufficient data on the Chinese stockpiles of critical materials within China that would be needed to answer the question of chokepoints that could be leveraged.[60] In the area of lithium-ion battery production, the Chinese technical literature does note that there could be supply chain vulnerabilities concerning nickel and cobalt, and recommends an iron and phosphate variant of lithium-ion battery technology to avoid the risk of becoming dependent on imports for the latter.[61]

Some critical materials can likely be accessed by China with help from Russia. On December 12, 2022, the Russian state-owned Rosatom Corp. supplied 6,477 kilograms of highly-enriched uranium (HEU) to China's fast-breeder reactor CFR-600 on Changbiao Island. The weapons-grade plutonium this breeder will produce could be used for nuclear warheads, but alternatively, commentators have also discussed the possibility that it could also be intended as fuel for future nuclear-powered submarines – currently, Chinese submarines are however thought to rely on low enriched uranium (LEU) as fuel.[62]

## 7. Recommendations for Congressional action

As anecdotal evidence of technology transfers in dual-use areas conducive to underwater warfare development shows, industry needs clearer guidelines and likely, also more assistance on how to identify technologies that may not be obviously dual-use, but may nonetheless be critical or difficult to produce components that enable significant undersea warfare capability gains in a potential adversary.

Western research institutions and industries would in particular benefit from a comprehensive and publicly accessible database of known contributing entities to Chinese undersea warfare capabilities covering also civilian commercial and dual-use fields, that also lists their various aliases and cross-shareholdings, as it can be particularly hard to identify risky partnerships and commercial dealings in such areas. The existing "Chinese Defence Universities Tracker" database by the Australian ASPI institute[63] is a good start, as it covers R&D institutions well, but not necessarily business entities.

Cross-sectoral learning processes might be furthered through workshops targeting industry executives at various levels, in which intelligence and law enforcement personnel could lead "post mortems" of various types of real-world case studies where export controls in the underwater warfare domain have failed to be adhered to for various reasons, or where no export controls existed in the first place. Raising awareness for national security concerns and enhancing knowledge of tech acquisition approaches should be a goal targeting in particular those responsible for day-to-day business relations, as technology transfer approaches and business activities constantly evolve and cannot be well addressed by a cookie-cutter approach.

Likewise, the awareness level of civilian researchers in fields that are critical for generating oceanographic data needed for submarine warfare - even though that may not be obvious to many researchers – should be enhanced in order to focus their attention to security-related issues and gain their cooperation. As an example on how this could be done, the Finnish approach to enhancing overall societal preparedness for crises via a system of "national defence courses" targeting key executive personnel across all sectors of society might be a structural model for such an initiative, even though the goal in this case would not be general societal preparedness for national security crises as in Finland, but rather, awareness of interconnections between national security and various industrial products and sectors. The Finnish course system is credited as being an effective tool contributing to a high level of security awareness across all sectors of society.[64]

Cyber espionage, though not discussed in this testimony, is a pervasive threat facing researchers across many disciplines, and where that is not yet the case, for instance in many underfunded universities across the Western world, the cyber security of research facilities should be enhanced by making it mandatory for institutions to implement a minimum of cyber security measures that are standard in industry, such as 2FA for E-mail, and assistance by the security services should proactively be offered to bolster the cyber security of individual researchers and research facilities, e.g. through group trainings or the like.

# Appendix

**Figure 1: Approximate Type and Age structure of the Chinese nuclear submarine fleet**

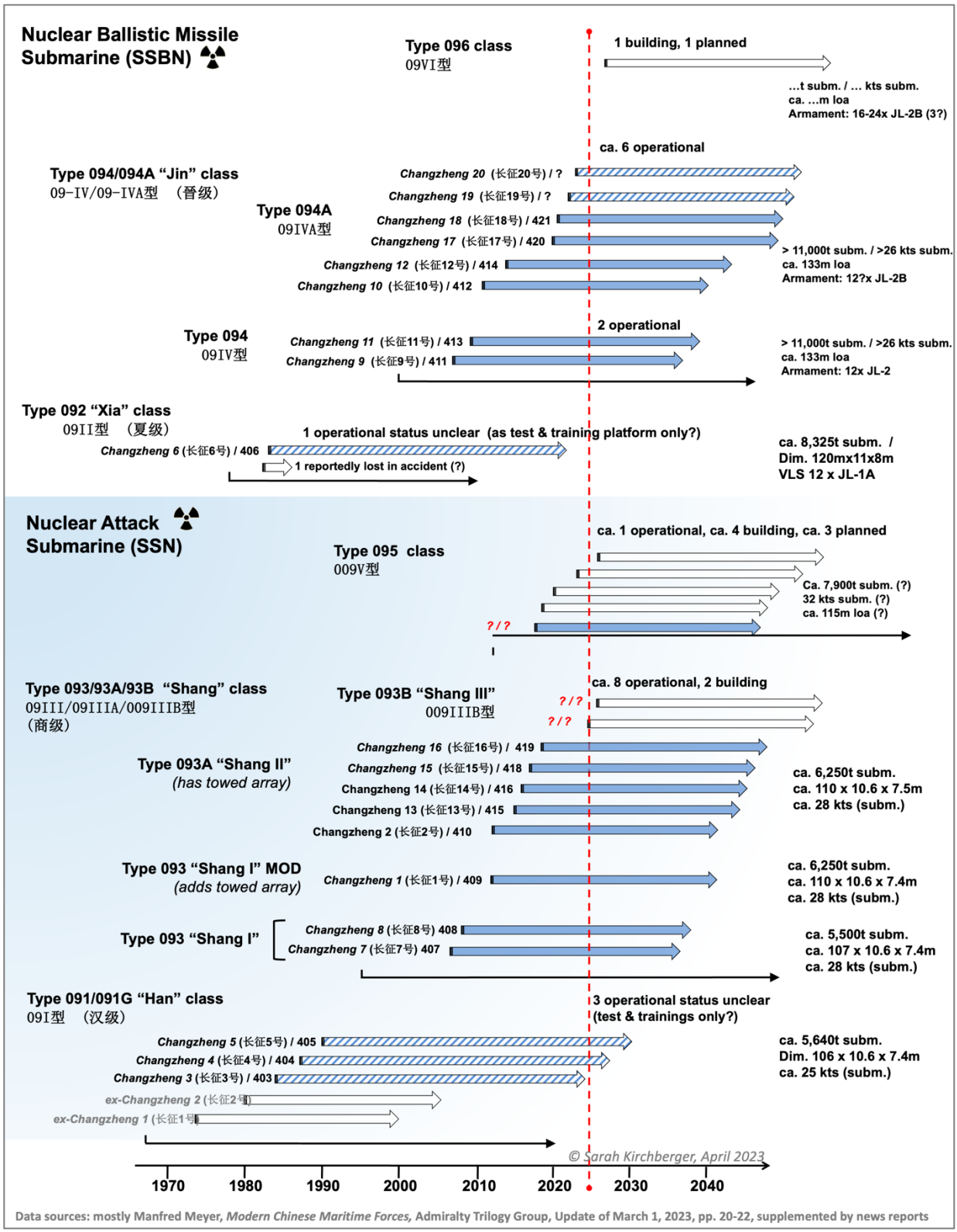
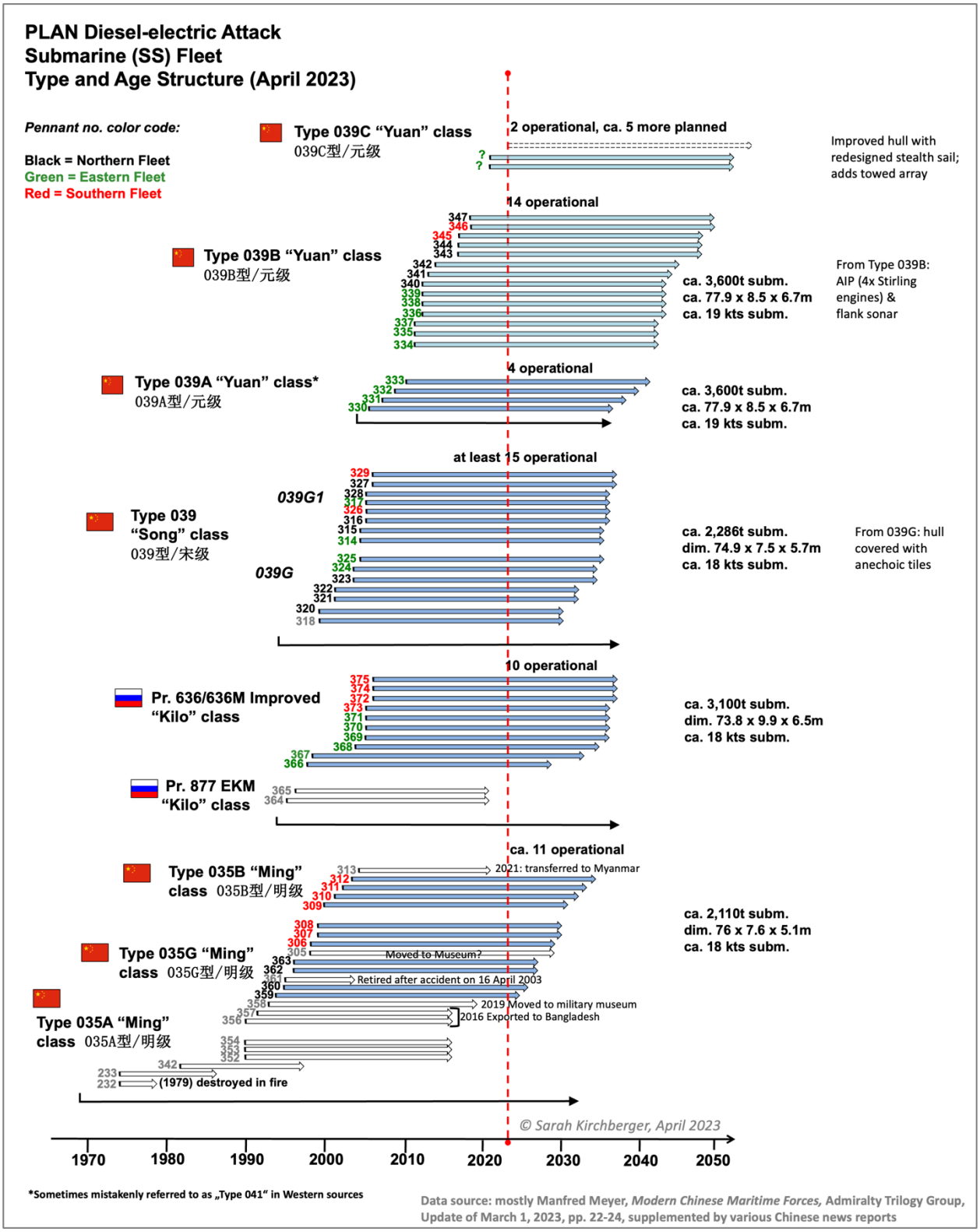


**Figure 2: Approximate Type and Age Structure of the Chinese Conventional Attack Submarine Fleet**



## Table 1: Selected Organizations Contributing to Chinese Submarine Warfare

*On the US Entity List; **Newly added to US Entity List in Dec. 2020; + Apparently not on the US entity list.

| Business area | Enterprise or unit | | Related military business |
|---|---|---|---|
| | Short Name | Full name / Alias | |
| General submarine design, ship hull development, and construction | 701st Research Institute** 七〇一所 | China Ship Design and Research Center** 中国舰船研究设计中心 | The only general research & design unit in China that develops small and medium-sized submarines. Has national defense key laboratory for electromagnetic compatibility and acoustic stealth technology. Also active in marine dynamic environment monitoring buoys etc. |
| | 719th Research Institute 七一九所 | Wuhan Second Ship Design Research Institute 武汉第二船舶设计研究所 | The only overall design institute for nuclear-powered ships in China, develops all nuclear-powered submarines including reactors. |
| | 702nd Research Institute* 七〇二所 | China Ship Scientific Research Center (CSSRC)* 中国船舶科学研究中心 | Applied basic research of hydrodynamics, structural mechanics and vibration, noise, impact resistance and other related technologies in ship and ocean engineering, as well as research, design and development of high-performance ship and underwater engineering |
| | 725th Research Institute* 七二五所 | Luoyang Institute of Ship Materials* 洛阳船舶材料研究所 | Development of ship materials and engineering application research. Has 4 seaport test stations |
| | 11th Research Institute+ 一一所 | Shipbuilding Technology Research Institute (STRI)+ 上海船舶工艺研究所 上 | Research on shipbuilding technology and marine engineering; R&D on hull welding technology and equipment; large-scale CNC cutting and automation equipment production lines; coating technology and equipment; application and process R&D of marine non-metallic materials; development of shipbuilding software systems and information technology integration platforms; non-destructive testing of metal materials, technical testing of non-metallic materials |
| | (formerly: Bohai Shipyard)+ | Bohai Shipbuilding Heavy Industry Co., Ltd. (BSHIC) 渤海船舶重工有限责任公司 | Constructs all nuclear-powered submarines |
| | 438 Factory+ | Wuchang Shipbuilding Industry Group Co. Ltd. 武昌船舶重工集团有限公司 | Main shipyard for building conventionally-powered submarines |
| | Jiangnan Changxing+ | Jiangnan Shipyard (Group) Co., Ltd. 江南造船（集团）有限责任公司 | Secondary shipyard for building conventional subs |
| Propulsion | 711th Research Institute* 七一一所 | Shanghai Marine Diesel Engine Research Institute (SMDERI) 上海船用柴油机研究所 | Main research institution for conventional submarine power systems. Has developed power systems for multiple types of submarines, including Stirling AIP systems |
| | Micro Powers+ | Shanghai Qiyao Power Technology, Ltd. (上海齐耀动力技术有限公司) | Maker of the Stirling AIP system for conventional submarines; a wholly-owned subsidiary of the 711th Research Institute. |

| | | | |
|---|---|---|---|
| | / | Shaanxi Diesel Engine Heavy Industry, Co. Ltd. (陕西柴油机重工有限公司)+ | Licencse-producer of German MTU 396-series marine diesel engines for submarines. |
| | (719th Research Institute 七一九所 – see above – develops all nuclear propulsion plants) | | |
| **Detection and Countermeasures 探测与对抗** | 7th Research Academy 七院** | China Naval Research Institute** 中国舰船研究院 | Research and design of submarine and ship-borne weapons and equipment |
| | / | Haiying Enterprise Group Co., Ltd.+ 海鹰企业集团有限责任公司 | China's first underwater acoustic equipment manufacturer. Hydroacoustic equipment, marine engineering special equipment and other special equipment, diving and underwater salvage equipment, navigation, meteorological and marine special instruments and meters |
| | 715th Research Institute** 七一五所 | Hangzhou Institute of Applied Acoustics** 杭州应用声学研究所 | Develops acoustic, optical and magnetic detection equipment. Has key laboratory of sonar technology, a first-level hydroacoustic measurement station, an underwater acoustic product testing center, and a second-level radio measurement station. |
| | / | Haisheng Technology Co., Ltd.+ 海声科技公司 | Underwater acoustic detection, navigation, rescue, and underwater security. and underwater acoustic transducers; a subsidiary of 715th RI |
| | 716th Research Institute** 七一六所 | Jiangsu Institute of Automation** 江苏自动化研究所 | Engaged in the research and development of electronic information transmission systems, etc. |
| | 726th Research Institute** 七二六所 | Shanghai Ship Electronic Equipment Research Institute** 上海船舶电子设备研究所 | R&D of underwater acoustic countermeasures and anti-countermeasure systems, underwater acoustic navigation and marine development application instruments and equipment |
| | 723rd Research Institute** 七二三所 | Yangzhou Marine Electronic Instrument Research Institute** 扬州船用电子仪器研究所 | Engaged in the development of electronic engineering systems and equipment |
| | 704th Research Institute** 七零四所 | Shanghai Marine Equipment Research Institute (SMERI)** 上海船舶设备研究所 | Application research of special auxiliary electromechanical equipment and systems for ships; vibration reduction and degaussing |
| | 368 Factory+ 三六八厂 | Hebei Hanguang Heavy Industry Ltd.+ 河北汉光重工有限责任公司 | It has key experimental facilities such as anechoic pools, and is a key research and development base for national underwater weapons. |
| | 662 Factory+ 六六二厂 | Chongqing Qianwei Technologies Group Co. Ltd.+ 重庆前卫科技集团有限公司 | Integrating information technology, computing technology, and automatic control, research direction is command and control system technology and high-performance computer system technology |
| **Command, Control and Computers 指挥控制与计算机** | 709th Research Institute** 七〇九所 | Wuhan Digital Engineering Institute** 武汉数字工程研究所 | Integrating information technology, computing technology, and automatic control, the research direction is command & control system technology and high-performance computer system technology |
| | 724th Research Institute** 七二四所 | Nanjing Ship Radar Research Institute** 南京船舶雷达研究所 | Engaged in the development and production of large-scale device data detection and intelligent systems such as ship radar systems |
| | / | Institute of Acoustics (IOA) at the Chinese Academy of Sciences (CAS) 中科院声学研究所 | Engaged in research on AI in command & control systems aboard submarines (intelligent support for sub commanders) |

| | | | |
|---|---|---|---|
| | 5th Research Institute<br>五所 /<br>Academy of Systems<br>系统院* | CSSC Systems Engineering Research Institute*<br>中国船舶工业系统工程研究院 | Ship combat command system, formation command system, joint combat command system, aircraft carrier aircraft automatic landing system |
| **Navigation and Communication<br>导航与通信** | 707th Research Institute**<br>七〇七所 | Tianjin Navigational Instrument Research Institute**<br>天津航海仪器研究所 | Technology research and equipment supply in inertial navigation, ship control systems, and hardened computers |
| | 722th Research Institute*<br>七二二所 | Wuhan Ship Communication Research Institute*<br>武汉船舶通信研究所 | R&D and manufacturing of communication electronic engineering, such as integrated data communication systems, broadband high-speed data transmission, high-frequency adaptive instantaneous communication systems, high-speed optical fiber integrated service transmission networks, special antennae, information security equipment, communication control and distribution, ship internal communication systems |
| | 717th Research Institute**<br>七一七所 | Huazhong Photoelectric Technology Research Institute **<br>华中光电技术研究所 | Engaged in photoelectric detection information processing and photoelectric system integration, astronomical navigation and inertial navigation |
| | 453 Factory<br>四五三厂+ | Chongqing Huayu Electric Group Co., Ltd+<br>重庆华渝电气集团有限公司 | Marine instrumentation, equipment and supporting products, inertial navigation, positioning and orientation devices |
| | 455 Factory<br>四五五厂+ | Changjiang Technology Co., Ltd+.<br>长江科技有限公司 | R&D and production of communication, navigation, positioning and orientation equipment |
| | / | Xi'an Dongyi Technology Group Co., Ltd.+<br>西安东仪科工集团有限公司 | Underwater acoustic testing, inertial navigation systems, radio assembly % debugging, reliability testing |
| | China Haiphong<br>中国海防+ | CSSC China Marine Information Electronics Company Ltd.+<br>中国舰船重工集团海洋防务与信息对抗股份有限公司 | R&D, production and manufacturing in information electronics, including underwater information transmission equipment, special equipment for underwater weapon systems and other special equipment, series of special marine power supply products, etc.) and testing and testing services |
| | / | Chongqing Qingping Machinery Co., Ltd.+<br>重庆清平机械有限责任公司 | Manufacture of special instruments for navigation, meteorology and oceanography; also special precision equipment for gear production and gear testing; high-precision special gears and gearboxes |

*Sources: 浙商证券有限公司 Zheshang Securities 2021: 舰船水声防务龙头,内生外延双轮驱动—中国海防深度报告 [A leader in naval hydroacoustic defense, on a two-wheel drive from domestic origins to outward-looking expansion - In-depth report about CSSC China Marine Information Electronics Company Ltd. / China Haiphong]. Hangzhou, 7 February 2021, p. 30; supplemented with company information from various company websites and job adverts.*

# Endnotes

[1] Cf. 樊旭艳 FAN Xu-yan, 何锡玉 HE Xi-yu, 杨亮 YANG Liang and 王叶 WANG Ye, "海洋遥感在军事海洋环境保障中的应用研究 (Research on application of ocean remote sensing in military marine)", *海军工程大学学报 (Journal of Naval University of Engineering)* Vol 17, No. 3 (Sept. 2020), 39-42. DOI: 10.13678/j.cnki.issn1674-5531.2020.03.009

[2] Attack Submarines – SSN, https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/article/2169558/attack-submarines-ssn/

[3] ONI, A Modern Navy with Chinese Characteristics, August 2009, https://irp.fas.org/agency/oni/pla-navy.pdf, p. 22.

[4] Manfred Meyer, *Modern Chinese Maritime Forces,* Admiralty Trilogy Group, Update of March 1, 2023, p. 21

[5] Christian Conroy, "China's Ballistic-Missile Submarines: How Dangerous?", *The National Interest,* November 18, 2013, https://nationalinterest.org/commentary/chinas-ballistic-missile-submarines-how-dangerous-9414.

[6] "JL-3 Missile to Change China's Emphasis of Nuclear Triad", *China-Arms,* June 24, 2019, https://web.archive.org/web/20230323111129/https://www.china-arms.com/2019/06/jl-3-missile-to-change-chinas-emphasis-of-nuclear-triad/

[7] Manfred Meyer, *Modern Chinese Maritime Forces,* p. 20

[8] Jamie Seidel, "'Highly unusual event': Chinese nuclear sub in 'embarrassing' South China Sea incident", *News.com.au*, October 17, 2019, https://www.news.com.au/world/asia/highly-unusual-event-chinese-nuclear-sub-in-embarrassing-south-china-sea-incident/news-story/650d17f451e27338e912f4b072cfcb02.

[9] See e.g. 叶礼裕 YE Liyu, 王超 WANG Chao, 郭春雨 GUO Chunyu, and 常欣 CHANG Xin, "潜艇破冰上浮近场动力学模型 (Peridynamic model for submarine surfacing through ice)", *中国舰船研究 (Chinese Journal of Ship Research)* 2018, 13(2), 51-59; YE Liyu 叶礼裕, WANG Chao 王超, CHANG Xin 常欣, ZHANG Hongyu 张洪雨, "冰桨接触的近场动力学模型 (Peridynamic model for propeller-ice contact)", *哈尔滨工程大学学报 (Journal of Harbin Engineering University),* 2018, 39(2): 222-228; and 黄加强 Huang Jiaqiang, 北极航行对潜艇航行性能影响研究 ["Research on Submarine Navigation in the Arctic"], *舰船电子工程* [*Ship Electronic Engineering*], Vol. 40, No. 9 (September 2020), 62-66.

[10] James Bussert and Bruce A. Elleman, *People's Liberation Army Navy Combat Systems Technology, 1949-2010*, Annapolis: Naval Institute Press 2011, p. 33

[11] Cf. 张严 ZHANG Yan, 武志东 WU Zhidong, and 张玉玲 ZHANG Yuling, "美英潜艇指控系统发展历程及启示 (Development of US and British Submarine Command Systems and Enlightenment)", *数字海洋与水下攻防 (Digital Ocean & Underwater Warfare)* 2022(06), 553-558. doi:10.19838/j.issn.2096-5753.2022.06.010; 王峰 WANG Feng, 张栋 ZHANG Dong & 孙飞龙 SONG Feilong, "锂离子电池装备于常规潜艇可行性分析 (Feasibility Analysis of Lithium-ion Batteries in Conventional Submarine)", 船电技术 (Marine Electric & Electronic Engineering) Vol.42 No.10 (2022.10), DOI:10.13632/j.meee.2022.10.004, pp. 152-155.

[12]美日潜艇的噩梦将到来 中国 20 亿巨资打造海底观测网 [The nightmare of American and Japanese submarines is coming, China has invested heavily in 2 billion to build a submarine observation network], *Sina.cn*, 31 May 2017, https://jmqmil.sina.cn/wqzb/doc-ifyfqvmh9628274.d.html

[13] 樊旭艳 FAN Xu-yan, 何锡玉 HE Xi-yu, 杨亮 YANG Liang and 王叶 WANG Ye, "海洋遥感在军事海洋环境保障中的应用研究 (Research on application of ocean remote sensing in military marine)", *海军工程大学学报 (Journal of Naval University of Engineering)* Vol 17, No. 3 (Sept. 2020), 39-42. DOI: 10.13678/j.cnki.issn1674-5531.2020.03.009

[14] 王峰 WANG Feng, 张栋 ZHANG Dong & 孙飞龙 SONG Feilong, "锂离子电池装备于常规潜艇可行性分析 (Feasibility Analysis of Lithium-ion Batteries in Conventional Submarine)", 船电技术 (Marine Electric & Electronic Engineering) Vol.42 No.10 (2022.10), DOI:10.13632/j.meee.2022.10.004, pp. 152-155.

[15] Richard D. Fisher, Jr., "The Impact of Foreign Technology on China's Submarine Force and Operations", in Andrew S. Erickson, Lyle J. Goldstein, William S. Murray, and Andrew R. Wilson (eds.), *China's Future Nuclear Submarine Force* (Annapolis: Naval Institute Press 2007), 135; Евгений Даманцев (Evgeny Damantsev), "Допрыгались! 7-й флот ВМС США попадёт на мушку уникальной модификации «Палтуса» [You've had it! US

7th Fleet hits the target of a unique modification of the Project 877 Paltus]", *Военное обозрение [Military Review],* September 18, 2018, https://topwar.ru/147131-doprygalis-7-j-flot-vms-ssha-popadet-na-mushku-unikalnoj-modifikacii-paltusa.html

[16] Евгений Даманцев (Evgeny Damantsev), "Операция НОАК по выдворению ВМС США из Южно-Китайского моря. Детали «Бьендонгской зоны A2/AD» - часть 2 [PLA operation to expel the US Navy from the South China Sea. Details of the Bien Dong A2/AD Zone - Part 2]", *Военное обозрение [Military Review],* July 5, 2017, https://web.archive.org/web/20230326165817/https://topwar.ru/119466-operaciya-noak-po-vydvoreniyu-vms-ssha-iz-yuzhno-kitayskogo-morya-detali-bendongskoy-zony-a2-ad-chast-2.html, transl. O. Husieva.

[17] 马宏伟 MA Hongwei, *走向深蓝的中国海军 [The Chinese Navy on the Way Towards Deep Blue],* 我们的军队系列丛书 [Series: Our Military], Shanghai: Fudan University Press 2020, 169-170.

[18] "JL-3 Missile to Change China's Emphasis of Nuclear Triad", *China-Arms,* June 24, 2019, https://web.archive.org/web/20230323111129/https://www.china-arms.com/2019/06/jl-3-missile-to-change-chinas-emphasis-of-nuclear-triad/.

[19] 马宏伟, *走向深蓝的中国海军,*160-170.

[20] Caleb Larson, "Russia and China Want To Build a Non-nuclear Submarine Together", *The National Interest,* August 28, 2020, https://nationalinterest.org/print/blog/buzz/russia-and-china-want-build-non-nuclear-submarine-together-167911

[21] Frank Jüris, "Sino-Russian Scientific Cooperation in the Arctic: From Deep Sea to Deep Space", in Sarah Kirchberger, Svenja Sinjen, and Nils Wörmer (eds.), *Russia-China Relations: Emerging Alliance or Eternal Rivals?* (Springer: Cham 2022), 185-202, https://doi.org/10.1007/978-3-030-97012-3_10, pp. 189-90 and 192-195.

[22] Ryan D. Martinson and Peter A. Dutton, "China Maritime Report No. 3: China's Distant-Ocean Survey Activities: Implications for U.S. National Security" (2018). CMSI China Maritime Reports. 3. https://digital-commons.usnwc.edu/cmsi-maritime-reports/3

[23] Stephen Chen, "Is China's latest space mission a step towards PLA tracking of nuclear submarines?", *South China Morning Post,* updated June 12, 2017, http://www.scmp.com/news/china/diplomacy-defence/article/2028686/chinas-latest-space-mission-step-towards-pla-tracking

[24] John Pomfret, "Chinese Submarine Accident Kills 70", *Washington Post,* May 3, 2003, https://www.washingtonpost.com/archive/politics/2003/05/03/chinese-submarine-accident-kills-70/755b8587-e1b2-4eba-a1fc-e88e4eb9c016/

[25] 王峰 WANG Feng, 张栋 ZHANG Dong & 孙飞龙 SONG Feilong, "锂离子电池装备于常规潜艇可行性分析 (Feasibility Analysis of Lithium-ion Batteries in Conventional Submarine)", 船电技术 (Marine Electric & Electronic Engineering) Vol.42 No.10 (2022.10), DOI:10.13632/j.meee.2022.10.004, pp. 152-155.

[26] Sebastian Strangio, "Thailand's Navy Chief Says Country Could Cancel Chinese Sub Contract", *The Diplomat,* November 23, 2022, https://thediplomat.com/2022/11/thailands-navy-chief-says-country-could-cancel-chinese-sub-contract/; "Wuhan trip to clear engine doubts", *Bangkok Post,* updated January 31, 2023, https://www.bangkokpost.com/thailand/special-reports/2494147/wuhan-trip-to-clear-engine-doubts.

[27] Interview on March 21, 2023.

[28] Pollpeter, Kevin and Mark Stokes. 2016. China's Military Shipbuilding Research, Development, and Acquisition System. In Andrew S. Erickson (ed.), *Chinese Naval Shipbuilding: An Ambitious and Uncertain Course,* pp.177-188. Annapolis: US Naval Institute, p. 178

[29] Ryan Fedasiuk, How China is Militarizing Autonomous Underwater Vehicle Technology, Maritime Executive, August 22, 2021, https://maritime-executive.com/editorials/how-china-is-militarizing-autonomous-underwater-vehicle-technology; Jeff Pao, "China's secret plan to become tech self-sufficient", *Asia Times,* Nov. 24, 2021, https://asiatimes.com/2021/11/chinas-secret-plan-to-become-tech-self-sufficient/

[30] 浙商证券有限公司 Zheshang Securities Co. Ltd., "舰船水声防务龙头,内生外延双轮驱动—中国海防深度报告 [A leader in naval hydroacoustic defense, on a two-wheel drive from domestic origins to outward-looking expansion - In-depth report about CSSC China Marine Information Electronics Company Ltd. / China Haiphong]". Hangzhou: Zheshang Securities (https://www.stocke.com.cn/), February 7, 2021, https://pdf.dfcfw.com/pdf/H3_AP202202081545678276_1.pdf?1644326407000.pdf, p. 23.

[31] For a detailed breakdown of the various legal, illegal, and extralegal strategies employed see: William C. Hannas and Huey-Meei Chang, "Chinese Technology Transfer – An Introduction", in: W.C. Hannas and Didi K. Tatlow (eds.), *China's Quest for Foreign Technology: Beyond Espionage* (N.Y.: Routledge 2021), 3-20.
[32] 浙商证券有限公司 Zheshang Securities Co. Ltd., "舰船水声防务龙头,内生外延双轮驱动—中国海防深度报告 [A leader in naval hydroacoustic defense, on a two-wheel drive from domestic origins to outward-looking expansion - In-depth report about CSSC China Marine Information Electronics Company Ltd. / China Haiphong]". Hangzhou: Zheshang Securities (https://www.stocke.com.cn/), February 7, 2021, https://pdf.dfcfw.com/pdf/H3_AP202202081545678276_1.pdf?1644326407000.pdf; automatic translation from China Haiphong website, http://www.cmie.csic.com.cn/n405/n414/index.html
[33] Cf. Caoyang Yu et al., "Onboard System of Hybrid Underwater Robotic Vehicles: Integrated Software Architecture and Control Algorithm," Ocean Engineering, 187, 106121, September 2019, https://doi.org/10.1016/j.oceaneng.2019.106121. The affiliations listed include the School of Naval Architecture and Ocean Engineering, Huazhong University of Science and Technology, Wuhan; HUST institute; and Shanghai Jiaotong University's School of Oceanography, all listed as "high risk" at ASPI's Defence Universities Tracker, see https://unitracker.aspi.org.au/universities/huazhong-university-of-science-and-technology/; https://unitracker.aspi.org.au/universities/shanghai-jiaotong-university/.
[34] Cf. Yao Haiyang, Wang Haiyan, Zhang Zhichen, Xu Yong, Juergen Kurths, A stochastic nonlinear differential propagation model for underwater acoustic propagation: Theory and solution, Chaos, Solitons & Fractals, Volume 150, 2021, 111105, ISSN 0960-0779, https://doi.org/10.1016/j.chaos.2021.111105, available at https://www.sciencedirect.com/science/article/pii/S0960077921004598
[35] "How is China Modernizing its Navy?" CSIS China Power Project, December 17, 2018. Updated April 20, 2022. https://chinapower.csis.org/china-naval-modernization/.
[36] See: https://web.archive.org/web/20170420112250/http://www.bsic.com.cn/Home/CorpSummary. BSHIC's official website, bsic.com.cn, as it is still listed on its holding conglomerate CSSC's website directory (http://www.cssc.net.cn/n11/index.html), seems to have been offline for years, while a hypothetical "bshic.com.cn" does not exist either.
[37] "How is China Modernizing its Navy?" CSIS China Power Project, December 17, 2018. Updated April 20, 2022. https://chinapower.csis.org/china-naval-modernization/.
[38] A recent overview of China's defense laboratory system by the Air University is very useful, but does not allow for easy screening of submarine warfare-related research entities in particular. See: https://www.airuniversity.af.edu/CASI/Display/Article/2987660/the-prc-state-defense-laboratory-system/. The same is true for most overviews of entities active in the defence sector.
[39] Ryan Fedasiuk, How China is Militarizing Autonomous Underwater Vehicle Technology, Maritime Executive, August 22, 2021, https://maritime-executive.com/editorials/how-china-is-militarizing-autonomous-underwater-vehicle-technology
[40] Elsa Kania, "Chinese Military Innovation in Artificial Intelligence", Testimony before the U.S.-China Economic and Security Review Commission Hearing on Trade, Technology, and Military-Civil Fusion on June 7th, 2019, https://www.uscc.gov/sites/default/files/June%207%20Hearing_Panel%201_Elsa%20Kania_Chinese%20Military%20Innovation%20in%20Artificial%20Intelligence_0.pdf, 25.
[41] See Wolong company homepages https://www.wolong-electric.com/application/details/80/78.html and https://www.wolong-electric.com/application/details/84/52.html (accessed April 4, 2023).
[42] See ATB Schorsch homepage at http://www.atb-motors.com/EN/Markets/Marine/Marine.aspx (accessed April 4, 2023).
[43] "Wie chinesische Investoren ATB Schorch runterwirtschaften" [How Chinese Investors Are Running Down ATB Schorsch], Factory, August 6, 2019, https://factorynet.at/artikel/wie-chinesische-investoren-atb-schorch-runterwirtschaften/
[44] "China's largest electric motor producer Wolong acquires GE's small industrial motor division", *Xinhua,* July 1, 2018, http://www.china.org.cn/china/2018-07/01/content_54278757.htm
[45] Thomas Newdick, "Watch This Chinese Z-8 Naval Helicopter Fly Just Feet Off The Ground Along A Highway", The Drive, December 17, 2020, https://www.thedrive.com/the-war-zone/38235/watch-this-chinese-z-8-naval-helicopter-fly-just-feet-off-the-ground-along-a-highway; "Helicopters I", Chinese Military Aviation Blog, http://chinese-military-aviation.blogspot.com/p/helicopters-i.html

[46] Tyler Rogoway, "Here Is Our First Clear Look At China's Z-20F Seahawk Helicopter Clone (Updated)", The Drive, October 14, 2019, https://www.thedrive.com/the-war-zone/30404/here-is-our-first-clear-look-at-chinas-z-20f-its-seahawk-helicopter-clone; https://www.thedrive.com/the-war-zone/38680/this-is-our-best-look-yet-at-chinas-z-20f-seahawk-clone-toting-air-to-ground-missiles

[47] JK Achuthan, "Advances made by China in the Field of ASW Sonar Systems", Indian Defence Review, November 22, 2021, http://www.indiandefencereview.com/news/advances-made-by-china-in-the-field-of-asw-sonar-systems/

[48] For further detail on the involved organizations, see Frank Jüris, "Sino-Russian Scientific Cooperation in the Arctic: From Deep Sea to Deep Space", in Sarah Kirchberger, Svenja Sinjen, and Nils Wörmer (eds.), *Russia-China Relations: Emerging Alliance or Eternal Rivals?* (Springer: Cham 2022), 185-202, https://doi.org/10.1007/978-3-030-97012-3_10, pp. 189-90 and 192-195.

[49] "Furious Russia Blasts China Over Unauthorized Copying Of Russian Military Hardware", *Eurasian Times,* December 23, 2019, https://eurasiantimes.com/furious-russia-blasts-china-over-unauthorized-copying-of-russian-military-hardware/

[50] Caleb Larson, "Russia and China Want To Build a Non-nuclear Submarine Together", *The National Interest,* August 28, 2020, https://nationalinterest.org/print/blog/buzz/russia-and-china-want-build-non-nuclear-submarine-together-167911

[51] Дмитрий Злобин [Dmitry Zlobin], Дракон «шакалит». Китай шпионит в России, вывозя военные секреты и технологии [Dragon is «jackaling». China spies on Russia, exporting military secrets and technology], Наша версия [Nasha Versiya / Our Version] No.5, February 8, 2021, https://web.archive.org/web/20211230035202/https://versia.ru/kitaj-shpionit-v-rossii-vyvozya-voennye-sekrety-i-texnologii (transl. Olha Husieva)

[52] Holger Stark, „Estonian Spy Scandal Shakes NATO and EU", Der Spiegel, November 17, 2008, https://www.spiegel.de/international/europe/western-secrets-for-moscow-estonian-spy-scandal-shakes-nato-and-eu-a-590891.html

[53] "China's cloud platform in ocean science starts operation", *Xinhua*, April 22, 2021, https://web.archive.org/web/20230326014656/http://en.people.cn/n3/2021/0422/c90000-9842451.html

[54] Cf. 樊旭艳 FAN Xu-yan, 何锡玉 HE Xi-yu, 杨亮 YANG Liang and 王叶 WANG Ye, "海洋遥感在军事海洋环境保障中的应用研究 (Research on application of ocean remote sensing in military marine)", *海军工程大学学报 (Journal of Naval University of Engineering)* Vol 17, No. 3 (Sept. 2020), 39-42. DOI: 10.13678/j.cnki.issn1674-5531.2020.03.009

[55] Ou, Xiaolin, Junjiang Zhu, Sanzhong Li, Yonggang Jia, Zhongjia Jia, Shengsheng Zhang, Shaoyu Zhang, Ruixue Chen, Xingquan Chen, Dong Ding, Huilin Xing, Yanhui Suo, Pengcheng Wang, and Yongjiang Liu. 2021. "Submarine Geomorphological Features and Their Origins Analyzed from Multibeam Bathymetry Data in the South China Sea" *Journal of Marine Science and Engineering* 9, no. 12: 1419. https://doi.org/10.3390/jmse9121419

[56] "Teledyne SeaBat T50-P Successfully Demonstrated at Chinese User Conference", Teledyne RESON website, 22 November 2016, http://www.teledyne-reson.com/news/teledyne-seabat-t50p-successfully-demonstrated-chinese-user-conference/; Accessed via Google cache 6 August 2017.

[57] Dong, Zhipeng, Yanxiong Liu, Long Yang, Yikai Feng, Jisheng Ding, and Fengbiao Jiang. 2022. "Artificial Reef Detection Method for Multibeam Sonar Imagery Based on Convolutional Neural Networks" *Remote Sensing* 14, no. 18: 4610. https://doi.org/10.3390/rs14184610

[58] "Antartica Survey with T50-P Installed on the Yun Zhou Tech M80B USV", Teledyne News, 14 January 2018, archived version: https://web.archive.org/web/20230324200828/http://www.teledynemarine.com/news/antartica-survey-with-t50p-installed-on-the-yun-zhou-tech-m80b-usv

[59] Elsa Kania, "Chinese Military Innovation in Artificial Intelligence", Testimony before the U.S.-China Economic and Security Review Commission Hearing on Trade, Technology, and Military-Civil Fusion on June 7th, 2019, *https://www.uscc.gov/sites/default/files/June%207%20Hearing_Panel%201_Elsa%20Kania_Chinese%20Military%20Innovation%20in%20Artificial%20Intelligence_0.pdf*, p. 20.

[60] Cortney Weinbaum et al., Assessing Systemic Strengths and Vulnerabilities of China's Defense Industrial Base, RAND, February 11, 2022, https://www.rand.org/pubs/research_reports/RRA930-1.html, pp. 7-8.

[61] Baba Tamim, "China: Lithium batteries may soon power 'world's largest fleet' of submarines", *Interesting Engineering,* Oct 30, 2022, https://interestingengineering.com/innovation/lithium-batteries-to-power-china-submarines.
[62] Patrick Senft @SenftPatrick, "The #US @DeptofDefense just announced that #Russia was supplying "highly enriched Uranium" to #China. Now, why would China do that? A brief…", Twitter, March 9, 2023, 7:22 pm, https://twitter.com/SenftPatrick/status/1633896095515328534.
[63] ASPI Defence Universities Tracker Database, https://unitracker.aspi.org.au
[64] For more details on this system, see "National Defence Courses", Finnish Security Committee Website, https://turvallisuuskomitea.fi/en/cooperation/national-defence-courses/

## OPENING STATEMENT OF GREGORY ALLEN, DIRECTOR, WADHWANI CENTER FOR AI AND ADVANCED TECHNOLOGIES, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

MR. ALLEN: Chairman Bartholomew, Vice Chairman Wong and distinguished members of the Commission. Thank you for inviting me to testify at the proceedings today.

I currently serve as the director of the Wadhwani Center for Artificial Intelligence and Advanced Technologies at the Center for Strategic and International Studies where I have the privilege of leading a team, conducting policy research at the intersection of technology and geopolitics.

Prior to CSIS, I spent three years working at the United States Department of Defense where I left most recently as the director of strategy and policy at the DoD Joint AI Center. Among my diverse duties were to advise senior DoD officials and participate in interagency policymaking processes on policy issues related to China's AI sector.

For my testimony today, I hope to offer a perspective informed by my direct experience working to accelerate DoD adoption as well as my direct experience engaging with Chinese officials, Chinese executives and Chinese experts on AI.

In 2018 and 2019, I traveled to China on five separate trips to attend major diplomatic military and private sector conferences focused on artificial intelligence. During these trips, I participated in a series of meetings with Chinese officials in China's Ministry of Foreign Affairs, leaders of China's military AI research organizations, Chinese foreign policy and military thinktank experts, and executives at Chinese AI companies.

As the United States' principal peer competitor in the field of technology, China has sought to expand in many emerging technology areas; foremost among them, the field of AI. As military competition with China gains increasing salience in our national security policy, U.S. leadership in the realm of military AI is not at all guaranteed.

While the United States has important advantages, China may be able to quickly take the lead in government and military adoption of AI capabilities. This is an outcome that the United States should seek to prevent.

To begin, I want to focus on the fact that artificial intelligence is a general purpose technology, analogous to computers or electricity. Try and think of a military technology that at some point in its life cycle does not involve electricity or computers. It essentially does not exist. So we should stop thinking about artificial intelligence as a discrete item or a discrete category such as aircraft or rocketry and start thinking about it more like computer software, a category of technology that is involved in other category of technology.

We're in the early stages of the modern AI revolution, but the pace of progress over the past decade has been transformational, and China has been a part of that transformational past decade as a leader in both the research, especially in the commercial adoption of AI, and increasingly in the use of AI for government, national security and even military applications. So to begin, I want to point out the fact that Chinese senior leaders see AI as foundational to the future of economic and military power.

In the most recent Chinese defense whitepaper, their equivalent of the U.S. National Defense Strategy, they declared intelligentization to be a military technology revolution based on artificial intelligence and that this revolution is equivalent to the mechanization revolution or the informatization revolution of the 20th century. I believe they're correct in this assessment.

Currently, China's most significant use of AI for national security applications is in domestic surveillance. I'm sure all of you are intimately familiar with the AI-based police states that they have established in Xinjiang and now in regions across China.

I want to point out that these efforts in domestic surveillance do not directly translate into additional military power, but they do offer indirect benefits.

In terms of what modern artificial intelligence is, it is a different approach to software. Rather than typing out each of the rules of the program by human hands, you expose a learning algorithm to a training data set, and I'm oversimplifying a bit here, the system programs itself.

The reason why this matters is that for some applications, the performance of machine learning-based software is radically superior to that of traditional software. Things that used to be incredibly costly, complicated, difficult or even impossible are suddenly viable, easy and perhaps even cheap. And facial recognition is foremost among these categories.

United States Department of Defense spent hundreds of millions of dollars working on facial recognition in the '80s and '90s using traditional software. Results were not great. But when you use machine learning, the performance suddenly goes through the roof.

Well, as a result of building out this massive facial recognition ecosystem across China, there's an entire generation of Chinese Communist Party officials who have experienced managing high performing AI programs. And it does not matter that performance in this case is profoundly unethical.

The point is they have this experience managing these wide-scale deployments of AI. They understand what the failure modes are. They understand how to work with advanced commercial companies.

And the companies that are building China's police state are absolutely state of the art. Companies like iFlyTek and SenseTime, they attend the most prestigious AI conferences in the world. They present their research there. And if the only metric of belonging is quality, they belong there.

And this is the backbone of where they are. So these indirectly translate to military AI. In AI, the data tends to be application-specific. So you cannot use facial recognition data to build a missile guidance system. You cannot use consumer financial data to build an underwater acoustic system.

But there is this overall AI ecosystem in China that is now closely tied to the national security apparatus, and this is the raw material from which their military AI ecosystem can now draw. And it's a much more deeply connected ecosystem than the U.S. military and the U.S. commercial technology ecosystem.

The United States is not doing nothing in the face of this competition. I believe there are two dates that will echo in history from 2022. February 24th when Russia invaded Ukraine and October 7th when the Biden Administration enacted a new set of export controls upon China's advanced AI and semiconductor technology.

All AI software has to run on semiconductor hardware somewhere. And at the present moment, China's semiconductor sector is deeply dependent upon foreign technology. I believe these export controls present a formidable barrier to China's progress in AI, including military AI, but by no means an insurmountable barrier.

And the organizations that are charged with carrying out this export controls, most notably the Department of Commerce, Bureau of Industry and Security has had a flat budget for the better part of a decade. It has been profoundly neglected.

In both our response to Russia's invasion of Ukraine and our response to China's use of AI and its military ecosystem, we have put export controls at the heart of national security policy. And very few people are asking the question, how are the organizations charged with carrying out this policy doing? What tools do they need to do their job better?

This is a profound mistake. The U.S. conversation around export controls is so focused on should we export control this, should we export control that, and failing to ask the types of questions that we ask in other aspects of our national security policy. Do the people charged with doing this job have the tools that they need? Are we making this the type of priority that it is? I believe that we're making some progress in this area, but it's only a fraction of what is needed, and I look forward to your questions and the conversation today. Thank you.

**PREPARED STATEMENT OF GREGORY ALLEN, DIRECTOR, WADHWANI CENTER FOR AI AND ADVANCED TECHNOLOGIES, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES**

**Statement before the**
**U.S.-China Economic and Security Review Commission**

# *"China's Pursuit of Defense Technologies: implications for U.S. and Multilateral Export Control and Investment Screening Regimes"*

A Testimony by:

**Gregory C. Allen**
Director, Wadhwani Center for AI and Advanced Technologies, CSIS

**Thursday, April 13, 2023**
**419 Dirksen Senate office Building**

Chairman Bartholomew, Vice Chairman Wong, and distinguished members of the commission, thank you for inviting me to testify in the proceedings today. My current employer, the Center for Strategic and International Studies (CSIS), does not take institutional policy positions. The views represented in this testimony are my own and should not be taken as representing those of my current or former employers.

I currently serve as the director of the Wadhwani Center for AI and Advanced Technologies at CSIS, where I have the privilege to lead a team conducting policy research at the intersection of technology and geopolitics. Prior to CSIS, I spent three years working at the United States Department of Defense (DoD) Joint Artificial Intelligence (AI) Center, where I most recently served as the director of strategy and policy. Among my diverse duties were to advise senior DoD officials and participate in interagency policymaking processes on policy issues related to China's AI sector. Additionally, during the 2021 Defense Policy Coordination Talks between the DoD and the People's Liberation Army (PLA), I was the DoD's representative in giving a presentation on reducing the risk of unintentional engagement and escalation related to military use of AI.

For my testimony today, I hope to offer a perspective informed by my direct experience working to accelerate DoD AI adoption, as well as my direct experience engaging with Chinese officials and experts on AI. In 2018 and 2019, I traveled to China on five separate trips to attend major diplomatic, military, and private-sector conferences focusing on artificial intelligence (AI). During these trips, I participated in a series of meetings with Chinese officials in China's Ministry of Foreign Affairs, leaders of China's military AI research organizations, Chinese foreign policy and military think tank experts, and corporate executives at Chinese AI companies.

As the United States' principal peer competitor in the field of technology, China has sought to expand in many emerging technology areas, foremost among them is the field of AI. As military competition with China gains increasing salience in our national security policy, U.S. leadership in the realm of military AI is not at all guaranteed. While the United States has important advantages, China may be able to quickly take the lead in government and military adoption of AI capabilities. This is an outcome that the United States should seek to prevent.

My testimony before this commission will attempt to provide an overview of how China perceives AI, how it develops AI, and, crucially, how it integrates AI into its security and military organizations. I will also address the U.S. and allied efforts to use export controls on semiconductor technology as a tool to influence the trajectory of China's AI sector. I will limit my remarks to those that are appropriate for an unclassified setting.

**I. China's senior leaders see AI as foundational to the future of economic and military power.**

In July 2017, China's State Council issued the New Generation Artificial Intelligence Development Plan (AIDP).[1] This document, as well as the issue of AI more generally, has received significant and sustained attention from the highest levels of China's leadership, including Xi Jinping, the general secretary of the Chinese Communist Party (CCP). Total Chinese national and local government spending on AI to implement this plan is not publicly disclosed, but it is clearly in the equivalent range of tens of billions of dollars. At least two Chinese regional governments have each committed to investing 100 billion yuan (~$14.7 billion in then-year exchange rates).[2] The opening paragraphs of the AIDP exemplify mainstream Chinese views regarding AI:

> AI has become a new focus of international competition. AI is a strategic technology that will lead in the future; the world's major developed countries are taking the development of AI as a major strategy to enhance national competitiveness and protect national security.

More recently, AI was the first technology priority listed in the Chinese government's five-year economic plan for 2021–2026.[3]

In addition to the AIDP and the five-year plan, AI also features prominently in China's most recent defense white paper, which in 2019 argued that,

> International military competition is undergoing historic changes. New and high-tech military technologies based on IT are developing rapidly. There is a prevailing trend to develop long-range precision, intelligent, stealthy or unmanned weaponry and equipment. War is evolving in form towards informationized warfare, and intelligentized warfare is on the horizon.[4]

---

[1] Graham Webster et al., "Full Translation: China's 'New Generation Artifical Intelligence Development Plan' (2017)," New America, August 1, 2017, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/.

[2] Xinhua, "Shanghai to Set up Multi-Billion-Dollar Fund to Develop AI," *China Daily*, September 18, 2018, http://www.chinadaily.com.cn/a/201809/18/WS5ba0ade9a31033b4f4656be2.html"; and Meng Jing, "This Chinese City Plans a US$16 Billion Fund for AI Development," *South China Morning Post*, May 16, 2018, https://www.scmp.com/tech/innovation/article/2146428/tianjin-city-china-eyes-us16-billion-fund-ai-work-dwarfing-eus-plan."

[3] "Xi Jinping: 'Strive to Become the World's Primary Center for Science and High Ground for Innovation'," DigiChina, March 18, 2021, translation by Ben Murphy, Rogier Creemers, Elsa Kania, Paul Triolo, and Kevin Neville, edited with an introduction by Graham Webster, https://digichina.stanford.edu/work/xi-jinping-strive-to-become-the-worlds-primary-center-for-science-and-high-ground-for-innovation/.

[4] State Council Information Office, *China's National Defense in the New Era* (Beijing: Foreign Languages Press Co. Ltd, July 2019), English translation available at https://www.airuniversity.af.edu/Portals/10/CASI/documents/Translations/2019-07%20PRC%20White%20Paper%20on%20National%20Defense%20in%20the%20New%20Era.pdf?ver=akpbGkO5ogbDPPbflQkb5A%3d%3d.

China's military leadership believes that the dawn of AI-enabled intelligentized warfare (sometimes translated as "intelligentization") represents a military technology revolution on par with the mechanization and informatization revolutions of the twentieth century.[5]

"Informatization" is as it sounds—the expansion of computers for data analysis and networking, including in the precision-guided munitions revolution of the late twentieth century.

For "intelligentization," the DoD stated in the 2022 China Military Power Report,

> [People's Liberation Army] PLA strategists have stated new technologies will increase the speed and tempo of future warfare, and that operationalization of AI will be necessary to improve the speed and quality of information processing by reducing battlefield uncertainty and providing decision-making advantage over potential adversaries. The PLA is also exploring next-generation operational concepts for intelligentized warfare, such as attrition warfare by intelligent swarms, cross-domain mobile warfare, AI-based space confrontation, and cognitive control operations. The PLA considers unmanned systems to be critical intelligentized technologies, and is pursuing greater autonomy for unmanned aerial, surface, and underwater vehicles to enable manned and unmanned hybrid formations, swarm attacks, optimized logistic support, and disaggregated ISR, among other capabilities.[6]

This long list of AI-related capabilities that the PLA is pursuing is appropriate. It reflects the fact that AI is a general-purpose technology, analogous to electricity or computers. Today there are relatively few military capabilities used by the DoD that do not involve electricity or computers at some stage in their life cycle, whether design, manufacturing, operational use, or maintenance. But in the history of U.S. military technology adoption, some applications incorporated electricity and computers decades before others. A similar, though perhaps faster, story is unfolding in the U.S. and Chinese militaries today with respect to AI.

**II. China's most significant national security application of AI is in domestic surveillance.** In recent years, China has initiated a brutal crackdown on residents of its Xinjiang province, predominantly targeting people of the Muslim Uighur minority. The Chinese government has installed an extraordinarily extensive AI-enabled system designed to surveil, censor, and constrain the actions of residents of Xinjiang. The ambition of this program has escalated dramatically over time, and elements of the program are now deployed in regions across China, not just Xinjiang.

This massive, unethical social experimentation has provided a wealth of funding, data, and operational experience for China's surveillance-industrial complex, including many companies at the forefront of Chinese AI development. iFlyTek, a leading Chinese provider of voice recognition and translation software, receives massive subsidies and revenue from the Chinese

[5] Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China* (Washington, DC: Department of Defense, 2021), https://media.defense.gov/2021/Nov/03/2002885874/-1/-1/0/2021-CMPR-FINAL.PDF.
[6] United States Department of Defense.

government.[7] Since 2017, it has collaborated with the government in providing a so-called "voiceprint" system to identify and track residents.[8] SenseTime, a leading Chinese provider of facial recognition software, plays a similar role for facial tracking in surveillance footage.[9]This in-the-field testing provides real-life use cases and training data that allow both companies to advance in their development of and operational experience with AI technology.

The human rights and civil liberties implications of these large-scale AI deployments are enormous. However, they are a separate issue from what the systems signify in terms of the depth and breadth of capability in China's AI sector and the Chinese security establishment's ability to effectively tap that capability. Even if the use case of this AI system is morally horrifying, it is nonetheless technologically and operationally significant. The Chinese state's ability to deploy and scale AI to this extent in a matter of just a few years should give us pause. While the American private sector has made impressive leaps, most recently in the field of generative AI, the Chinese government has demonstrated a dramatic pace of public-sector AI adoption, itself a nontrivial administrative process.

**III. China's efforts in domestic surveillance AI offer indirect benefits for military adoption.** Although the Chinese Ministry of State Security (MSS) and local government police forces have shown enthusiasm for adopting AI as part of the CCP's domestic security and surveillance operations, it is not guaranteed that this technological success will carry over into the realm of military applications.

Modern machine-learning AI using deep neural networks offers the opportunity for incredible gains in system performance, but that performance depends on having large quantities of training data during development. Moreover, training data needs to closely resemble operational conditions.

In general, it is much easier to get such training data on commercial customers or domestic surveillance targets than from an enemy military, especially if friendly weapons systems and sensors do not often come within range of enemy ones. The most mature U.S. national security AI applications are ones such as AI-enabled analysis of satellite reconnaissance imagery. Even in peacetime, satellites get to take a lot of pictures of Russian and Chinese military forces, and those pictures can be digitally labeled by human experts to turn them into training data. Training data is what machine-learning AI systems learn from. The combination of a learning algorithm and training data is how AI systems learn to recognize what is in an image. But training data is generally application-specific. Training data for satellite image recognition typically only helps build satellite image recognition AI. One cannot magically use labeled satellite image data to train an AI for a missile's guidance computer (at least not with today's technology).

---

[7] Henny Sender, "China's IFlytek Raising up to $350m to Invest in AI," *Financial Times*, June 5, 2019, https://www.ft.com/content/d4dbbd18-81a8-11e9-b592-5fe435b57a3b.
[8] Will Knight, "MIT Cuts Ties With a Chinese AI Firm Amid Human Rights Concerns," *Wired*, April 21, 2020, https://www.wired.com/story/mit-cuts-ties-chinese-ai-firm-human-rights/.
[9] Johana Bhuiyan, "US Sanctioned China's Top Facial Recognition Firm over Uyghur Concerns. It Still Raised Millions," *The Guardian*, January 7, 2022, https://www.theguardian.com/world/2022/jan/06/china-sensetime-facial-recognition-uyghur-surveillance-us-sanctions; and Christian Shepherd, "China's SenseTime Sells out of Xinjiang Security Joint Venture," *Financial Times*, April 15, 2019, https://www.ft.com/content/38aa038a-5f4f-11e9-b285-3acd5d43599e.

Getting enough of the right sort of training data to incorporate modern AI into, say, a robotic tank's targeting computer, is a much tougher technical challenge. It is not impossible in principle, but in practice, there are far fewer opportunities to collect the right sort of training data unless your country is currently at war. This is critical to keep in mind in the context of China's widespread use of AI for domestic surveillance. China may have data advantages related to facial recognition for domestic surveillance applications or even commercial applications such as consumer finance, but these data sets have limited relevance for military applications. For some military AI applications, such as precision missile targeting or autonomous drone navigation, China may have no data advantage whatsoever compared with the United States.

Despite this, China's domestic AI deployment has supported military development in lasting, durable ways. For one, an entire generation of Chinese government officials now has experience with the benefits and drawbacks of an AI program and how to effectively administer it at large scale. Private sector corporations, such as iFlyTek and SenseTime, likewise gain experience and connections collaborating with the Chinese government, the CCP, and the Chinese military and national security establishments. Chinese companies such as iFlyTek and SenseTime routinely publish high-quality research and attend prestigious international conferences. Their research operates at or above the level of U.S. companies in the same AI sub-fields. This success—directly related to the massive quantities of data and operational experience that these firms get from participating in domestic surveillance—gives them an advantage in the field of technological development, as well as in access to investment capital, government revenue, and talent.

By contrast, in the United States, major tech firms do not routinely have the same depth of cooperation with our national security organizations in the field of AI. Part of this can be attributed to our commitment to democratic values and our societal choices not to pursue the types of unethical AI applications that are so widespread in China. However, U.S. national security agencies must continue making the needed reforms to deepen cooperation with leading commercial technology companies and accumulate relevant operational experience with AI.

**IV. Unclassified information regarding China's research and adoption of military AI has important limitations, but available evidence suggests that China is pursuing development of AI-enabled lethal autonomous weapons.**

I previously addressed the differences in developing military versus surveillance AI. Although China has boasted of competency in both, evidence on the extent of Chinese military AI adoption is significantly more limited, particularly at the unclassified level.

Chinese military AI systems are generally developed in secret until they are either sufficiently advanced to serve a deterrence purpose or to be part of military exports. The available sources in the public domain related to Chinese military AI adoption, such as military-affiliated newspapers and academic journals, are worth paying attention to but must be evaluated cautiously. These sources, by their very nature, cannot discuss the full view of China's military advancements and in many cases are individual opinions and speculation rather than official government policy. They may also be exaggerated to carry the Chinese military's desired messages about its own strength.

The best available indications, however, suggest that China's strategy is ambitious, moving beyond any sort of on-the-battlefield human supervision into increasingly autonomous AI-enabled warfare. For example, Zeng Yi, a senior executive at NORINCO, China's third-largest defense company, gave a public speech in 2018 in which he described his company's (and China's) expectations for the future implementation of AI weapons: "In future battlegrounds, there will be no people fighting."[10] Zeng predicted that by 2025 lethal autonomous weapons would be commonplace and said that his company believes ever-increasing military use of AI is "inevitable. . . . We are sure about the direction and that this is the future." I transcribed Zeng's comments (as provided by the simultaneous translators) as I was in attendance at the same conference. However, in the subsequently released transcript of the conference session, all mention of Zeng's presentation and participation was removed, likely indicating that the Chinese government censors had determined it was not in China's interest to have that information in the open.

Zeng's comments are consistent with ongoing Chinese autonomous military vehicle development programs and China's current approach to exports of military unmanned systems. China's government is already exporting many of its most advanced military aerial drones to Middle Eastern countries such as Saudi Arabia and the United Arab Emirates. China's government has stated that it also will export its next-generation stealth drones when those are available.[11]

Though many current-generation drones are primarily remotely operated, Chinese officials generally expect drones and military robotics to feature ever more extensive AI and autonomous capabilities in the future. Chinese weapons manufacturers are already selling armed drones that advertise significant amounts of combat autonomy. Ziyan, a Chinese military drone manufacturer, has sold its Blowfish A2 model to the UAE and in November 2019 reportedly was in negotiations with Saudi Arabia and Pakistan for Blowfish A2 sales.[12] Ziyan's website states that the 38-kg Blowfish A2 "autonomously performs more complex combat missions, including fixed-point timing detection, fixed-range reconnaissance, and targeted precision strikes."[13] Depending on customer preferences, Ziyan offers to equip the Blowfish A2 with either missiles or machine guns.

Beyond using AI for autonomous military robotics, China is also interested in AI capabilities for military command decisionmaking. Zeng Yi expressed some remarkable opinions on this subject, stating that today "mechanized equipment is just like the hand of the human body. In future intelligent wars, AI systems will be just like the brain of the human body." Zeng also said that "Intelligence supremacy will be the core of future warfare" and that "AI may completely change the current command structure, which is dominated by humans" to one that is dominated by an "AI cluster." Zeng did not elaborate on his claims, but they are consistent with published

[10] By revenue, NORINCO is the third-largest defense company in China and the ninth-largest worldwide. Gregory C. Allen, *Understanding China's AI Strategy* (Washington, DC: Center for New American Security, February 2019), https://www.cnas.org/publications/reports/understanding-chinas-ai-strategy.
[11] Dake Kang and Christopher Bodeen, "China Unveils Stealth Combat Drone in Development," Associated Press, November 7, 2018, https://www.apnews.com/6b2d2857f73c4fa387379c16b0dc60b9.
[12] Ludovic Ehret, "China Steps up Drone Race with Stealth Aircraft," Phys.Org, November 9, 2018, https://phys.org/news/2018-11-china-drone-stealth-aircraft.html.
[13] Ziyan, "Blowfish A2 Product Overview."

thinking in some Chinese military circles. Several months after AlphaGo's momentous March 2016 victory over Lee Sedol, a publication by China's Central Military Commission Joint Operations Command Center argued that AlphaGo's victory "demonstrated the enormous potential of artificial intelligence in combat command, program deduction, and decisionmaking."[14]

**V. The DoD has sought defense policy dialogues with the PLA on military AI risk reduction but has repeatedly been refused.**

Machine learning, the technology paradigm at the heart of the modern AI revolution, brings with it not only opportunities for radically improved performance but also new failure modes. When it comes to traditional software, the U.S. military has decades of institutional muscle memory related to preventing technical accidents, but building machine learning systems that are reliable enough to be trusted in safety-critical or use-of-force applications is a newer challenge. To its credit, the DoD has devoted significant resources and attention to the problem: partnering with industry to make commercial AI test and evaluation capabilities more widely available, announcing AI ethics principles and releasing new guidelines and governance processes to ensure their robust implementation, updating longstanding DoD system safety standards to pay extra attention to machine learning failure modes, and funding a host of AI reliability and trustworthiness research efforts through organizations such as the Defense Advanced Research Projects Agency (DARPA).

However, even if the United States were somehow to successfully eliminate the risk of AI accidents in its own military systems—a bold and incredibly challenging goal—it still would not have solved risks to the United States from technical failures in Chinese military AI systems. What if a Chinese AI-enabled early warning system erroneously announces that U.S. forces are launching a surprise attack? The resulting Chinese strike—wrongly believed by China to be a counterattack—could be the opening salvo of a new war.

Substantive diplomacy on this topic is worth pursuing and, if successful, could meaningfully contribute to reducing the risk of a future U.S.-China conflict. There is loud public support in prominent Chinese venues for such a dialogue. However, during my tenure as the director of strategy and policy at the DoD Joint Artificial Intelligence Center, the DoD did just that, twice.[15] Both times the Chinese military refused to allow the topic on the agenda. In the second attempt, the Defense Policy Coordination Talks of 2021, I gave a presentation on U.S. military efforts to reduce AI risks associated with unintentional engagement and escalation. The PLA refused to discuss the issue.

It is important that such risk-reduction dialogues occur bilaterally between the DoD and the PLA, not just via the Chinese Ministry of Foreign Affairs' public proclamations at the United Nations. The Chinese Ministry of Foreign Affairs is not a direct analogue of the U.S. State Department, which complicates its ability to authoritatively speak on behalf of the PLA. In the

[14] Central Military Commission Joint Staff, "Accelerate the Construction of a Joint Operations Command System with Our Nation's Characteristics CMC Joint Operations Command Center," Seeking Truth, August 15, 2016.
[15] Gregory C. Allen, "One Key Challenge for Diplomacy on AI: China's Military Does Not Want to Talk," CSIS, *Commentary*, May 20, 2022, https://www.csis.org/analysis/one-key-challenge-diplomacy-ai-chinas-military-does-not-want-talk.

Chinese Lenninist system, the Chinese military is a part of the CCP, not the Chinese government, which controls the Chinese Ministry of Foreign Affairs. Though both organizations ultimately have the same leader—Xi Jinping is both the president of the People's Republic of China and chairman of the CCP—experience has shown that there is no substitute for direct DoD-PLA dialogue on military issues.

**VI. The U.S. edge in advanced AI research does not necessarily translate to skill in adoption.**

The United States is unquestionably the leader in developing the foundational science of AI. We have deeper reserves of institutional talent and knowledge. However, historically, it is not always true that the inventor of a cutting-edge technology or maker of a scientific discovery is its primary beneficiary.

Consider the case of stealth aircraft. Several of the key underlying scientific breakthroughs that enabled stealth technology originated in 1962 in the Soviet Union with research by Petr Ufimtsev, a physicist at the Moscow Institute for Radio Engineering. English translations of Ufimtsev's work were not available until 1971.[16] Despite having a nine-year head start, and later making an aggressive effort to replicate U.S. advances, the Soviet Union never successfully fielded stealth aircraft, while the United States did so in 1981.[17] If the U.S. aerospace research community had never come across Ufimtsev's breakthrough work, it is possible that the initial invention of stealth aircraft might not have occurred until decades later.

In the case of AI, we cannot allow the United States to play the role of the Soviet Union in the stealth story. Our leadership in AI technology research does not inherently mean that the United States will lead in the effective military adoption of AI.

**VII. As a strong but still developing global military, China has advantages in AI adoption.**

Some leaders in China's government see AI as a promising military "leapfrog development" opportunity, meaning that it offers military advantages over the United States and could be easier to implement in China than in the United States.[18]

The term "leapfrog development" describes a technology for which laggard countries can skip a development stage, or one for which being behind on the current generation of technology actually offers an advantage in adopting the next generation. A commonly cited example is the rapid and widespread adoption of cellular phone technology in countries that had only minimal landline phone adoption. Kai-Fu Lee, one of the leading venture capitalists in China's AI sector, argues that the absence of many developed-economy capabilities, such as easy credit checks, have led to a flood of Chinese entrepreneurs making innovative use of AI capabilities to fill those

[16] Petr Ya Ufimtsev, "DTIC Translation - Method of Edge Waves in the Physical Theory of Diffraction," Defense Technical Information Center, September 07, 1971, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=AD0733203.
[17] Director of Intelligence, "US Stealth Programs and Technology: Soviet Exploitation of the Western Press," Central Intelligence Agency, August 1, 1988, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB443/docs/area51_44.PDF.
[18] Webster et al., "Full Translation: China's 'New Generation Artifical Intelligence Development Plan' (2017)."

gaps.[19] Plastic credit cards are nearly nonexistent in China, but mobile phone payments secured by facial recognition are ubiquitous.

China's emphasis on AI as a leapfrog technology enabler extends to national security applications. China's 2017 National AI Development Plan identifies AI as a "historic opportunity" for national security leapfrog technologies.[20] Chinese defense executive Zeng Yi echoed that claim, saying that AI will "bring about a leapfrog development" in military technology and presents a critical opportunity for China.

If this strain in Chinese thinking is correct, that AI presents a leapfrog opportunity, it would mean that China is better positioned to adopt military AI than the United States. In this theory, the United States' current advantages in stealth aircraft, aircraft carriers, and precision munitions actually would be long-term disadvantages because the entrenched business and political interests that support military dominance today will hamper the United States in transitioning to an AI-enabled military technology paradigm in the future.[21] As one Chinese think tank scholar explained to me, he believes that the United States is likely to spend too much to maintain and upgrade mature systems and underinvest in disruptive new systems that make America's existing sources of advantage vulnerable and obsolete. China's military also faces perverse incentives to protect legacy systems, but to a far lesser extent: Chinese military spending tripled from 2007 to 2017, technology is a top priority, and there is a general understanding that many of its current platforms and approaches are obsolete and must be replaced regardless.[22]

Just one of many examples of China's AI leapfrog strategy is its prioritized investment and technology espionage for low-cost, long-range autonomous and unmanned submarines.[23] China believes these systems will be a cheap and effective means of threatening U.S. aircraft carrier battlegroups and an alternative path to projecting Chinese power at range. In some cases, Chinese thinkers see military AI research and development as a cheaper and easier path to threatening America's sources of military power than developing Chinese equivalents of American systems.

The United States still outspends China on defense, but much of that spending is tied up in legacy programs. The concern with regard to AI adoption is two-fold. First, the existence of

---

[19] Kai-Fu Lee, *AI Superpowers: China, Silicon Valley, and the New World Order* (Boston: Houghton Mifflin Harcourt Trade & Reference Publishers, 2018).
[20] Specifically, the report says that China should "firmly seize the major historic opportunity for the development of AI . . . and support national security, promoting the overall elevation of the nation's competitiveness and leapfrog development."
[21] See, for example, Leo Blanken, Jason Lepore, and Stephen Rodriguez, "America's Military Is Choking on Old Technology," *Foreign Policy*, January 29, 2018, https://foreignpolicy.com/2018/01/29/americas-military-is-choking-on-old-technology.
[22] In nominal RMB terms. Source: Nan Tian et al., "Trends in World Military Expenditure, 2017," Stockholm International Peacre Research Institute, May 2018, https://www.sipri.org/publications/2018/sipri-fact-sheets/trends-world-military-expenditure-2017.
[23] Stephen Chen, "China Developing Robotic Subs to Launch a New Era of Sea Power," *South China Morning Post*, July 23, 2018, https://www.scmp.com/news/china/society/article/2156361/china-developing-unmanned-ai-submarines-launch-new-era-sea-power; and James Eng, "Woods Hole Oceanographic Institution Says Hack Linked to China," NBC News, October 16, 2016, https://www.nbcnews.com/tech/security/woods-hole-oceanographic-institution-says-hack-linked-china-n446226.

legacy programs provides a strong economic disincentive against investing in new approaches that are built from the ground up. This creates a painful division of funds in which the lion's share of research is invested in maintaining and improving existing systems and integrating them with AI, and only a minority is dedicated to programs designed with AI from square one.

Second, there is a deeper cultural and organizational issue. Many DoD organizational structures face a bias toward more expensive and sophisticated "exquisite" technologies. However, it may be that the most promising near-term use cases for AI will be inferior to the systems and processes that they replace in terms of traditional performance metrics but superior in terms of cost, availability, or expendability. The DoD should not let philosophical attachment or organizational inertia allow it to fall behind in the field of new and disruptive AI innovations.

**VIII. Many of the obstacles to China's adoption of military AI are similar to those of the United States.**

The main ingredients to developing AI are straightforward, if not easily procurable: (1) a model needs large quantities of data matching its expected operational use case to train; (2) skilled AI researchers and engineers must be recruited and retained, at either public or private research institutions; and (3) AI labs need a consistent funding stream to support their computational infrastructure and staff. These three ingredients are the key raw materials which in a productive environment can be channeled into the development of military AI. However, on all these fronts, neither China nor the United States has the quantities desired.

Data is always at a premium, especially for the niche use cases that relate to military functionality. While surveillance data, both from the internet and from Xinjiang, is plentiful for the Chinese government, how they might source sufficient data for autonomous targeting or underwater navigation remains to be seen. Likewise, American tech companies have no shortage of information on online social media activity or consumer spending habits, but this cannot be applied to military uses.

Likewise, engineers, and particularly researchers, are a limiting resource. The United States and China both draw from a finite field of talent in which demand far outstrips supply.

Finally, and most plainly, AI labs and companies, whether public or private, require consistent funding in order to thrive. While AI is a fundamentally transformational technology, the immediate benefits to customers may not immediately be apparent. AI is highly theoretical—until it is not. OpenAI was founded in 2015 but took seven years to dazzle the world with ChatGPT. In the intervening time, it was supported by a $1 billion investment from Microsoft—something not every AI startup is fortunate enough to have.[24] In China, flagship companies such as iFlyTek and SenseTime operate with a heavy input of data and a large revenue stream from the Chinese government. The principal limiting ingredients of China's AI are, like ours, questions of data, money, and personnel, and we should not underestimate the value of staying ahead of China in these basic ways.

[24] Grace Kay, "The History of ChatGPT Creator OpenAI, Which Elon Musk Helped Found before Parting Ways and Criticizing," *Business Insider*, February 1, 2023, https://www.businessinsider.com/history-of-openai-company-chatgpt-elon-musk-founded-2022-12.

**IX. Recent U.S. export controls on semiconductor technology are designed to limit the future advancement of China's military AI sector.**

The AI development stack is not merely an issue of software. All AI software has to run on semiconductor hardware somewhere, and many aspects of that hardware ecosystem are controlled by the United States and allied countries. For example, almost all AI models are trained on graphics processing units (GPUs)—sophisticated, parallel chips originally designed for gaming but often designed and optimized today for training sophisticated AI models. As of September 2022, Nvidia and AMD, two American GPU providers, were responsible for 95 percent of China's domestic GPU market. Nvidia, and its proprietary CUDA software architecture, are the foundation that AI researchers use to develop and train their models. CUDA makes it much easier for programmers to write massively parallelized software (as all modern AI software is) and ensures backward and forward compatibility so that older chips can still run newer software and vice versa.[25] Any customer who seeks to stop using Nvidia chips has to leave the CUDA ecosystem, which requires solving a lot of incredibly hard software problems for which CUDA already provides free answers. Those free answers reflect billions of dollars of investment in the CUDA platform by both Nvidia and its customers. As a result, China has high barriers to establishing a domestic competitor in the space of the next-generation chips that are necessary for AI.

In 2018, a Chinese government-run newspaper, *Science and Technology Daily*, published a list of 35 "chokepoint" technologies where Chinese domestic production significantly lags the international standard. Each of these technologies is an area in which Chinese leaders are concerned that the United States and its allies could choke off China's access, making them a national security concern. Among the 35 technologies, seven concern computer chips or chip manufacturing, sectors that are currently dominated by a group of companies across Taiwan, South Korea, the Netherlands, Japan, Germany, and the United States.[26]

The Biden administration's October 7 export controls lay out a unified theory of pressure that seeks to make access to American chips extremely difficult. The controls have five interlocking elements[27]:

1. Strangle the Chinese AI and supercomputing industries by choking off access to high-end chips.

2. Block China from designing AI chips domestically by choking off its access to U.S.-made chip design software and U.S.-built semiconductor manufacturing equipment.

3. Block China from manufacturing advanced chips by choking off access to U.S.-built semiconductor manufacturing equipment.

[25] Ben Thompson, "Shopify vs. Buy With Prime, Instagram Shopping, CUDA and China," Stratechery, September 7, 2022, https://stratechery.com/2022/shopify-vs-buy-with-prime-instagram-shopping-cuda-and-china/.
[26] These seven include photolithography machines, chips, high-end capacitors and resistors, core industrial software, photoresists, and ultra-precision polishing techniques. "35 Key 'Stranglehold' Technologies," PRC Ministry of Education, edited by Ben Murphy, translated by Etcetera Language Group, Inc, May 13, 2021, https://cset.georgetown.edu/publication/35-key-stranglehold-technologies/.
[27] Gregory C. Allen, "Choking off China's Access to the Future of AI," CSIS, October 11, 2022, https://www.csis.org/analysis/choking-chinas-access-future-ai.

4. Block China from developing its own semiconductor manufacturing equipment by choking off access to U.S.-built components.

5. Ensure that China does not replace lost access to U.S. semiconductor technology by partnering with U.S. allies.[28]

In theory, these four policies should definitively hamper China's march toward AI technology. However, China's export control evasion activities are significant and growing. My primary recommendation is that Congress focus on concrete strategies to tighten this enforcement and shore up remaining gaps that risk allowing China to close the AI gap.

**X. The Department of Commerce's Bureau of Industry and Security must be technologically modernized to combat China's evasion of export controls.**

The five chokepoints mentioned above are not all alike in the case of enforcement. Chipmaking equipment, which is large and expensive and requires significant post-sale support, is easiest to enforce. However, from China's perspective, the most direct path to continued AI progress is continuing to use U.S. chips. It is at this first and crucial chokepoint that China most flagrantly attempts to evade our export controls, and too often succeeds.

I and colleagues at CSIS recently conducted an in-depth analysis on U.S. export controls enforcement capacity.[29] Our findings were concerning.

The Bureau of Industry and Security (BIS) at the Department of Commerce oversees most export controls. Unfortunately, BIS is increasingly challenged by worldwide smuggling and export control evasion networks, especially those that are supported by Russia and China. For example, investigators have examined the wreckage of downed Russian weapons systems in Ukraine and found that they contain U.S. and allied components, including semiconductor electronics that were manufactured years after the implementation of the 2014 Russia export controls.[30]

As our geopolitical rivals pursue increasingly aggressive and better-resourced means of obtaining critical technology, BIS must use every tool available to increase capacity and productivity for effective enforcement. The need for robust U.S. export controls is more strategically critical than at any time since the end of the Cold War, but BIS's enabling technology is in a dreadful state. The cause is simple: decades of underinvestment. Current and former BIS staff told me in a series of interviews that the major government databases that they

[28] Gregory C. Allen and Emily Benson, "Clues to the U.S.-Dutch-Japanese Semiconductor Export Controls Deal Are Hiding in Plain Sight," CSIS, March 1, 2023, https://www.csis.org/analysis/clues-us-dutch-japanese-semiconductor-export-controls-deal-are-hiding-plain-sight; and Gregory C. Allen, Emily Benson, and Margot Putnam, "Japan and the Netherlands Announce Plans for New Export Controls on Semiconductor Equipment," CSIS, *Commentary*, April 10, 2023, https://www.csis.org/analysis/japan-and-netherlands-announce-plans-new-export-controls-semiconductor-equipment.

[29] Gregory C. Allen, Emily Benson, and William Alan Reinsch, "Improved Export Controls Enforcement Technology Needed for U.S. National Security," CSIS, November 30, 2022, https://www.csis.org/analysis/improved-export-controls-enforcement-technology-needed-us-national-security.

[30] Jeanne Whalen, "U.S. Probing How American Electronics Wound up in Russian Military Gear," *Washington Post*, June 15, 2022, https://www.washingtonpost.com/world/2022/06/15/us-computer-chips-russian-military/.

use to monitor trade flows and identify suspicious activity can perform only a fraction of the needed functionality and crash routinely. Instead of knowledge graph databases and machine learning—capabilities that have revolutionized both the private sector and other federal agencies with similar missions—BIS analysts perform their work primarily using Google searches and Microsoft Excel.

Modern, data-driven digital technologies utilizing AI and machine learning can and should play an integral role in enhancing BIS export control enforcement capabilities. Relatively modest investments could lead to 5 to 10 times greater analyst productivity. Despite the increasingly pressing need to invest in these new enforcement capabilities, the budget of BIS has not increased commensurate with the increased number of export-controlled items, the evolving threat landscape, and the growing pressure from an increasingly sophisticated evasion regime.

A changed geopolitical landscape demands reinvigorated U.S. government export controls capacity, and this cannot be done without additional resources. CSIS analysis of relevant comparable data-driven digital technology modernization efforts by other U.S. government agencies with similar mission requirements suggests that this could be accomplished with an additional appropriation for technology modernization at BIS of roughly $25 million annually for five years. This funding would allow BIS to better ingest, connect, and analyze hundreds of billions of records from both government and open-source data. By applying modern data science and machine learning techniques, BIS could increase productivity across all its processes. For example, it could automatically detect that a purported Eastern European “tractor manufacturer” has the same phone number as a supplier of engines to the Russian military. This figure accounts for opportunities at BIS to improve collaboration with other U.S. government agencies and the need to prevent unnecessary duplication of effort.

However, a more productive enforcement analysis community will identify more entities as likely shell companies engaging in illicit transactions. This will in turn increase the need for enforcement agents to conduct site inspections or criminal investigations of these identified entities. Despite the severe current technological limitations on the efficacy of the analytic community, its work is already identifying enough candidate entities for inspection to more than fully consume the capacity of the current staff. Therefore, in addition to the $25 million annual increase for five years to support new technology and staff for BIS analytical capabilities, BIS will also require an additional $18.4 million and 48 positions annually for the Export Enforcement organization as well as another $1.2 million for additional classified facility space for these individuals to support the classified aspects of their work. Thus, the total size of the additional BIS budget appropriation that I and my CSIS colleagues recommended is $44.6 million annually.

In terms of return on investment, this $44.6 million annual increase in BIS’s budget is likely to be one of the best opportunities available anywhere in U.S. national security. The U.S. government is currently spending tens of billions to assist Ukraine in destroying the weapons of Russia’s military, which too often are powered by U.S. technology. Providing a few tens of millions of dollars annually to BIS to modernize the technology that enables export controls enforcement would go a long way toward ensuring that far fewer Russian and Chinese weapons using U.S. technology are built in the future.

As every street corner narcotics dealer knows, there is a major difference between a business transaction being illegal and it being impossible. The U.S. export licensing and administration process determines whether or not an international sale by a U.S. entity is permissible, but the efficacy of enforcement of the controls determines whether or not such sales will succeed when they are attempted and whether the terms of the license are honored subsequent to export. There are a variety of tactics that illicit actors can use to gain access to U.S. technology in defiance of export controls, ranging from outright theft and smuggling to the use of shell companies that hide the identity of an unlawful end user behind a front company falsely purporting to be purchasing the item legally. Former Department of Commerce and U.S. intelligence community officials interviewed for our CSIS project said that it can sometimes take the Russian and Chinese military mere days to successfully set up a shell company for purchasing U.S. technology, while the current process for uncovering a shell company's illegal activity may take years, if it is uncovered at all.

**XI. Conclusion**

The United States and the People's Republic of China are peer competitors in the key field of AI. But although the two sides are roughly equally matched, the advantages and disadvantages of each are not the same. The United States has deep industry, scientific, and institutional knowledge in the sciences of machine learning and exercises significant control over the physical supply chain of chips that are the cornerstone of AI development. However, we have not matched China's level of government adoption for security applications, as well as public-private cooperation.

The United States government has tools for influencing both the trajectory of U.S. military AI adoption as well as China's AI trajectory. On the latter issue, I feel that the main focus of the conversation in Washington, D.C., is incomplete. There is a great deal of focus on which technologies to apply export controls and to which countries. But there is a missing discussion about U.S. export controls capacity. The export controls policy that the United States has enacted on China's AI and semiconductor sectors is a direct challenge to two of China's top technological priorities for both their economy and national security. It is clear that China will devote extraordinary resources to circumventing those controls, and they are already doing so. The United States government should be willing to devote significant additional focus and funding toward ensuring that China does not succeed.

Thank you for the opportunity to testify today, and I look forward to your questions.

## PANEL II QUESTION AND ANSWER

VICE CHAIRMAN WONG: Thank you, Mr. Allen. Thank you to our witnesses. We are going to move in reverse alphabetical order for our questioning, and we will begin with Commissioner Wessel.

COMMISSIONER WESSEL: Thank you, all. This has been a rich discussion as this has been a great hearing already. Thank you.

Mr. Allen, I want to start with your last comment, and I know in our next panel we're also going to be going into export controls. But help on the broader set of the ecosystem around innovation, so export controls as it relates to what may be shared with others, the development of the technologies themselves in terms of academic research, basic research, et cetera, in our innovation funding system both within DoD, DIU and other arms that do things there, as well as venture capital.

We recently had discussions with a number of venture capital firms, those benefitting or developing technologies, whether it was in space or otherwise, and we have a robust ecosystem, but it seems to be unlike China's subject to fits and starts.

And the recent Silicon Valley Bank question raised concerns about the ecosystem funding. What would you do to ensure that the pace of AI development in the U.S. can continue, accelerate, we can lead, dominate, but also we can limit leakage, if you will.

MR. ALLEN: The U.S. venture capital ecosystem is the best in the world, bar none. But it's good at certain types of activities. If you look at venture capital companies, and I am a business school graduate myself, they're going after investments that are more likely than not going to fail.

They have an extreme risk tolerance because they only need one company out of the 20 companies in an individual investment fund to succeed. And if the other 19 go out of business, that is a tolerable outcome. But they also have certain types of blindspots.

There's certain types of investments that the venture capital ecosystem in the venture capital business model is not necessarily a great fit for. You have seen U.S. companies that were pushed to pursue the type of growth objectives that venture capital companies tend to be interested in, increasing in size by 20-fold in a period of five years.

Not every type of technological development follows that path and is necessarily a good fit for that investment model. At the same time, the government investment model that the United States tends to pursue really especially with the one I know best, which is the one pursuit by the Department of Defense, really struggles outside of the area of basic research or research affiliated with an existing program of record.

So we're quite good at things like sort of advance the very early stage science of a given material where we are interested in certain thermodynamic properties. We know how to spread a lot of money around and let one of those flowers finally bloom. We also know how to say, we need the F-35 system to be upgraded according to the following metrics.

But where we really struggle in our innovation ecosystem, especially in the Department of Defense, is around disruptive innovation. And I want to point out here that there's a formal business theory of disruption. In common news reporting, you will see that disruption is used as a synonym for a big change. This is not what disruption change in formal corporate strategy terms.

Specifically, disruptive innovations often start out as lower performing than what they ultimately supplant and replace, but they nevertheless succeed because they are cheaper and

easier and more widely available and useful in other ways besides the traditional performance metrics.

Think about Netflix streaming, for example. When Netflix originally went online in streaming, their video quality was poor, and their content selection was poor. But nevertheless, it was available any time you wanted it. And that ultimately rode a different technological growth curve than something like a Blockbuster or the traditional Hollywood Studios.

Well, the United States is currently facing several potential avenues of military technological disruption. Think about the difference between loitering munitions and missiles. The best U.S. missiles can travel hundreds of miles at faster than the speed of sound and hit a target within an accuracy of a few meters, but they cost more than a $1 million per shot.

By contrast, you can take commercial drones as Ukrainian military forces are currently doing, lightly militarize them, and suddenly you have something that can offer a crude form of long-range precision strike for thousands of dollars. It's lower performing than the missile, but it's so cheap that you don't necessarily care about that lower performance.

The United States military is almost perfectly designed to be poorly suited to pursue disruptive military innovations. We're really good at the early stage stuff. We're really good at the sustaining innovation for improving the already good stuff.

But when there are lower performing systems that might ultimately make our existing sources of advantage obsolete, we have this massive systemic blindspot and tend to ignore those types of disruptions.

COMMISSIONER WESSEL: Thank you. Appreciate it.

VICE CHAIRMAN WONG: Commissioner Schriver.

COMMISSIONER SCHRIVER: Thank you, Mr. Chair.

And thank you our witnesses. This is absolutely fascinating and really appreciate everybody's statements. A couple questions, if I can get them in.

Dr. Ohlandt, we've heard for some time that where the Chinese have consistently struggled and lagged is in high performance aircraft engines in their fighters. Do we have a good sense of why?

And if we know why, do we know if it is the result of our actions, whether that's export control or whatever it may be, and if that's the case, can we duplicate that in other areas of potential Chinese innovation? So you get my question.

Is this sui generis, or is there something we can learn from this case study that's applicable?

DR. OHLANDT: No, it's an excellent case study which actually does have a good explanation. So, the Chinese are not the first to try to steal technology. And so engine competition between engine companies going back to World War II, after World War II, was very commonplace. And so engine companies tend not to even patent their technology.

They keep their secret sauce as trade secrets so that their competitors can't figure out what they've been doing. This is just habit in the industry for years, for decades. And so it's essentially by accident that when the Chinese show up and trying to start copying this technology, it was not easily accessible.

And even when those engine companies did joint venture with the Chinese in the '80s and the '90s, they knew -- I mean, it happened before with other partners in other countries. And so that's what's happened to it. It's really about controlling your technology and essentially not trusting other people out there.

The bottom line is that post -- after the end of the Cold War, business just figured, oh, we can work with everyone. We can trade with anyone.

It's really a case of not being foolish, how you keep your technology and what you put out there. So, on one hand, I can hope that most of the commercial world has just woken up to the fact. I've repeatedly said before is that the big difference between the Cold War and today is that we didn't trade massively with the Soviet Union.

We do trade massively with the Chinese. Business people often think, well, the Chinese have a legal system. If they screw me over, I'll go through their legal system and get a fix-it. That's not the way the Chinese legal system works. It does not work like our system in almost any way, shape or form except on the superficial level.

So anyway, there's a specific story about there, and it's kind of a lucky accident in the history things, but hopefully people learn from that lesson. And it does argue for finding what technologies we can protect. I think the recent actions on CHIPS and bringing the Japanese and the Netherlands into that arrangement, if you just go it alone, it's not going to work.

But if you think about how the market is organized, how the industry works, who the partners are, and if you can get them all on board, then you can successfully do exactly what happened by accident with the jet engines.

COMMISSIONER SCHRIVER: Thank you. That's very helpful.

Dr. Kirchberger, as a former ASW guy, I really enjoyed your testimony, and I appreciate it. I'm a little less optimistic about the U.S. commercial private sector to come aboard through education and workshops, but I appreciate knowing that an educational aspect to this might be helpful.

But would you say we know enough to know, if we didn't want to just do sort of the workshop approach but we wanted to regulate, do we know enough about the remaining chokepoints that may exist and what we can potentially control to thwart Chinese innovation in the area of ASW?

Because it sounded as though -- I heard of U.S. content as you were describing where they were getting various things, but there's also -- you said by far and away the biggest contributor was Russia.

So if we wanted to go beyond workshops and regulate, do we know enough to know where these chokepoints are, and could we effectively do this in your assessment?

DR. KIRCHBERGER: So my workshop recommendation may sound a little bit naïve to you, but it's actually coming from a practical perspective because I have worked in the naval shipbuilding industry, and I have seen things I am not willing to publicly say here in terms of how it's just individual people at a particular point in time make decisions, and they often do not have national security on their mind when they're on a tight project deadline or they see an opportunity to do something that might get them somewhere.

I'm not excluding myself in any way, right. If there's no clear regulation, you need both. You need regulation, you need also accountability. It needs to be clear what lines can be crossed, but you also need the awareness and the willingness of people to cooperate.

As a citizen of Finland, I know this approach definitely works with society preparedness there, and I was thinking similarly if you do these cross-sectoral exchanges and people share stories, what works and what doesn't work, this can really help raise general awareness. Finns say national defense starts in kindergarten. That's when they start educating them about critical thinking, and this is what it boils down to. But as to your question on the technologies. Yes,

indeed, in some respects the ship really has sailed. So some things are already in China. We don't get that reverse.

Russia is becoming so dependent on China that I'm really truly worried that going forward, they may lose all inhibitions on sitting on their secrets just because of this huge economic and political dependency that's developing.

And we've seen indications, as I mentioned, of the hydroacoustics research that they are conducting to get in the Russian Arctic, no less. So that is quite sensitive. In that sense, I don't know. It's hard to pinpoint any particular technology because the number of technologies that go into ASW is so huge.

It's absolutely vast, and I am afraid that a lot of the stuff that is like public knowledge, commercially available, so it's anywhere already in China. So I know that submarine building may be something else because specific materials are needed and the skills are not necessarily something you can learn from a book.

It's quieting technology, it requires engineering experience, and if you don't have that, it can be very hard to replicate like with the turbines. But these small undersea vehicles, it boils down to can they at some point make lithium ion propulsion for these undersea vehicles that are safe and good? Can they make data links that really have the bandwidth to transport all that oceanographic data that they're collecting?

So it boils down to these things, and I think China -- my gut feeling is that China's industries are quite well-positioned to solve a lot of the problems they still have, but it may be less easy in the actual manned submarine field.

VICE CHAIRMAN WONG: Okay. Commissioner Price.

COMMISSIONER PRICE: Thank you, and thank you all for your time today and for your research. I have so much. I'm having a little trouble deciding where to start.

But just following up on that, Dr. Kirchberger, were you suggesting that people are so focused on their silos, the areas that they're in, that they don't see the bigger picture? Is that what you were trying to get to? Okay.

As we talk about the recommendations, and all of you have recommendations in your written testimony. Some of you spoke to it more or less in what you just presented. Can you each go back to the recommendation you think is the most important and what you think would be the hardest part of implementing that recommendation? Is that too broad? I hope not. Give it a try.

DR. OHLANDT: I can do that quickly. So I think obviously the protecting the military aviation technology and developing our own is the most important one.

But the hardest one is that in the commercial aviation field, sort of figuring out what the level playing field is going to be for -- it's really about investments, is how does the government subsidize or invest in its aviation industry between Europe and the U.S.

But if we could come to an agreement between the EU and the U.S. on those issues, then all of a sudden we now have the opportunity to hold the Chinese commercial aircraft industry to a standard and potentially prevent a problem down the road.

COMMISSIONER PRICE: Yes.

DR. POLLPETER: I guess I'll take two stabs at this. One is in regards to China's space and missile programs, they've come so far so fast that I'm afraid that any major reform of export controls would probably not stop China from advancing. They've been able to just do so much. But getting along the lines of what Greg Allen has been talking about is anything we could do to properly fund and organize our export control efforts. On the other side of the coin, I think we also need to focus on how we can just keep ahead because China's not going to stop advancing

in this area. And how do we promote the basic research that is necessary to fund our missile and space programs.

DR. KIRCHBERGER: Yes, on my end, I would argue that it's very important among the allies to do this together because a lot of the advanced technologies, like tiny islands that are in one of these countries. It's a vast network of countries that are cooperating on the undersea warfare technologies.

And I think what we need is these databases or manageable tools that are user friendly, that some research facility or some business executive can actually handle to check what entity am I dealing with?

Because a lot of these counterparts that approach businesses and they may not even look like it's a Chinese company, and they may certainly not look they are the subsidiary of the state-owned company. And they go by different aliases. They sometimes change their names quite vastly and look completely different.

And it can really, really hard in practice to conduct due diligence. It costs a lot of money to do it properly. So there's the question. How do we equip the people who may be in charge in a research facility or in a company or even individuals who feel they need to do this out of their own feeling of responsibility?

How do you equip them to do this if they're not Mandarin speakers? And China is making it really difficult on purpose to do this type of research. They're now shutting down access to their scientific journals database, CNKI, that a lot of us have been probably relying on also for research. So that's the problem.

So this creation of such database costs a little bit of money and a lot of time. And the existing ones, like the one the ASPI Institute has created in Australia, the Defense University's tracker covers these research institutions well, but not businesses, and it's not geared towards particular areas like aerospace or undersea warfare. So there could be something done, maybe as allies.

MR. ALLEN: I'd like to address two recommendations in particular. The first is around export controls enforcement capacity, which I touched on briefly before.

Prior to Russia's invasion of Ukraine, the United States had some senior officials make some remarkable threats about what were going to be the effects of U.S. sanctions and U.S. export controls against Russia.

Essentially, we said we were going to cut Russia off from advanced technology and put their economy into an inflationary death spiral. Now, Russia does not publish its budget for export control evasion, but after this threat, what would you guess happened to the budget for smuggling and export control evasion in Russia? I think you're right.

And in the case of China on October 7th, AI is China's top technology modernization priority listed in their five-year economic plan. With our October 7th export controls, we said to China, your dreams are not going to come true.

What do you think happened to the budget for China's export control evasion programs? They went up. What's going on at the Department of Commerce, Bureau of Industry and Security with their budget?

In inflation-adjusted terms over the past decade, arguably it's gone down. There has been some increases in the past year, but they're actually for new programs related to protecting imports. So the export control folks have not gotten a budget increase.

I think this is appalling, an appalling mismanagement of resources. And in particular, I would point on the technology enabling capacity available to the folks who work at BIS. The databases that they mine, that they analyze in order to identify, oh, this is a suspicious export. This might be tied to an export control evasion network.

It's currently so unreliable that if you execute the same search query twice, you're not necessarily guaranteed to get the same result twice because parts of the system are crashing that frequently. These folks need help.

If you're going to base so much of your national security upon a successful export control regime, then your enforcement of that regime needs to be really strong, and we're not giving these folks the tools that they need.

The second area I want to focus on is innovation -- and I see I'm going to be told to move on, so I'll skip that one, perhaps.

VICE CHAIRMAN WONG: We can come back to you, but I do want to remind folks we do have five minutes for questions. I've been lax. I'll be more rigid coming up.
Commissioner Mann.

COMMISSIONER MANN: Thank you. I have a question for Dr. Ohlandt. It's a historian's question, but I remember writing in the early '80s when a secretary of state left his job, went to work for a leading American company, that would be United Technologies, to provide aviation equipment to China.

And the question is for how long and to what extent does the United States at least start to provide such technology to China, when did those effort stop, or did they?

DR. OHLANDT: So they evolved over the years. The bottom line is that China is a huge market. It's 20 percent of the world's population, now it's 20 percent of the world's economy, so that makes it about 20 percent of the commercial aircraft market. And so there's money to be made there.

And we have historically sold lots of airplanes to them. The bottom line was that in the opening of the '80s, it was like, okay, let's go see if we can do business.
And the bottom line is that most of the ventures did not turn out well. Airbus got a little bit deeper. McDonnell Douglas was there for a while, but then they ended up being bought out by Boeing, and so that ended. And so there were attempts.

To me, the alternative analogy actually is that with Japan, Boeing started working with them back in the '60s or the '70s, and they had the same trust issues. They used small parts. There were parts of the airplanes, so on and so forth.

On the 787, the most recent Boeing airplane, the Japanese companies essentially designed the wing, and they still build all of them. And so that trust was developed.

And the Chinese scenario didn't turn out that way, so I would argue that people were skeptical by the time the noughts rolled, around and certainly teens, I don't think any aviation business was foolish enough to realize that they were going to be able to really work with the Chinese. And COMAC was founded 15 years ago, and so that was pretty much the declaration of war from the Chinese side.

VICE CHAIRMAN WONG: Any thoughts from other witnesses whether it's undersea or whatever, to what extent did the United States ever provide help.

DR. KIRCHBERGER: Well, in the Navy, there was actually a decade from, I think, starting in the late-1970s until 1989 when the arms embargo was imposed where the United States shared very advanced technologies with China. For instance, gas turbines for naval surface vessels.

They were then, of course, no longer exported, and China switched to license producing Ukrainian gas turbines after they no longer could get the American ones, but this is one example. And there were other technologies. I know about sonar that came to China, I think, via a licensed Italian company that exported a Raytheon-made sonar system to China, for instance.

But there were a lot of other things. So that is universal. All the European and also America leading manufacturers have done that. In that decade, it seemed that China was a good counterweight to the Soviet Union. And then of course, Tiananmen put an end to that. But by that time, a lot of knowledge had already been transferred.

And in particular, the industrial infrastructures have been upgraded. So a lot of work had gone into helping the Chinese get better at manufacturing and upgrading their methods and their processes and managerial knowledge and everything. That's also very valuable.

COMMISSIONER MANN: And for AI?

MR. ALLEN: The linkages between China's AI sector and the United States' AI sector are extraordinarily deep. A report by Tsinghua University out of China found in 2019 that of all China's international collaborations in AI, more than half of the research papers were published with U.S. coauthors.

So these communities are deeply interlinked. And then on the hardware level, for the types of chips that you use to train large AI models in a data center-type environment, more than 95 percent of the chips that are used in China are designed by U.S. companies.

These are the types of chips that the export controls were designed to cut off access to. So there really isn't a part of the Chinese AI ecosystem that isn't some way drawing upon the U.S. AI ecosystem.

COMMISSIONER MANN: Thanks very much.

VICE CHAIRMAN WONG: Thank you.

Commissioner Helberg, are you with us?

(Pause.)

VICE CHAIRMAN WONG: Okay. Commissioner Goodwin?

COMMISSIONER HELBERG: Hi. I'm here --

VICE CHAIRMAN WONG: There he is. Okay, great.

COMMISSIONER HELBERG: Xi Jinping has given several speeches in recent weeks instructing his military to be prepared to go to war. Mr. Allen has rightfully pointed out that AI is one of the CCP's top technology priority. I'd like to ask a question about leakage, which was a topic alluded to by Commissioner Wessel earlier.

This Commission has recommended the instatement of restrictions on outbound capital flows to China, and particularly in areas that are sensitive technology verticals.

Can you help us understand, Mr. Allen, the specific urgency and the right analogies to think about how urgently the White House should carry out an executive order or the Congress should push through a bill to restrict outbound capital flows to China?

MR. ALLEN: There's a great deal of precision and tailoring that goes into these restrictions that I'm not prepared to speak to what exactly is right and wrong on every aspect of the restrictions, but I can say that it is at this point inappropriate for U.S. venture capital investors or other types of investors to be making large investments in China's AI sector without some kind of review for whether or not that work is going to end up supporting the Chinese national security establishment and the Chinese military establishment.

I'll point out that the United States' policy, at least with respect to artificial intelligence in semiconductors, is becoming increasingly coherent. By which I mean the October 7th export

controls focused on certain performance thresholds in the technology where the most advanced systems are not allowed to be exported, but the far older legacy systems are allowed to be exported.

And then the CHIPS Act further states that organizations that are going to receive money to invest in semiconductor manufacturing in the United States have, as guardrails, cannot make investments tied to those same performance thresholds in China.

And so I think this sort of unified ecosystem between what the United States is subsidizing in our industrial policy, what we are enacting in terms of export controls, and what we are enacting in terms of investment screening, both outbound/inbound, that all needs to be part of a coherent framework.

And I believe we're seeing a coherent framework emerge with respect to semiconductors, but there's countless more work worth doing in this area, and urgently. And I believe that the primary barrier is capacity.

The October 7th export controls, if you read them, they are extraordinarily complicated. It took a lot of smart people a really long time to identify those perfect performance thresholds.

Why haven't you seen equivalent export controls in quantum? Because quantum is also extraordinarily complicated, and it takes a long time to do this right. So if we want to move fast, then we need to design these bureaucracies with adequate capacity to be able to move fast. And keep in mind, they're also going to have to be able to update these over time. Technology does not stay constant. Those export controls that were enacted on October 7th, people are already trying to design around those controls, and that's something that needs to be constantly monitored, constantly updated, and we need bureaucracies that can move at that speed.

COMMISSIONER HELBERG: And researchers in your field, China is a very opaque system, and obviously we, by contrast, are an extremely open system. We publish transparently a lot of our AI research and so forth.

What sources of information do researchers in your field draw on in order to develop an accurate assessment of where China stands technologically relative to the U.S.?

And how confident are you that we can rely on these sources of information in order to make sound decisions to determine whether or not China is ahead or behind us in key artificial intelligence verticals?

MR. ALLEN: At the broadest level, it's not especially hard. If you go to the most prestigious AI research conferences, you will find Chinese university scholars, Chinese companies there. Their papers are winning prizes at these conferences.

If you go to the performance benchmark indexes that are maintained by a variety of academic institutions, it is utterly routine to see Chinese research organizations win.

However, there are reasons to be skeptical of paper counting or patent counting or all of the metrics. As a common management aphorism, what gets measured gets managed for better and for worse. And so these metrics are metrics that also Chinese bureaucrats track, and they might try and pad their stats.

I don't think there's going to be an effortless mechanism for us to have incredibly precise understanding of where China stands in every AI vertical, but I do believe it's not very hard to notice that the U.S. national security establish is lagging in its adoption of AI.

COMMISSIONER HELBERG: And my last question is do you think there is a chance that they might be underreporting their advancements in AI, concealing their most advanced systems?

MR. ALLEN: In regards to the academic research and commercial work, a lot of the best Chinese AI research is published in English because they benefit tremendously from being a part of the international research community.

In terms of commercial applications, they're looking to make money. And to make money, your applications need to be available to customers. So in that regard, most of it is available openly. In terms of the national security applications, yes, definitely. They're trying to keep this secret.

COMMISSIONER HELBERG: Thank you.

VICE CHAIRMAN WONG: Commissioner Goodwin, also virtual.

COMMISSIONER GOODWIN: Thank you, Mr. Chair.

And my appreciation to all the witnesses. Dr. Ohlandt, I wanted to follow up with you in your exchange with Commissioner Price in response to her earlier question about how the U.S. can work with the EU to develop a set of shared principles for investing in commercial aviation and then hold China to those standards. And in your written testimony, you referenced the long running WTO dispute between Boeing and Airbus and the cooperative framework that was actually announced to help resolve that dispute in 2021.

And in that framework, part of the deal was just that, an agreement to work to establish a working group to analyze potential disputes, to develop and articulate clear standards of acceptable investment in airlines, and to work together and cooperate in countering the non-market practices by Chinese companies. Where are we on that?

Specifically with regard to those joint efforts between the U.S. and the EU as part of the cooperative framework that was announced in 2021?

DR. OHLANDT: I must admit that I do not have any current details. I mean obviously that was good news when it happened and when it came out.

The reality is that when you're talking about trade negotiations of any sort, there are a lot of political aspects to it. Not only do they need to figure out some ground rules, but then they need to get all the political constituencies in Europe and in the U.S. that care about it to agree to it and then sign up for it.

In this particular case, I believe the threat of COMAC and China has become clear to both Boeing and Airbus, who are the primary players at hand here. And because we only have two major enterprises behind that, that the political agreement should be simpler than it is in some other trade areas.

But the bottom line is I think everyone here realizes that what I'm talking about is not easy. And as far as I know, there has not been any clear result on exactly what kind of government funding is available.

And then to boot, once you agree to the ground rules, in the U.S.'s case, you need Congress to appropriate the resources, whether it's additional fundamental research, whether it's additional STEM education, or whether it is direct loan guarantees to a Boeing project or something. I mean, all those are things that were in play.

Even if we have a set agreed of rules, it's going to take a few years before that all acts. Anyway, that's to the best of my knowledge where we are is kind of waiting for that to unfold, but we're headed in the right direction.

COMMISSIONER GOODWIN: Why don't you talk a little bit about the health of the commercial aviation industry in China, specifically the health of airlines, including not only the, I guess, two to three large carriers in China, but also a lot of the smaller independent and regional airlines.

What has been the impact of zero-COVID policies on passenger traffic, where has domestic demand for airline travel in China now, and what is the impact of airline health and airline viability in the face of those challenges on China's ability to leverage its commercial aviation manufacturing capacity to contribute to a defense capability.

DR. OHLANDT: So their aviation industry functions like all the other aviation industries, which as I said are very national-centric. Even though national carriers are not as common as they were once upon a time, every nation regulates their own sovereign airspace.

Even when you have open skies agreements, which we do in many cases, you still have a limited number of runways on which planes can land, and there are always agreements in order to attempt to keep a level playing field on international travel or passenger air traffic.

And so the Chinese airline companies, as you mentioned there are at least three big ones and then another half dozen or more little ones, they play those exact same games, except that they have to deal with the regulatory system in China, which is as we all know not as transparent as it is anywhere else. And a huge part of the airline industry is sort of your cost of capital, and that's also unclear there.

The big difference with China than it is anywhere else is that they have a large population, but it is all very densely located. The vast majority of their population is only in half their country, and they've invested heavily in rails. And so the greatest competition with Chinese airlines is Chinese rails, which is also a major priority of the government.

And so the reality is that their domestic markets are, I think, always going to be somewhat hamstrung. It's certainly not as viable as the U.S. Therefore, they're going to look to the international markets.

Certainly, the U.S. has leverage when they're talking about flying between China and the U.S., but then rest of the world has leverage in that area as well in an attempt to get them to stick to whatever standards we agree on the aircraft as well as the airline side.

COMMISSIONER GOODWIN: Thank you.

VICE CHAIRMAN WONG: Wonderful.

Commissioner Glas.

COMMISSIONER GLAS: Thank you all for sharing your sharing your expertise with us today.

My question actually is directed at Mr. Allen. I know we talked a little bit about this in your testimony, this will be part of our next panel, the importance of the Department of Commerce, Bureau of Industry and Security plays a key and critical role in terms of our enforcement activities on export controls, semiconductors being one of those areas.

We are, as you noted in your previous comments about China, is evading export controls as well as other actors. This job is becoming increasingly complicated in a world with rapidly changing technological advancements, including in AI, gamesmanship of the bad actors to engage in illicit transactions through shell companies, and just sort of the complicated geopolitical world in which we live with Russia and the complicated issues with Taiwan.

There's a lot of talk in Washington these days. It's associated with the debt ceiling and the cascading impacts of potential budget cuts or not. What is the true cost to U.S. companies, our economic and national security, if we don't properly resource the Bureau of Industry and Security? Thank you.

MR. ALLEN: Thank you for your question, and I would refer you to the comments of a previous director of the U.S. National Security Agency, which referred to China's industrial espionage efforts as the greater transfer of wealth in human history.

When China gets access to U.S. technology that they are not supposed to have access to, the cost to U.S. businesses can be extraordinary. It can be existential. It can be the end of a given business. And we've actually seen this happen in multiple industries in, not just the United States, in our allies.

Countries and companies who have decided to partner with China to access their extremely large and attractive consumer market suddenly find that their joint venture partner has taken all of the technology and that they're being forced out of the Chinese market.

Or even companies that today push back on export controls, you can find noteworthy cases in the Department of Justice in which there has been exfiltration of their data in violation, not just export controls, but just theft, law, here in the United States.

This is a major drain on the United States' economy. And the amount of money that we're talking about to strengthen the Bureau of Industry and Security is trivial. We are talking about a price of a helicopter per year. That would make a potentially 4x to 5x improvement in the average productivity of a BIS analyst.

I do not say this lightly. I think this is the highest return on investment opportunity anywhere in U.S. national security.

COMMISSIONER GLAS: Given that, why do you think that we've seen a relatively static budget given the complicated nature of some of our relationships?

MR. ALLEN: I think we're focused in export controls on the wrong conversation. Should we export control this, should we export control that. That is not a conversation that Congress should be having. The bureaucrats need to be empowered to make those decisions.

Obviously, may be given the top-level leadership and guidance as to what is the priority and how they should be able to make rules, but they need the flexibility to move agilely and actually act. And then they need the capacity, bureaucratically, to do it.

But when do the lobbyists dissent in Washington? It is about a specific item being export controlled, which even if it's in the five-year or ten-year interest of a given company, might lead to a pretty bad quarter. And a lot of leadership of companies think in those terms.

And so there's not really, in the same way that we have a major defense industrial base, there's not a Department of Commerce industrial base that is arguing constantly for why it's worthwhile to strengthen this organization.

And the folks who scream loudest about export controls and who do hire the most lobbyists are usually the folks who are thinking about the quarterly earnings impact, not the long-term national security interests of the United States.

COMMISSIONER GLAS: Thank you.

VICE CHAIRMAN WONG: Commissioner Friedberg.

COMMISSIONER FRIEDBERG: Thank you, and thanks for our witnesses for another excellent set of presentations.

Dr. Kirchberger, I'd like to start with you. I think you've correctly pointed out that U.S. undersea warfare capabilities are a key area of continuing advantage for the United States. In some ways, this is becoming even more important as China's ability to target surface vessels and fixed targets off their coasts has increased.

And so not surprisingly, we see now that China is increasing its efforts to improve its capacities in anti-submarine warfare. But really as you point out, they're just getting started. My understanding is that it took the United States decades to really master anti-submarine warfare.

So my first question would be what reasons are there for thinking that China can do this more quickly? Do they have an easier problem because they're not so much concerned with open ocean search but because they're focused on their coastal areas?

Are there possible technological breakthroughs that are just over the horizon that could allow them to make the oceans transparent or something along those lines?

DR. KIRCHBERGER: Thank you, Commissioner, for an excellent question, really. I'd just come from a submarine conference at the Naval War College, so we had a lot of discussions on exactly these topics there. One has to understand that China is facing a fundamentally different situation and challenge when it comes to undersea warfare than the United States was facing in the Cold War.

So you have a globally operating navy that consists today exclusively of nuclear-powered vessels because you need them to have the range and the speed, you need them to protect carriers, for instance, and then you had these SOSUS installations in the Greenland-Iceland-U.K. gap basically to catch Russian submarines when they try to transit into the North Atlantic.

So China is basically a country that is fenced in by the First Island Chain and has extremely shallow, crowded, noisy littorals to watch over, to conduct area defense in. So for this type of operating area, you need a fundamentally different approach and that they are following with these diesel submarines that are relatively small, and they can really become invisible in such an environment.

I think this what Commissioner Schriver was referring to as an ASW practitioner you know trying to find such a submarine in such an environment with the most advanced technologies is a needle in a haystack. You can basically forget about it once it has an AIP propulsion system, and this is what the Chinese have by now.

So this is the one side of the coin, the area defense aspect. This can become really nasty in terms of a Taiwan scenario, blockade scenario or whatever because even a single submarine can really threaten a very large area and make it very, very hard for surface ships to operate there.

And then of course the Chinese have the aspect of nuclear deterrence. They want to break through the First Island Chain. They want to get first control of the South China Sea of the deep areas in the South China Sea, the only area that China can actually access directly from its own uncontested coastline to have a sanctuary for its boomers and its nuclear submarines basically to operate.

And this is what they're trying to do. They want to squeeze everyone out, and this has never actually been a focus for the United States in that sense. United States boomers have been operating under the Arctic ice and everywhere where they wanted.

Whereas the Chinese are sort of trying to copy what the Russians are practicing up in the Kola Peninsula area with their Bastion approach. So this is fundamentally different. And also, therefore, the technologies that they're focused on and the things that make a difference are different.

COMMISSIONER FRIEDBERG: Okay. Thank you very much.

Mr. Allen, if I could just very briefly. Would you say that it is accurate to describe the objective of U.S. strategy regarding China's artificial intelligence industry to slow their development in artificial intelligence? Is that now the goal?

MR. ALLEN: Yes, that is now the explicit goal. And I would go further. The October 7th export controls were in some sense narrowly targeted, going after only the most advanced AI chips and the most advanced semiconductor manufacturing technology. But in a larger sense, they were a reversal of 25 years of U.S. trade and technology policy toward China.

We have, for a long time, had a policy of slowing the advance of China's technological progress. This is the first time I'm aware of in which we took steps to actively degrade China's technological capability, which is to say there are certain semiconductor fabrication facilities in China with certain advanced technologies.

Our goal was to shut those facilities down. And similarly, if you think about the most advanced AI models in use today, things like ChatGPT, GPT-4, the equivalents, cutting off China's access to the most advanced chips is designed to prevent them from not really accessing that current state-of-the-art, but preventing them from accessing what the state-of-the-art will be in five years and ten years.

COMMISSIONER FRIEDBERG: Thank you.

VICE CHAIRMAN WONG: Thank you. Commissioner Cleveland is taking a pass, so we'll move to Commissioner Borochoff.

COMMISSIONER BOROCHOFF: Thank you.

COMMISSIONER CLEVELAND: Actually, I'm here. Sorry.

VICE CHAIRMAN WONG: Okay. Well, let's revert back. Commissioner Cleveland.

COMMISSIONER CLEVELAND: Thank you, and I actually want to build on what Mr. Allen just said that the October 7th controls were designed specifically to control AI and degrading capability. Can you talk a little about how that effort might or might not be supported by our European allies?

Are they relevant to the process? Are they irrelevant? And if this is actually an active effort to degrade Chinese capabilities as you say, how are we collaborating with and what are the consequences with Europe?

MR. ALLEN: The October 7th export controls are an interlocking mechanism designed to target various chokepoints in China's AI and semiconductor industries, and it would take me some time to explain how the various chokepoints depend upon one another.

But with regards to cooperation and Europe, I'll focus specifically on two chokepoints. The first relates to the design of the most advanced chips for processing AI algorithms. These chips are typically designed by U.S. companies but manufactured in Taiwan. But when they are manufactured in Taiwan, they are using U.S. semiconductor design software, and they are using U.S. semiconductor manufacturing equipment.

Based on that standard, the United States has applied the Foreign Direct Product Rule, which means that Taiwanese manufacturers will not accept chip designs that are destined for sale in China whether they are coming from a Chinese company or a European company.

So our use of the Foreign Direct Product Rule and the centrality of Taiwan in the semiconductor ecosystem has implications for European compliance in the area of chip design.

In the case of semiconductor manufacturing equipment, there are five companies that dominate the global market for semiconductor manufacturing equipment. One of those companies is a Dutch company, ASML, which is involved in the production of lithography equipment principally.

The Dutch government, just last month, announced a new set of export control policies that will cover advanced deep ultraviolet lithography machines, and this follows on the Dutch government's decision to apply export controls to extreme ultraviolet lithography machines.

So with regards to the Netherlands, I believe we have been seeing precisely the cooperation that the United States is seeking. Although, in their announcement, the Netherlands did not mention either of the United States or China, and there is no formal announcement by any party of the existence of an agreement to this effect.

The other country that I would point to in Europe that is most significant would be Germany, which is not a leader in the integrated semiconductor manufacturing equipment, but is a major leader in the supply of semiconductor manufacturing equipment components. They make the lasers and the mirrors that go into ASML's lithography equipment, among many other items. And we have not yet seen any movement from the German government or the European Union as a whole related to these types of export controls.

And although you did not ask, I would also add that Japan is a giant in the field of semiconductor manufacturing equipment, and Japan also recently announced export controls that are broadly consistent with those that the United States adopted on October 7th.

And here again, there is no mention of an agreement or no mention of China. Though, I believe the effect will be aligned to U.S. intentions as stated in the October 7th policy.

COMMISSIONER CLEVELAND: Thank you. That's very helpful, particularly on the lack of movement on the German and EU on lasers and mirrors.

I have one more question following off on Commissioner Helberg asked whether or not the Chinese were potentially concealing some of their most important national security data, and you talked about paper counting and the metrics they could pad, statistics.

Could you comment on the recent decisions that the Chinese are withholding data in publicly-released research documents and what that might mean in AI and quantum and other areas?

MR. ALLEN: Briefly, I do believe this is directly tied to U.S. export controls, which is to say that China pays attention to U.S. export controls, and China also speculates on what might have been the information that drove those export controls.

And I think there is now increasing caution in both China and Russia about openly acknowledging the existence of commercial ties or academic ties that might ultimately result in sanctions or export controls.

COMMISSIONER CLEVELAND: They're withholding data to prevent sanctions control?

MR. ALLEN: That is correct.

VICE CHAIRMAN WONG: Great, thank you.

COMMISSIONER CLEVELAND: Thank you.

VICE CHAIRMAN WONG: Commissioner Borochoff.

COMMISSIONER BOROCHOFF: Thank you.

In the little over three years that I've been here, all of us have seen a tremendous increase in the awareness of our elected officials as to the tremendous danger that exists with both in the export control area and outbound investment area.

And a year ago, there was a lot of discussion about the variable interest entities at one of our hearings and the fact that they routinely change names, routinely get on an entity list, and suddenly they're not making the same thing or they are owned by someone else.

We had a Commissioner who is very adept at doing his own research and found companies in China that were partially owned by a hotel company that had a small investment in a nuclear warhead company.

So this question is a little bit to anybody who wants to comment it, but I'd like to start with Dr. Kirchberger and then go to you, Mr. Allen.

You mentioned the Australian lists that have been compiled. The prime minister there kind of famously said, we're going to stop the influence of China, and we're going to start identifying the companies that are dangerous to us.

And they tied it to a variety of both outbound and inbound investment in their country, as well as creating export controls for themselves. My question is, is that a model, what they're doing, where they're trying to track the companies in a little different way, I think, than we are at BIS.

I know that BIS is both undermanned and unable to -- sometimes, they can't even keep people on the entity list from winning in court. So I'd like to hear your view on some of -- I know you're a naval expert, but it translates to all these other issues as well.

DR. KIRCHBERGER: I am also a foreigner, so I have not worked inside the U.S. system ever. I only know the export control system in the country I live in, which is Germany. But I must say from my perspective, I constantly use these Australian tools and databases that they've created because it's very convenient and user friendly.

It's relatively recent, so there is not all the data in there yet that needs to be in there. It has always functioned off the manpower that is available on the time and the funding for that, ultimately, because the research is very time-consuming.

And it is about to get more time-consuming because China's indeed taking steps to prevent exactly the type of information that is interesting to people like us to leak. So lots of entities do not longer have a website. They basically shut down their websites.

Sometimes, one has to go to the Wayback Machine and find old versions of the website and get the information. I have come to great lengths to actually look into the company profiles created by securities companies within China of particular entities of interest because these company profiles that are written for Chinese investors, they contain a surprising amount of detail.

And now that I said this out loud, probably this is the next kind of thing that's not going to be available. So, yes, the short answer is yes.

COMMISSIONER BOROCHOFF: Do you find them credible?

DR. KIRCHBERGER: The Australians are doing it well. And since they've made this good start, I think rather than duplicating than what they already did, maybe just work with that and enlarge that. That would be my recommendation.

MR. ALLEN: I would echo that Chinese corporate ownership structures have always been Byzantine and largely opaque, and I think they're about to get considerably more opaque. There's two things that I would point out, though, which is that there was additional tools for the entire Bureau of Industry and Security that were created as part of the October 7th export control regulations.

The first is making the unverified list an automatic pathway to the entity list. If the Chinese government and the entity in question do not cooperate with and use checks. I believe this is a useful new authority for the Bureau of Industry and Security.

The second is that the chip restrictions and the semiconductor equipment restrictions are no longer even attempting to apply on a military end use, military end user basis. They are now applying on a China-wide basis. And I believe that this is appropriate.

Essentially, the United States for decades had been saying to China that we are willing to allow commercial exchange to expand rapidly, but we do not want to be involved in promoting the growth and technological advancement of your military.

And I believe China's rebuttal was a policy of military-civil fusion in which the deep linkages between their commercial entities and their military entities were both strengthened and made more obscure. And so I believe that this China-wide restriction is an appropriate next step, but at present, this only exists in semiconductors and AI, and we'll probably need to apply it to other areas.

COMMISSIONER BOROCHOFF: Thank you.

VICE CHAIRMAN WONG: Wonderful.

Chairman Bartholomew.

CHAIRMAN BARTHOLOMEW: Thank you very much. Thank you to all of our witnesses.

Dr. Kirchberger, I noted in your bio that you speak Finnish among the other languages, and I was going to be very impressed by that. However, because you grew up in Finland, it was a whole lot easier to do.

(Laughter.)

CHAIRMAN BARTHOLOMEW: Dr. Ohlandt, just a comment before I get to my questions, and that is, of course, the competition between Airbus and Boeing has been used by the CCP to achieve other ends for several decades.

And we've seen most recently that Airbus is, even from this trip that President Macron just took, Airbus has signed another agreement in order to shift some assembly and production into China. Thank you for mentioning the impact on the industrial base -- the industrial manufacturing base.

Dr. Allen, I will ask a question, but I'm going to ask the other people first. You mentioned disruptive innovation. I appreciated your definition. This morning, in the panel that we had before, there was a discussion about the R&D sort of process instructor in China.

Are they better positioned to do disruptive innovation as you defined it than we are? But before, I don't know how any of you sleep at night knowing what you know about the challenges that we have.

But let's start with Dr. Pollpeter. Is there something in particular? I mean, we know about challenges with propulsion systems and quieting technologies and jet engines that the Chinese are having difficulty getting.

But sort of looking forward, is there some technology or something that you are concerned that they are going to get that makes you think it's over when they get that?

DR. POLLPETER: My concern is that one of the things that I fear they already have, which is some sort of orbital bombardment system, if they're able to perfect that, which they tested back in 2021. But looking forward beyond that, there's maybe nuclear propulsion for spacecraft, electric propulsion.

China is very interested in exploiting the economic resources in space, so things like space-based solar power or asteroid mining or even moon mining, things that we're looking at as well, has the potential to change the economic structure or the economic plan in how you regard space programs.

CHAIRMAN BARTHOLOMEW: Great, thanks.

Dr. Ohlandt, any particular thing other than what we know about their inability to do some things with jet engines that you see? And actually, I wanted to ask about new materials in

aviation. Is there innovation going on and new materials that might have an impact that they're ahead of us on, for example?

DR. OHLANDT: Not that they're ahead of us. I'll start with the new materials; that's the easy one. I'll harp on what my fellow panelist said. Our allies have material technologies that are better than the U.S. and composite technologies. There are a number of countries that do that.

On one hand, they are vulnerable to the Chinese getting access to those. They're outside U.S. control. But number two, we in the U.S. want access to them, and we want to leverage them. But particularly in the defense space, we prefer to buy our weapons from our companies and our own domestic industrial base.

And so I would argue that cooperating with our allies, especially in technology areas where they have advantages -- where they have something that is better than what we have here is exactly both to protect it from the Chinese getting it but then also for us to be able to leverage it and work with them. And so materials happen to be one of them.

I'll leave it there.

CHAIRMAN BARTHOLOMEW: Dr. Kirchberger.

DR. KIRCHBERGER: Yes, I think with the submarines and such, they are set with the Russian help, so they will have good enough submarines, let's put it that way. But I'm concerned, actually, about this ocean surveillance network ambition that they have.

And it ties together, actually, artificial intelligence because you need AI algorithms to make sense of the vast amounts of oceanographic and other data that you're going to collect in such an active and passive sensor network. And this data needs to be transmitted through data links via satellites, actually, to computing centers.

So there's a couple of chokepoints, you could say. On the one hand, it's the data links and such. They need to have the bandwidth, but also you need the processing power and the algorithms. And this is where I'm worried, and I'm wondering.

I'm not an expert in that field, so I can't say what kinds of technologies in particular with semiconductors, what types of AI developments are particularly important for achieving this type of multistatic ASW that the Chinese are aiming at.

But what I do know that in experiments and satellites constellations, by the way, they play a major role in ocean surveillance. So these nanosatellites, even commercial small nanosatellites, the Chinese have been shooting satellites into the sky at an amazing rate the past couple of years.

And some of them already equipped with AI algorithms to do something like automatic ship recognition for surface ships and so on. So what I'm wondering is where can we maybe find chokepoints in these types of technologies because if they actually are successful, what they could realize in some littoral areas is the transparent ocean for themselves.

So they see everyone else, but nobody else knows where the Chinese submarines are. That would not be a good situation.

CHAIRMAN BARTHOLOMEW: Thanks.

Dr. Allen?

MR. ALLEN: First, I regret to inform you that I'm not a doctor.

(Laughter.)

MR. ALLEN: Your question about whether or not China is better positioned to do disruptive innovation. I believe there's certainly reason to suspect that they are and that they would be. I mentioned that I previously served in the Department of Defense at the Joint

Artificial Intelligence Center. I'd like to share just two anecdotes that I thought were remarkably illuminating.

The first is I had the privilege of befriending a program manager at a U.S. intelligence community research agency. His process for receiving a security clearance prior to his managing a portfolio of AI research programs, his security clearance took three years. That's three years of him not doing that work in U.S. national security where the shortage of talented folks is just astonishing.

The second, I would say, is in -- when we were procuring AI technologies, if you had come from the future in a time machine with the specific exact system that I wanted and needed, you're probably at least six months to a year away from touching the warfighter.

That's how extraordinarily time-intensive the cybersecurity reviews are, the integration security reviews are, et cetera, et cetera. And I would contrast that with the fighters in the war in Ukraine who have demonstrated AI being an idea in somebody's head to it being a beloved application on the battlefield in a matter of weeks.

When it comes to China, I want to be honest that we know less, especially at the unclassified level, about all of their military uses of AI.

But at least in terms of their strategic documents, they certainly talk about it as a leap frog technology, as the type of technology where just because we are behind the United States in this area or that area, doesn't necessarily mean we're going to have a disadvantage in making it to the next generation of technology.

So I believe that they're thinking about it in disruptive terms, and they're pursuing it in disruptive terms. Thank you.

CHAIRMAN BARTHOLOMEW: Great. Thanks. Yes, the Ukrainians have just been really extraordinary in what they've been able to do, both at the low-tech level with grenades and commercial drones and also on the AI front.

Dr. Kirchberger, it's not a question. I just meant when I mentioned that you were from Finland to note how pleased we are that the Finns have joined NATO and how much we have to learn from you, from the Finnish society about critical thinking in young children all the way through to a security system. Thanks.

DR. KIRCHBERGER: Thank you.

VICE CHAIRMAN WONG: Dr. Pollpeter, I think it's worth emphasizing and perhaps framing some of the implications and statements of your testimony on the nuclear arsenal of China. China is engaged and has been engaged in a rapid increase in buildup of its nuclear warheads.

And not just of a strategic high-yield nature, but of lower-yield tactical warheads which introduce challenges to traditional nuclear doctrine, and I believe greatly increase the chances of an actual nuclear exchange in warfare. They're pairing this with a massive buildup in missiles, and in particular intermediate-range missiles of which they enjoy an advantage of thousands. The United States' arsenal currently has zero, I believe.

They have also added a new leg to the traditional nuclear triad, as you said, to make it a nuclear quad, of space based or space launched missiles which make ballistic missile defense obsolete and also happens to be in violation of a 50-year-old treaty on the militarization of space of which they are a party.

And they're doing this all without participating in any nuclear transparency discussions, crisis management mechanisms that during the Cold War were key to ensuring that that war stayed cold and not hot in terms of nuclear warfare.

So I lay this out to ask, number one, whether you kind of agree with that framing. And number two, given that framing, is the United States doing enough to meet this nuclear challenge, and is the nonproliferation community internationally putting enough focus on China, on pressuring China, on proposing new mechanisms to control all of these areas where China is greatly expanding the nuclear threat scenarios for the world?

DR. POLLPETER: Chairman, I guess I would have to agree 100 percent with everything you said. I think it's almost, to some extent, an existential problem for the U.S. Their ability to maybe use nuclear weapons at a lower threshold if they're using, let's say, several kiloton nuclear weapons against an aircraft carrier battle group.

It really takes away that proportional response since we have much larger warheads. What are we going to do? Nuke downtown Beijing? We're left with very few options that are really escalatory.

Unfortunately, I think the PRC government has demonstrated in the past few years that time and time again that they are not interested in discussing any sort of arms control, whether it's about AI, whether it's about cyber, whether it's about space or whether it's about nuclear issues.

I just think that they don't see that it's in their advantage right now to engage in those discussions. And that any sort of discussion would naturally lend some sort of advantage to the U.S. So I'm pretty pessimistic about any type of arms control effort that would bring the Chinese around to the negotiating table.

And I also think that efforts on part of the nonproliferation community would probably similarly be unsuccessful. I just don't think they have that interest. Which then leads us to then what are our responses, what our strategic responses, and whether that means that we need to create a more diversified nuclear arsenal, whether we need to think more about developing our IRBMs, MRBMs.

These are tough decisions to make. It would be a big change from the way we have conducted nuclear deterrence for the past few decades, but I think it's a discussion that we need to start having because we certainly don't want to be held hostage to some sort of nuclear threats that China may pose.

VICE CHAIRMAN WONG: Thanks.

In the 50 seconds we have left, Dr. Kirchberger, I just want to ask a little bit of your views on AUKUS as a mechanism for doing allied coordination on undersea warfare capabilities of our own and perhaps implementing some of the recommendations you've made on controlling technology that goes to China since it seems like AUKUS really is, at least at this point to me, the main feature is on submarine capabilities.

DR. KIRCHBERGER: Thank you, yes. Actually, I have seen AUKUS when it was first announced first as a policy signal since it's going to take a long time to actually bear fruit, so to speak. But it was a policy signal towards China, from their point of view, very undesirable outcome for sure.

The fallout within Europe as you know was a little bit ambiguous because of the, yes, unfortunate situation that France found itself a place in. But I think leaving that part aside, I do find it is a promising approach, really. Because what we have here is a synergy.

We have Australian interests in getting a really a viable long-term solution for their submarine problem. And we have this convergence, you could say, of fear that the situation in East Asia and the Western Pacific could become unstable.

And it is feedback that the Communist Party needs to get, I think, that allies that have long been sitting on the fence about China and not trying to alienate China in any way, are willing to take such drastic steps, really.

And you see it also in Japan, you see that in some countries in Europe that they're really doing things that would have been unthinkable, frankly. Take the Czech president-elect's phone call with the Taiwanese President Tsai. This would just not have happened a couple years ago. So I believe the true value of AUKUS will only unfold in the technology sense over many years. I do think it's promising, in particular also the technology sharing agreements that it entails, not just in terms of the submarines that ultimately are going to come out of it.

It might be a good impulse also on strengthening the submarine building base because there's a chokepoint there on our side, right. The British and the American infrastructure for building submarines, they're just not geared to enhancing the output quickly.

And that is one of the problems that we're facing also now with the Ukraine war depleting a lot of systems, and we need to sort of get industry to be able to cope with more demand in a quick time.

And that's one of the things that AUKUS could provide a stimulus to to get production geared up a little more. This is just waiting for more details on actual AUKUS transactions, so that's all I'm going to say on that.

VICE CHAIRMAN WONG: Thank you, and thank you to all of our panelists. That was very edifying.

We will take a one-hour break for lunch and reconvene at 2:05. Thank you.

(Whereupon, the above-entitled matter went off the record at 1:09 p.m. and resumed at 2:04 p.m.)

## PANEL III INTRODUCTION BY CHAIRMAN CAROLYN BARTHOLOMEW

CHAIRMAN BARTHOLOMEW: Our third panel today will provide a frame -- a forward-looking assessment of how Congress, the Administration, and U.S. allies and partners could close loopholes in existing export control and investment screening policies and procedures and develop new policies and procedures in order to control technology flows to China for use in advanced weapons.

First, we'll hear from Cordell Hull, a Visiting Fellow at the George Mason University's National Security Institute. He's the former Acting Undersecretary of Commerce for Industry and Security.

He's a new voice for the Commission and will discuss U.S. domestic export controls. Welcome.

Next, we will hear from Martijn Rasser, who is the Managing Director at Datenna, is that how it's pronounced? Datenna, Inc.

Mr. Rasser is also appearing before the Commission for the first time, and he will discuss opportunities and obstacles in international coordination on export controls.

Finally, we will hear from Emily Kilcrease, who is a Senior Fellow and Director of the Energy Economics and Security Program at the Center for a New American Security.

Ms. Kilcrease will offer prospective steps the U.S. can take to improve inbound investment screening and pilot an outbound investment screening mechanism. Welcome back Ms. Kilcrease.

I smile when I read people's titles, because they all seem to be getting longer and longer and longer. And, I wonder how they fit on business cards.

Thank you all very much for your testimony. I'd like to remind you to keep your remarks to seven minutes.

Mr. Hull, we'll begin with you.

**PREPARED STATEMENT OF CORDELL HULL, VISITNG FELLOW, NATIONAL SECURITY INSTITUTE**

MR. HULL: Thank you, Chairman Bartholomew and Vice Chairman Wong, it's a pleasure to be before the Commission this afternoon. I am delighted to be joined on the panel by Martijn Rasser and Emily Kilcrease, two distinguished experts in their field.

My testimony today will focus on how export controls address the PRC's military modernization; the government's effectiveness in identifying and controlling technology to ensure it is not illicitly transferred to the PRC; potential steps to streamline the export-control process; the effectiveness of enforcement; government and private-sector coordination; as well as policy recommendations for the Commission.

Before providing my remarks, as the Chairman noted, I'm here in my capacity as a Visiting Fellow at the George Mason -- at National Security Institute of the George Mason School of Law. Any remarks I give are in my personal capacity and not meant to reflect any views of any organization with which I'm affiliated.

While in the government, I had the privilege of seeing export controls and foreign investment from the legislative and executive side. As is clear from my background, I have a strong view of national security, and in particular the challenges posed by the PRC.

My time as Undersecretary was spent implementing ECRA and FIRRMA, something I'm sure we'll talk a lot about today, with a particular view on the varied challenges posed by the PRC.

From China's increasing assertiveness to disrupt the rules-based international order, to its repression of human rights, to its well-known policies of military-civil fusion, it's an export-control challenge unlike any we've ever seen.

Adding to the fact that our economies are intertwined to a degree never before seen with an adversary, the challenges are many. But, we must continue to regulate in a way that doesn't inhibit research and development that has allowed us to out-innovate much of the world.

It's important to bear in mind that export controls are a time-limited solution that gets less effective each day, as our adversaries continue to make strides in the inevitable advancement of technology.

And, we should also recognize the world is shrinking. We can no longer unilaterally control our way out of things and hope to have a preclusive effect on what our adversaries are able to obtain.

We need to work with allies and partners to ensure that we're aligning controls where possible and affecting the best possible controls we can.

Our mantra should be this, multilateral and plurilateral where we can, unilateral where we must. But, let me be clear, if the call is a close one, national security must win.

I'll talk about the successes of some of our recent export-control moves, as well as offer some ideas for moving forward.

We've had to see change in the way export-controls have been done in the last decade or so. We've seen enhancements of the Entity List, from putting Huawei, then the largest telecommunications company in the world on the List, to using the List to sanction those who are repressing Uyghurs and other Muslim minorities in China, actors undertaking malign activities in the South China Sea, as well as trade-secret theft.

We've issued rules that attach China's efforts for military-civil fusion, or MCF. We've also put out the Foreign Direct Product Rule, which in short puts controls on designated items to actors when those items are created using any U.S. origin technology.

Perhaps most effectively and most recently, in October the Department of Commerce along with the interagency put out strong controls aimed at China's indigenous semiconductor industry.

And, what it did there was attack China's ability to produce high-end graphic AI chips, or to receive high-end graphic AI chips, as well as certain types of semiconductor mat -- semiconductor manufacturing equipment.

Those efforts were rewarded by plurilateral adoption or upcoming plurilateral adoption, I should say, with the Dutch and the Japanese Governments, which of course, will make the controls even more effective.

But, there are additional opportunities for success. China is a determined, persistent adversary. We should seek to align our control, export controls with other tools in the U.S. toolkit, including the China Military Industrial Company List, administered by the Treasury Department, visa restrictions administered by the State Department, and investment controls.

There's also been discussion about a fifth multilateral export control regime. And, although I'm not opposed to the idea of aligning with other technodemocracies, I do remain a little hesitant that another regime based on consensus would be effective given the challenges we face and the differing views of our allies on Russia, on China, excuse me. And, Russia as well. With that said, we should still try. We should also work with our allies to help them align their legal authority so they're able to issue controls in the same way that we can, or at least a similar way.

So, where multilateralism maybe insufficient, I'm much more confident about plurilateralism. As we've seen with the October 2022 controls for the semiconductor controls, as well as the Foreign Direct Product Rule arising out of Russia's invasion of Ukraine, plurilateralism can work. I think it is the new normal.

The government works hard and generally does a good job controlling technologies of concern. Two areas where I think the government is having particular struggles are AI and quantum computing.

I am certainly happy to talk about why I think that is. Unfortunately, I'll put out at the outset, I struggled to come up with a strong, coherent answer for that.

So, I hope not to leave you disappointed with it. But, it's something that I think we do need to discuss.

I also said I would talk about enforcement. As you can imagine with things like semiconductors and other small dual-use items, enforcement is quite difficult.

There were 41,446 licenses issued in fiscal year 2021. Of those, only 1,030 received end-use checks. Quite simply, there are so many items out there, and we're not able to check all of it. As well as in the PRC, there are administrative obstacles with from pre-clearance with Chinese government authorities to inevitable time delays that really prohibit us from doing an effective job of doing end-use checks in China.

It's also important that we continue to have interaction with the private sector. But sides, the government and the private sector bring important pieces to the export-control debate. And, it's important that both sides are talking.

Unfortunately, a challenge that I found both now in the private sector and when I was in government, is that the private sector often wants advanced notice for controls. That's obviously

difficult as we saw with Huawei, with stockpiling. It took three and a half years after Huawei's listing to work through.

But, mindful of the time, let me touch on quickly my recommendations and then I'm happy to discuss it further in the question and answer session.

I do think we need to study a single licensing system and perhaps a single licensing entity. Right now, the defense articles and dual-use export controls are administered by two different agencies pursuant to two different lists. We should consider whether that continues to make sense.

I think we should delink export controls in CFIUS. I think the technology is moving much too quickly. And, we run the risk of our allies being able to run faster before we're able to bring transactions into CFIUS and effectively review them.

And finally, we should consider when listing a party on the entity list that we list the party's entire set of subsidiaries rather than just the top level.

But, thank you. I am pleased to take your questions.

CHAIRMAN BARTHOLOMEW: Great. Thank you. Mr. Rasser?

**PREPARED STATEMENT OF CORDELL HULL, VISITNG FELLOW, NATIONAL SECURITY INSTITUTE**

**Testimony before the U.S.-China Economic and Security Review Commission**

Hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"
Panel III: "Policy Tools for the United States and Its Allies and Partners"

Cordell A. Hull
Former Acting Under Secretary of Commerce for Industry and Security (2019-2020)
Visiting Fellow, National Security Institute,
George Mason University Antonin Scalia Law School

April 13, 2023

## Introduction

Chairman Bartholomew and Vice Chairman Wong, it is a pleasure to be before the Commission this afternoon. I am delighted to be joined on this panel by Martijn Rasser and Emily Kilcrease, both distinguished experts in their fields.

My testimony today will focus on: (i) how export controls address the People's Republic of China's (PRC) military modernization; (ii) the government's effectiveness in identifying and controlling technology to ensure it is not illicitly transferred to the PRC; (iii) potential steps to streamline the export-control process; (iv) effectiveness of enforcement; (v) government and private-sector coordination; and (vi) policy recommendations for the Commission.

Before providing my remarks, I would like to state that I am testifying to you today in my capacity as a Visiting Fellow at the National Security Institute of George Mason University's Antonin Scalia Law School. The views expressed in my testimony are personal and do not reflect the views of any organization with which I am affiliated.

While in government, I had the privilege to see export controls and foreign investment from the legislative branch and implementation in the executive branch. While serving as the Acting Under Secretary for Industry and Security at the Department of Commerce, I worked with my interagency colleagues to implement the Export Control Reform Act of 2018 and, to a lesser extent, its companion legislation the Foreign Investment Risk Review and Modernization Act (ECRA and FIRRMA, respectively). Both pieces of legislation were items I worked on when I was the General Counsel of the House Permanent Select Committee on Intelligence.

As is clear from my background, I have a strong view of national security, and in particular the challenges posed by the PRC. My time as under secretary was spent implementing ECRA and FIRRMA to meet the many and varied challenges posed by the PRC.

From China's increasing assertiveness to disrupt the rules-based international order, to its repression of human rights, to its well-known practice of military-civil fusion (MCF), it is an export-control challenge unlike any this country has faced before.

Adding to the fact that China is our country's largest trading partner, and our economies are intertwined to an extent never before seen with a foreign adversary, we must remain laser-

focused on ensuring our technology and innovation are not turned against us. But we must do so in a way that does not unnecessarily inhibit research and development that has enabled us to out-innovate much of the world.

It is important to bear in mind that export controls are a time-limited solution and that controls may get less effective each day as technology advances and/or adversaries find work arounds. To be optimally effective, they must account for foreign availability and should be implemented with other actions, such as investment restrictions, but also ensuring we continue to run faster.

We must also recognize that the world is shrinking. No longer can we unilaterally control a wide variety of items and have a preclusive effect on inhibiting our adversaries' abilities to obtain them. Working with allies and partners is essential to ensure that controls we put in place are effective while taking care not to limit progress. Our mantra should be: multi- or plurilateral where we can, unilateral where we must.

Let me be clear: if the call is a close one, national security must always win.

But as the U.S. government moves to create and implement new tools in the export-control arena, it must ensure that it is doing so in a way that does not inhibit innovation, has a clear view of the national security problem it is trying to solve, and uses all sources of information to solve that problem.

**U.S. export control system's role in China's defense modernization**

The last decade or so has seen a profound shift in the way we consider dual-use export controls related to PRC.[1] The U.S. government, led by the Department of Commerce's Bureau of Industry and Security (BIS), where I served, has led the way in implementing that shift.

While several of the actions listed below represent successes in the U.S. government's efforts to ensure American technology is not being used against our interests, more can and should be done.

**Entity List**

Perhaps the most publicly known change is the enhanced use of the Entity List. That list permits BIS to impose a license requirement under the Export Administration Regulations (EAR) for exports to parties on the list when they are "believed to be involved" or risk becoming involved "in activities contrary to the national security or foreign policy interests of the United States."[2] The U.S. government has broadened the use of the list mostly from front companies diverting

[1] I use the caveat of "dual use" because shipments of defense articles or services have been largely prohibited to China because of the uprising in Tiananmen Square in 1989. Following the PRC's actions to stifle pro-democracy protestors, Congress amended the Arms Export Control Act and its implementing regulations, the International Traffic in Arms Regulations. 22 U.S.C. § 2778; 22 C.F.R. § 126.1 (listing China as a country subject to a "policy of denial"); *see also* Name Redacted, China: Economic Sanctions, CONG. RES. SERV., R44605, at 6 (2016), https://bit.ly/3FBX9rL.

[2] 15 C.F.R. § 744.16.

controlled technology and scientists involved in proliferation activities to large multi-national companies. That use brought about wide-ranging effects on U.S. and allied industry.

The addition of Huawei in 2019,[3] then the largest telecommunications firm in the world, brought the list into the consciousness of many Americans. In the years since, there have more than 100 Huawei-related entities added to the list. BIS also added the Semiconductor Manufacturing International Corporation (SMIC), China's national champion semiconductor fabrication company, due to its support of the PRC's military modernization efforts.[4]

The Entity List's expansion has not been limited to Huawei and SMIC. There have been novel listings related to human rights in the Chinese Communist Party's (CCP) repression of Uyghurs and other members of Muslim minority groups in the Xinjiang Uyghur Autonomous Region (XUAR);[5] malign activities in the South China Sea;[6] and trade-secret theft.[7]

A recent listing further underscores the scope of this shift to ensure the PRC's military is not using our technology and innovation against us or for repression around the world. In March 2023, BIS added three subsidiaries of BGI, f/k/a Beijing Genomics Institute, to the Entity List because the "actions of these entities concerning the collection and analysis of genetic data present a significant risk of diversion to China's military programs."[8]

Showing the utility of the Entity List, BIS recently issued a rule that made it easier to add companies to the list where they or their government fail to cooperate with end-use checks.

[3] Addition of Entities to the Entity List, 84 Fed. Reg. 22961 (May 21, 2019) (adding Huawei Technologies Co., Ltd. and more than 60 of its affiliates to the Entity List).

[4] Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities from the Entity List, 85 Fed. Reg. 83416 (Dec. 22, 2020).

[5] Additions to the Entity List; Amendment To Confirm Basis for Adding Certain Entities to the Entity List Includes Foreign Policy Interest of Protection of Human Rights Worldwide, 88 Fed. Reg. 18983 (Mar. 30, 2023); Additions and Revisions to the Entity List and Conforming Removal from the Unverified List, 87 Fed. Reg. 77505 (Dec. 19, 2022); Addition of Certain Entities to the Entity List, Revision of Existing Entry on the Entity List, Removal of Entity from the Unverified List, and Addition of Entity to the Military End-User List, 86 Fed. Reg. 36496 (July 12, 2021); Addition of Certain Entities to the Entity List, 86 Fed. Reg. 33119 (June 24, 2021); Addition of Certain Entities to the Entity List, Revision of Existing Entries on the Entity List, 85 Fed. Reg. 44159 (July 22, 2020); Addition of Certain Entities to the Entity List; Revision of Existing Entries on the Entity List, 85 Fed. Reg. 34503 (June 5, 2020); Addition of Certain Entities to the Entity List, 84 Fed. Reg. 54002 (Oct. 9, 2019).

[6] Addition of Entity to the Entity List, and Addition of Entity to the Military End-User List and Removals from the MEU List, 86 Fed. Reg. 4862 (Jan. 15, 2021), *revised*, 87 Fed. Reg. 38920 (June 30, 2022); Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities from the Entity List, 85 Fed. Reg. 83416 (Dec. 22, 2020); Addition of Entities to the Entity List, and Revision of Entries on the Entity List, 85 Fed. Reg. 52898 (Aug. 27, 2020).

[7] Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities from the Entity List, 85 Fed. Reg. 83416 (Dec. 22, 2020).

[8] Additions and Revisions of Entities to the Entity List, 88 Fed. Reg. 13673, 13674 (Mar. 6, 2023). The parent entity, BGI and another subsidiary, Beijing Liuhe BGI, were previously added to the Entity List in 2020 for "conducting genetic analyses used to further the repression of Muslim minority groups in the XUAR." Addition of Certain Entities to the Entity List; Revision of Existing Entries on the Entity List, 85 Fed. Reg. 44159, 44159-60 (July 22, 2020).

Where BIS cannot verify a company's bona fides, they may be added to the Unverified List (UVL).[9] Once on the UVL, a party is not able to use license exceptions, such as obtaining replacement parts for a previously exported item. Last fall, BIS added a rule that will put parties on the Entity List where there is sustained non-cooperation from the parties' host government on end-use checks.[10] The recent rule change properly and more aggressively targets these companies and foreign governments inhibiting end-use checks, giving the U.S. government another tool.

Begun in 1997, the Entity List then largely listed front companies for diversion and certain actors involved in proliferation-related activities. We have since moved to designating large companies and national champions in critical industries. Today there are 631 China-based parties on the Entity List.[11] BIS's continued use of the Entity List is a welcome development in aid of ensuring our technologies are not used for malign purposes, including against Americans.

The Entity List does have its shortcomings, however. By relying on a system targeting end-users, malign actors can play corporate shell games to circumvent the purpose of the listing. And although the regulations have a forward-looking element to permit listings where a party "poses a significant risk of being or becoming involved" in activities contravening the national security and foreign policy interests of the United States,[12] in my experience the listings are almost always for conduct that has already occurred.

Another shortcoming is that BIS lists out each subsidiary of a listed party, as well as the party's address. It certainly is not difficult to change a corporate name or address to evade the listing, something that is reportedly happening with one of the newest listed parties, Inspur.[13] As discussed below, it is worth exploring whether changes should be made to this process to ensure a more complete capture of related parties.

The U.S. government also should work to integrate the lists where possible, recognizing that each has different authorities. For example, the CMIC List administered by the Treasury Department targets companies supporting the military-industrial complex of the PRC.[14] It would seem that any company on that list, and therefore prohibited from listing on U.S. securities

[9] 15 C.F.R. part 744, Supp. 6.

[10] Revisions to the Unverified List; Clarifications to Activities and Criteria That May Lead to Additions to the Entity List, 87 Fed. Reg. 61971, 61972 (Oct. 13, 2022).

[11] Emily Kilcrease & Michael Frazer, Sanctions by the Numbers: SDN, CMIC, and Entity List Designations on China, CENTER FOR A NEW AMERICAN SECURITY (Mar. 2, 2023) (there are now "603 Chinese persons are included on the Entity List"); Additions and Revisions of Entities to the Entity List, 88 Fed. Reg. 13673 (Mar. 6, 2023) (adding an additional 28 Chinese parties to the Entity List).

[12] 15 C.F.R. § 744.11(b).

[13] Ian Talley, Asa Fitch & Clarence Leong, Loophole Allows U.S. Tech Exports to Banned Chinese Firm, WALL ST. J., Mar. 24, 2023, https://on.wsj.com/3zw7nGD.

[14] 31 C.F.R. part 586.

exchanges, would be acting contrary to the national security and foreign policy interests of the United States[15] and should therefore also be prohibited from receiving U.S.-origin technology.

The breadth and volume of additions to the list are an important tool in our national security toolkit. The U.S. government should take care to ensure that it is being sufficiently proactive and adding parties to the Entity List in a timely manner.

**Foreign-produced Direct Product Rules**

The increased use of the Entity List has forced the U.S. government to likewise enhance some of the preexisting mechanisms of how to enforce it. One such example is the expansion of the Foreign-produced Direct Product Rule (FDPR).

Shortly after Huawei was added the Entity List, it became apparent that the U.S. government needed a better plan to inhibit circumvention of the prohibitions. The global nature of the semiconductor supply chain provided ample opportunity for Huawei and those interested in continuing to supply it to render the Entity List restrictions less potent. Under the initial listing, companies could simply move production offshore, effectively getting around the prohibition.

To counter that concern, the U.S. government determined that more action was needed and issued a new set or restrictions. What resulted was a set of two rules that, in short, limited Huawei's ability to source chips that were made with U.S.-origin design software or semiconductor manufacturing equipment, no matter where the chips were made.[16]

The use of the rule against Huawei paid almost immediate dividends. The United Kingdom reversed its earlier decision to permit Huawei into its telecommunications system, pointing to the FDPR as a reason for changing course.[17]

The FDPR has been applied several times since. Following Russia's invasion of Ukraine, the U.S. government used the FDPR across Russia and Belarus.[18] More recent actions also invoke the FDPR, including restrictions on advanced computing and supercomputers,[19] elements of the

[15] 15 C.F.R. § 744.11(b).

[16] Addition of Huawei Non-U.S. Affiliates to the Entity List, the Removal of Temporary General License, and Amendments to General Prohibition Three (Foreign-Produced Direct Product Rule), 85 Fed. Reg. 51596 (Aug. 20, 2020); Export Administration Regulations: Amendments to General Prohibition Three (Foreign-Produced Direct Product Rule) and the Entity List, 85 Fed. Reg. 29849 (May 19, 2020).

[17] Press Release, United Kingdom, Department for Digital, Culture, Media & Sport, et al., "Huawei to be removed from UK 5G networks by 2027," July 14, 2020, https://bit.ly/40RDQTB.

[18] Expansion of Sanctions Against Russia and Belarus Under the Export Administration Regulations (EAR), 87 Fed. Reg. 22130 (Apr. 14, 2022); Implementation of Sanctions Against Russia Under the Export Administration Regulations (EAR), 87 Fed. Reg. 12226 (Mar. 3, 2022).

[19] Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use; Entity List Modification, 87 Fed. Reg. 62186, 62189 (Oct. 13, 2022).

supply chain of Iranian unmanned aerial vehicles sent to Russia,[20] and Chinese computing companies aiding in China's military modernization efforts.[21]

The FDPR was a sea change in how the U.S. government regulates the use of U.S.-origin technology. Although no system is perfect, the FDPR has made it more difficult for our adversaries to obtain our technology.

**Military-Civil Fusion**

The CCP aims to develop the People's Liberation Army into a world-class military by 2049. As a result, it has embarked on a whole-of-government and whole-of-private sector effort to do so. That effort is personally overseen by CCP General Secretary Xi Jinping.[22] Given the rise of China's – and other foreign adversaries', for that matter – practice of MCF, the U.S. government recognized it needed to adapt export controls to meet the challenge.

As an export control problem set, MCF is among the most difficult. Particularly in a place like China, MCF challenges export-control licensing and enforcement, given the often unclear distinctions between civilian and military entities. In addition, the CCP is adept at transferring to its military technology developed and intended for use in the civilian arena.

In April 2020, BIS issued a rule to tighten controls on military end use and end users (MEU), applying a presumption of denial of licenses to such users.[23] Building upon a 2007 rule that imposed a license requirement on items intended for military end-use in China, the 2020 MEU rule expanded the license requirements to military end-users there and broadened the range of items subject to a license. It also warned exporters to China that the rule "will require increased diligence with respect to the evaluation of end users in China, particularly in view of China's widespread civil-military integration."[24] The 2020 MEU Rule applied the controls to Russia and the Maduro Regime in Venezuela, in addition to China.

Following the 2020 MEU rule, BIS created a Military End User List (MEU List).[25] The MEU List aimed to help exporters know who the U.S. government viewed as MEUs and for whom a license would be required to export items. Importantly, it did not relieve exporters of the

[20] Export Control Measures Under the Export Administration Regulations (EAR) To Address Iranian Unmanned Aerial Vehicles (UAVs) and Their Use by the Russian Federation Against Ukraine, 88 Fed. Reg. 12150 (Feb. 27, 2023).

[21] Additions and Revisions of Entities to the Entity List, 88 Fed. Reg. 13673, 13674 (Mar. 6, 2023).

[22] U.S. Dep't of State, The Chinese Communist Party's Military-Civil Fusion Policy, undated, https://bit.ly/3TpZMTb (last visited Apr. 4, 2023).

[23] Expansion of Export, Reexport, and Transfer (in-Country) Controls for Military End Use or Military End Users in the People's Republic of China, Russia, or Venezuela, 85 Fed. Reg. 23459 (Apr. 28, 2020).

[24] *Id.* at 23460.

[25] Addition of "Military End User" (MEU) List to the Export Administration Regulations and Addition of Entities to the MEU List, 85 Fed. Reg. 83793 (Dec. 23, 2020) (adding 102 MEUs to the newly created list, including 57 from China).

obligation to conduct their own due diligence to ensure their items were not aiding these adversaries' militaries.[26]

A sampling of Chinese entities on the MEU list includes Aviation Industry Corporation of China, a state-owned military and civilian aerospace company, as well as a subsidiary of China State Shipbuilding Corporation, a company that builds ships for the People's Liberation Army Navy.[27]

The U.S. government's efforts to isolate known MEUs and provide guidance to the business community is a welcome development. But we must remain vigilant and modify the list as necessary. The government must also hold exporters to their obligations to conduct diligence on their shipments, particularly to China, but also to destinations that present a high risk of diversion.[28]

The U.S. efforts to impose a due diligence requirement on putative exporters to destinations with significant MCF is all the more important given the PRC's recent raid on a U.S. due diligence investigations firm.[29] If the CCP is going to inhibit on-the-ground diligence within the PRC, the U.S. government should require a greater showing to permit the shipment of sensitive items to the PRC.

**Controls on indigenous Chinese semiconductor companies**

In October 2022, the U.S. government imposed perhaps the most impactful controls on the PRC's indigenous semiconductor industry.[30] Focusing on high-end AI chips and semiconductor manufacturing equipment, the rule aimed to implement National Security Advisor Sullivan's pronouncement that relative advantages are no longer sufficient.[31]

The rule imposed controls on items helpful to the PRC's advanced computing capabilities, which "are being used by the PRC for its military modernization efforts."[32] The efforts include the military's "autonomous military systems, such as those used for cognitive electronic warfare,

[26] Addition of "Military End User" (MEU) List to the Export Administration Regulations and Addition of Entities to the MEU List, 85 Fed. Reg. 83793, 83794 (Dec. 23, 2020) (noting the MEU List "is not exhaustive" and exporters "must still conduct due diligence for parties not on the list").

[27] 15 C.F.R. part 744, Supp. 7 (MEU List).

[28] 15 C.F.R. § 772.1 (defining "knowledge" under the EAR as not only "positive knowledge," but "also an awareness of a high probability of its existence or future occurrence," and prohibiting conscious disregard or willful avoidance of facts).

[29] Michael Martina & Yew Lun Tian, China detains staff, raids office of US due diligence firm Mintz Group, REUTERS, Mar. 24, 2023, https://reut.rs/40o5uaX.

[30] Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use; Entity List Modification, 87 Fed. Reg. 62186 (Oct. 13, 2022).

[31] Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit, THE WHITE HOUSE, Sept. 16, 2022, https://bit.ly/3LXznuk.

[32] Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use; Entity List Modification, 87 Fed. Reg. 62186, 62187 (Oct. 13, 2022).

radar, signals intelligence, and jamming" and designing and testing weapons of mass destruction, "hypersonics and other advanced missile systems."[33] The rule imposed a foreign direct product control on several entities related to the PRC's supercomputing capabilities.

The rule also imposed controls on certain semiconductor manufacturing equipment. Concerned about the military-modernization efforts relevant to the supercomputers controls in the preceding paragraph, the equipment-based control also flowed from concerns about the PRC's nuclear expansion efforts.[34] The controls seek to limit indigenous Chinese semiconductor companies to two generations behind the current leading edge.

Similar to sanctions imposed by Treasury's Office of Foreign Assets Control (OFAC), the rule also imposed a U.S.-person control.[35] The control was followed by an amendment to ECRA permitting control of U.S.-person activities to certain military, security, or intelligence services.[36] The October semiconductor control seeks to limit citizens, legal permanent residents, U.S. companies, and any person in the United States from assisting indigenous PRC semiconductors from working on leading-edge products.[37]

Following the unilateral imposition of these controls, the U.S. government worked to gain plurilateral acceptance with the Japanese and Dutch governments.[38] That reported success is important because those countries have companies that made some of the most competitive manufacturing equipment covered by the controls. Although the Dutch and Japanese controls are unlikely to match the full scope of the U.S. controls, it is likely that they will inhibit significant portions of the PRC's indigenous semiconductor production. Had the U.S. government failed to secure agreement, the PRC would have been able to obtain the foreign items and evade the purpose of the controls.

The PRC is continuing to look for ways out from under the restrictions. Although comprehensive data are not available publicly, early indications are that the controls are working. There are reports that the PRC is responding to the controls on high-end chips by doubling down on making decade-old legacy chips to potentially flood world markets, an issue which presents its own set of problems.[39] These chips – defined at the 28 nanometer node or above – are embedded in a wide variety of automotive, weapons, and internet of things products. There are

[33] *Id.*

[34] *Id.*

[35] *Id.* at 62193.

[36] 50 U.S.C. § 4812(a)(2)(F), as amended by Pub. L. No. 117-263, § 5589(b) (2022).

[37] For the definition of "U.S. Person" under the EAR, see 15 C.F.R. part 772.

[38] Alexandra Alper & David Shepardson, U.S. official acknowledges Japan, Netherlands deal to curb chipmaking exports to China, REUTERS, Jan. 31, 2023, https://reut.rs/40N79GD; Tim Kelly & Miho Uranaka, Japan restricts chipmaking equipment exports as it aligns with US China curbs, REUTERS, Mar. 31, 2023, https://reut.rs/3nMPpgi.

[39] Jane Lee, et al., Analysis: China's massive older chip tech buildup raises U.S. concern, REUTERS, Dec. 13, 2022, https://reut.rs/3GDCpAz; Sujai Shivakumar, The Strategic Importance of Legacy Chips, CENTER FOR STRATEGIC & INT'L STUDIES (Mar. 2023), https://bit.ly/3KdcDns.

also reports that the PRC has enlisted Alibaba and Tencent to assist in designing chips using open-source architecture to undermine the purpose of the controls.[40] The reports of state direction certainly give rise to the concern that any advancements could be used to further the PRC's military.

Time will tell on the ultimate effect of these controls. We must keep in mind that, like any export control, these controls will be time-limited and will need to be paired with efforts to run faster. The PRC is spending vast sums of money to try and build indigenously these machines and the products they make. The U.S. government and our partners, including the Dutch and Japanese, should continue to monitor the effectiveness of the controls.

**Additional opportunities for success**

Although the U.S. government has made many significant and positive strides, there will always remain more work to be done. Simply put, China is a determined, persistent adversary unlike any the dual-use export control community has encountered before. Its practice of obtaining technology through IP theft, forced joint ventures, and non-traditional collectors around the world pose significant challenges.

Reports of U.S.-origin semiconductors being used to test Chinese hypersonic vehicles should concern us all.[41] A more recent example is reported links to a U.S. firm's subsidiary selling components that were found in the suspected Chinese spy balloon.[42] BIS did put several companies on the Entity List for supporting the Chinese balloon program, but the company mentioned in the news reporting was not one of them.[43] These two recent examples underscore the difficulty of a post-hoc enforcement after the items have been transferred; the technology is already in the hands of the adversary, and it has already been used against us. The government should rely more heavily on the "pose[s] a significant risk of being or becoming involved, in activities contrary to the national security or foreign policy interests of the United States" portion of the Entity List rules.[44] The export-control interagency can then agree on a licensing policy consistent with the threat posed by the party.

I believe the October 2022 controls, particularly where supported plurilaterally by the Dutch and Japanese, will make it more difficult for the CCP to use our technology against us. The alignment and use of other U.S. government tools – like the Chinese Military Industrial

[40] Matthew Humphries, Following US Sanctions, China Decides Its Future Lies with RISC Chips, PC MAGAZINE, Dec. 2, 2022, https://bit.ly/40VvE4E; Anna Gross & Qianer Liu, China enlists Alibaba and Tencent in fight against US chip sanctions, FINANCIAL TIMES, Nov. 30, 2022, https://on.ft.com/3U7SDam.

[41] Ellen Nakashima & Gerry Shih, China builds advanced weapons systems using American chip technology, WASH. POST, Apr. 9, 2021, https://wapo.st/3TJj3PP; Cate Cadell & Ellen Nakashima, American technology boosts China's hypersonic missile program, WASH. POST, Oct. 17, 2022, https://wapo.st/3TsBw2C.

[42] Andrew W. Lehren, Dan De Luce and Yasmine Salam, U.S. firm's subsidiary sold electronics to Chinese defense firm linked to spy balloon program, NBC NEWS, Mar. 6, 2023, https://nbcnews.to/3TBJMxt.

[43] Additions to the Entity List, 88 Fed. Reg. 9389 (Feb. 14, 2023).

[44] 15 C.F.R. § 744.16.

Company List administered by the Treasury Department – is a force-multiplier to help stem the flow of items and funds from the United States destined for the Chinese military.

There are discussions about adding a fifth multilateral export-control regime related to the China challenge. Although I would welcome the opportunity for the United States to align with like-minded countries on the threat posed by the CCP, I remain unconvinced another regime-based-on-consensus system would be effective. Many of our allies in recent years have made great strides in recognizing the threats, but there is still too wide of a gulf to make a consensus-based regime workable.

Apart from the lack of consensus on what to do to meet the China challenge, some of our allies and partners lack the legal frameworks to impose controls similar to what we do in the United States. Although I am currently skeptical of a new regime, I strongly believe the U.S. government should work closely with our allies to help them align their legal authorities to use export controls to meet this new challenge. In doing so, we should offer drafting assistance, as well as share relevant intelligence to ensure our partners are armed with the information to make informed choices.

Where multilateralism may be insufficient, I am more optimistic that plurilateralism will work. My view is guided by the success of the FDPR and that of the October 2022 semiconductor controls. With respect to the former, the U.S. government assessed the market and determined that a unilateral semiconductor control as applied to Huawei would be workable. A second iteration of the FDPR saw more than 30 U.S. allies align, or agree to align, their controls to ensure their technologies would not feed the Russian war machine in Ukraine and potentially beyond. In addition, the reported plurilateral agreement between the United States, Netherlands, and Japan on the October 2022 controls shows promise. Although lacking in terms of speed and certainly not a panacea, plurilateral controls represent the new way forward.

**Effectiveness in identifying and controlling technologies of concern**

The U.S. government works hard to identity and control technologies to destinations and entities of concern. It will surprise nobody, however, that the speed of technology moves far faster than the federal government. That challenge becomes even more acute when the government takes a technology to be controlled to one of the multilateral regimes, a process that can take several years.

Take for example the SMIC Entity Listing described above. That listing was designed to limit exports for items "uniquely required" to produce below 10 nanometers.[45] At the time, that was two generations behind the leading edge. But in the semiconductor industry, the speed of the technology moves quickly, and there is essentially a new technology node every two or so years.

The U.S. government generally does a good job identifying technologies of concern. The process relies heavily on the government research community, as well as the Department of Defense and the Intelligence Community. Two emerging technologies it struggles to identify and

[45] Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities from the Entity List, 85 Fed. Reg. 83416, 83417 (Dec. 22, 2020).

control are artificial intelligence (AI) and quantum computing. There are several reasons for this.

First, there is wide dispute of what is the state of the art and therefore worth controlling. In 2018, following the passage of ECRA, BIS issued an advanced notice of proposed rulemaking to learn more about certain emerging technologies; among them, AI and quantum computing.[46] Many of the comments BIS received disputed those were even emerging technologies.

A second problem is one of scoping. Few would likely argue that placing export controls on the voice assistant on one's phone is an effective use of BIS's and its partners' limited time. That calculation might change, however, if that same or similar technology would allow voice-command to launch munitions against troops on the battlefield.

Third, experts in these fields will often tell you there are many segments of each of these technologies where the United States is not in the lead and thus any export controls would be self-defeating. Although the United States leads in several quantum and AI-related technologies, we do not have a monopoly. Any controls must account for foreign availability or similar technologies, including from China.

Fourth and finally, the speed of the adoption of emerging technologies poses a challenge of identifying and controlling it at the right time. It is sometimes a difficult exercise to decipher the blurred lines between research and development of a technology and its adoption. It can also take time to determine whether that technology has military application. The government should take care not to inhibit research that allows us to run faster, but it should not be too hesitant to control where technologies would give our adversaries a military advantage detrimental to the United States or in furtherance of identified U.S. foreign policy.[47]

Unfortunately, I struggle to identify the appropriate scoping for AI and quantum computing. The easiest – though I am not sure the most effective – way to control it is through end-use and end-user controls, similar to the October 2022 semiconductor controls, and have a destination-based control at certain thresholds. It would be important to craft a licensing policy that accounts for foreign availability but ensures that we are imposing a license requirement on U.S.-origin items that may aid the PRC military and intelligence services.

**Finding the right structure and process for dual-use export controls**

BIS and its interagency colleagues face a veritable deluge of licenses. In FY 2021, the most recent year for which data is publicly available, BIS processed 41,446 licenses.[48] Given the more aggressive use of the Entity List, the FDPR, Russia-related controls, and additional controls

[46] Review of Controls for Certain Emerging Technologies, 83 Fed. Reg. 58201 (Nov. 19, 2018). Section 1758 of ECRA required the Secretary of Commerce to lead a "regular, ongoing interagency process to identify emerging and foundational technologies" essential to the national security of the United States. 50 U.S.C. § 4817(a).

[47] *See, e.g.*, 50 U.S.C. § 4811(1).

[48] U.S. Dep't of Commerce, Bureau of Industry & Security, Annual Report to Congress Fiscal Year 2021, at 18 (BIS 2021 Annual Rep.), https://bit.ly/3TyzNJe.

on semiconductor and other computing-related items to China, the licensing trend has been upward. I expect that to continue.

The Commission should request a study of the utility of moving to a single licensing system. Given our adversaries' blending of civilian and military, we must ask ourselves whether the current export-control construct continues to make sense.

The current bifurcation also can yield uncertainty. For instance, in FY 2021, BIS worked with the State Department on 226 commodity jurisdiction requests.[49] These requests ask State and Commerce to determine whether a particular item is subject to State's rules relating to defense articles or services under the International Traffic in Arms Regulations or Commerce's EAR. They are complex undertakings and can be time-consuming, often taking several months.

Although I do not currently have a well-formed view of whether a single licensing system and/or agency makes sense, I do think it is worth study. I am mindful that Congress only five years ago passed ECRA on a bipartisan basis. That said, it has been a busy five years, as our adversaries have become increasingly aggressive. Being able to move at pace with the threats, while reducing uncertainty to the exporting community, should be the goal.

**Enforcement is difficult but improving**

With the proliferation of rules, addition of parties to the Entity List, and expansion of the FDPR, BIS has its hands full with enforcement. To meet this challenge, BIS's enforcement has 30 domestic offices and soon to be 10 international offices at embassies and consulates, including in Beijing.[50] But only a fraction of licenses granted are subject to end-use checks. Of the 41,446 licenses granted in FY 2021, BIS completed 1030 end-use checks.[51]

As one can imagine, ensuring something as small as a semiconductor remains in the right hands is difficult. Indeed, in the wake of the October 2022 semiconductor controls, there are reports that Chinese AI companies on the Entity List are using intermediaries to rent or otherwise acquire chips that are export-controlled.[52] The task is made all the more difficult when one considers the steps BIS must take to conduct end-use checks in China, which include pre-approval from the PRC government, lengthy delays, and other bureaucratic obstacles. In some cases, the circumvention is state-backed, including reports that the October rules "prompted the proliferation of state-backed computer clusters, which stockpiled Nvidia chips and rented out access of the technology to blacklisted companies." It is difficult to imagine that the CCP would do so if not to assist its military, given its MCF policy.

[49] BIS 2021 Annual Rep. at 19.

[50] U.S. Dep't of Commerce, Bureau of Industry & Security, Organization, https://bit.ly/3yZUhkN (last visited Apr. 4, 2023); BIS 2021 Annual Rep. at 45-46.

[51] BIS 2021 Annual Rep. at 45.

[52] Eleanor Olcott, Qianer Liu & Demetri Sevastopulo, Chinese AI groups use cloud services to evade US chip export controls, FINANCIAL TIMES, Mar. 6, 2023, https://on.ft.com/40dR4ts.

Recent actions by BIS offer promise for tightened enforcement. In June 2022, BIS issued a memorandum pointing to increased use of "egregious" case designations, which can yield higher penalties; non-monetary settlements for less-significant cases, including required compliance program enhancements; elimination of no admit, no deny settlements; and publicly posting the charging letters.[53] The latter two, in particular, are welcome changes. Requiring violating parties to admit their wrongdoing and making their conduct public will serve an educational purpose and hopefully cause parties to reconsider before violating.

To meet the challenge of expanding controls, and the licenses they bring, BIS must be resourced adequately. In this stage of the great power competition era, BIS reminds me of Treasury's Terrorism and Financial Intelligence (TFI) component in the wake of 9/11. We are aware of the problem, and hopefully like TFI, Congress will see fit to ensure BIS has the resources, both financial and interagency assistance, to meet the challenge. Significant investments in technology, particularly to harness the power of AI and big data analytics, are necessary.[54]

Congress should look at increasing the incentives for compliance. The current ceiling for a civil violation is $300,000, adjusted for inflation, or twice the value of the transaction.[55] Parties who violate ECRA may also have their export privileges revoked.[56] Increasing the use of denial orders – which prohibit an offending party's ability to export anything from the United States – would have a positive effect on incentivizing parties' compliance with the rules.

Enforcement is and likely will always remain a challenge. The very nature of the items make diversion possible. Keeping penalties significant may further incentivize exporters to comply with the law.

**Private-sector coordination is difficult to achieve, but a necessary part of the process**

The considerations in crafting and implementing national security rules, while simultaneously limiting collateral damage is perhaps the most difficult aspect of export-control regulation. The interaction between the government and the private sector is critical. Both sides have crucial expertise to help make policy: intelligence, geopolitical, and national security on the government side; and technological, market, and economic on the industry side. Each needs to be brought to bear to craft effective policy.

Unfortunately, the interaction between the government and the private sector is often less than ideal. It was the rare case that a company would come in and work to help shape potential controls on the front end. Industry is often reflexively and completely opposed to new controls.

[53] Mem. For All Export Enforcement Employees from Matthew S. Axelrod, Further Strengthening Our Administrative Enforcement Program, June 30, 2022, https://bit.ly/3nbyrbm.

[54] *See, e.g.*, Gregory C. Allen, et al., Improved Export Controls Enforcement Technology Needed for U.S. National Security, CENTER FOR STRATEGIC & INT'L STUDIES (Dec. 2022), https://bit.ly/3MiinPw (recommending $25 million annually for technology upgrades and staff increases, $18.4 million and an additional 48 positions for enforcement).

[55] 50 U.S.C. § 4819(c).

[56] *Id.*

Instead, it was more often companies would come in after the release of a rule and offer helpful suggestions.

It is difficult to blame industry entirely. Because much of export control policy has inputs from intelligence and law enforcement sources, the conversations can often be one way. I was acutely aware of the disappointment during meetings when the government response was "we can't tell you that" given the need to protect classified or other sensitive information.

Both during my time in government and now in the private sector, I have often thought about whether there is a better way for industry and the government to work together better. Often and quite understandably industry wants advance notice for planning purposes. It is difficult to do so, however. Providing advance notice would only exacerbate the stockpiling problem we have seen in some cases. For instance, it was widely reported that Huawei was stockpiling chips in advance of the FDPR.[57] It was only the end of 2022 – more than three and a half years after Huawei was added to the Entity List – that the company reportedly exhausted its stockpile.[58]

Regular engagement with industry is an important part of the process. The government should share information where it can, and I believe it does. Both sides must engage in good faith and with an understanding of the threats we face.

**Recommendations for Congress**

As my testimony makes clear, there have been many recent successes in dual-use export control policy as it relates to China. But more can be done to ensure we retain the nimbleness to face a determined and persistent adversary.

**Study a single licensing system**

Although ECRA is less than five years old, Congress and/or the Commission would be wise to consider whether moving to a single export-licensing system makes sense. Particularly considering China's and other adversaries' MCF policies, having two different systems can yield consequential delays. These are delays we can ill afford when our adversaries are continuing to use any means to overtake us.

The Obama Administration launched a comprehensive export-control reform effort in 2009.[59] Notwithstanding the "'byzantine amalgam of authorities, roles, and missions scattered around

[57] Lauly Li & Cheng Ting-Fang, Huawei builds up 2-year reserve of "most important" US chips, NIKKEI ASIA, May 28, 2020, https://s.nikkei.com/40bOnZJ.

[58] Iris Deng, Struggling Huawei runs out of advanced in-house-designed chips for smartphones amid US trade sanctions, Counterpoint report says, SOUTH CHINA MORNING POST, Dec. 21, 2022, https://bit.ly/3n9PjPR.

[59] For a good overview of the history of this effort, see generally The U.S. Export Control System and the Export Control Reform Initiative, CONG. RES. SERV., R41916, at 10-21 (2020), https://bit.ly/3JWqJcZ.

different parts of the federal government,'"[60] the export-control reform effort did not make headway into implementing single-licensing system.

Any single licensing system should of course have all necessary intelligence inputs to ensure effectiveness. If it is determined that such a licensing system would be preferable, it is critical to ensure that the administering body be well-resourced and have all necessary authorities, as well as having the proper supporting analytic functions to bring together sufficient economic and technical data, intelligence collection, and open-source information.

**Consider de-linking export controls from CFIUS**

As part of ECRA and FIRRMA, Congress decided to tie critical technologies and export controls to make certain CFIUS transactions mandatory. Although well-intentioned and done in lieu of adding an outbound investment review provision, the speed with which export controls and technology move is insufficient to meet the challenge.[61] The preference for multilateral controls slows the process of linking to CFIUS.

Rather, Congress should consider amending FIRRMA and putting sector-level review in place for certain sensitive technologies, no matter where the acquiring entity is based. It is tempting to create a foreign adversary list to tie to these sectors, but China's increasing use of variable interest entities to shield the true nature of certain companies counsels in favor of sector-wide notification. The declaration process introduced in FIRRMA seems a good middle ground for notification, as opposed to a full notice. It would allow CFIUS to move quickly past filings that present little concern, while at the same time giving the government visibility into the transaction.

**Consider a process that includes all of a party's subsidiaries when being added to the Entity List**

The current process of adding parties to the Entity List is flawed in that BIS determines which of a party's subsidiaries should be added to the list, as well as including the party's address. That gets the burden backwards; if a party is on the Entity List, and an exporter seeks to send items to a "good" subsidiary, it should come to Commerce and make the case.

The OFAC 50 Percent Rule provides an instructive example. OFAC rules prohibit doing business with any affiliate of a blocked party where the blocked party owns 50 percent or more of the affiliate.[62] OFAC additionally advises U.S. persons "to act with caution" when dealing with a non-blocked entity where a blocked person is affiliated, even at less than 50 percent.

[60] *Id.* at 10 n.19 (quoting Secretary of Defense Robert M. Gates, speech before the Business Executives for National Security, April 20, 2010).

[61] The Commission has heard from other witnesses suggesting this proposal, including by one of my NSI colleagues. *See* Testimony of Giovanna Cinelli, Fellow, National Security Institute, George Mason University Antonin Scalia Law School, at 12 (Sept. 8, 2021), https://bit.ly/40ptudw.

[62] Dep't of the Treasury, Revised Guidance on Entities Owned by Persons Whose Property and Interests in Property are Blocked, Aug. 13, 2014, https://bit.ly/3FIjGmV.

BIS could adopt a similar posture of putting all subsidiaries of a party on the Entity List or the MEU List or doing so at some prescribed threshold. For administrative purposes, it would be preferable to put all subsidiaries on, regardless of ownership threshold. Putting the burden on the exporter seeking to do business with a listed party is a reasonable step.

Adding parties to the Entity List is a time- and manpower-intensive process, and one that should harness big data analytic capability. The process today is entirely too reliant on manual inputs. Although we want to ensure we are putting eyes on the most relevant information, much of it can be culled by analytic programs that exist elsewhere. In addition, given the shift in the kinds of companies being added, the litigation risk is much higher than before. It is even more important that the agencies involved have considered sufficient information and build the file to withstand a potential court challenge.

It is important to use all of those tools to ensure that parties added to the Entity List are done so in a way that captures the national security threat and does not permit shell games to avoid the effect of the listing.

* * *

As discussed above, the export-control landscape with respect to the PRC has shifted markedly in recent years. Our government and industry have shifted, too, and they must continue to adapt to this new normal.

I often said when I was in government that I was privileged to work on an area with such bipartisan agreement. That will be important as we go forward and Congress and the executive branch continue to refine our export-control system to meet the challenges ahead.

I look forward to your questions.

**OPENING STATEMENT OF MARTIJN RASSER, MANAGING DIRECTOR, DATENNA INC.**

MR. RASSER: Chairman Bartholomew, Vice Chairman Wong, Members of the Commission, thank you very much for the opportunity to appear before you today. And, it's a real honor to be here with my colleagues, Emily Kilcrease and Cordell Hull.

Before I start, I wish to reiterate that the views expressed today are my own. And, that I'm here in my personal capacity.

Technological leadership, how a country invents, innovates, and deploys technologies to compete economically and to secure its interests, is a central feature of strategic competition. In May 2018, Xi Jinping gave a speech titled "Strive to Become the World's Primary Center for Science and High Ground for Innovation," in which he described emerging and critical technologies such as AI, semiconductors, and quantum computing as key instruments of state.

Xi emphasized the need for independent innovation and has repeatedly referred to the importance of self-reliance. This framing drives Beijing's strategy for science and technology as well as its industrial policies.

U.S. leaders also view technology as a key enabler of economic, political and military power. Recent examples of how American policy makers are framing the issue, are the 2022 U.S. National Security Strategy and National Security Advisory Sullivan's September 2022 speech describing a strategy to renew and sustain technological leadership.

Export controls are a key means to maintaining an edge in technological leadership. Export controls in most cases will require coordination with, and participation of one or more allied and partnered countries.

The United States rarely has sufficient dominance in a technology area to go it alone. In areas where it does, unilateral action puts major burdens on U.S. companies and friendly foreign entities that are part of their supply chains.
Multilateral coordinated approaches to export controls are therefore not just desirable, but often imperative to be effective.

I described in my written testimony how technological capabilities and requisite know how are defused and oftentimes there is no clear technology leader and multiple viable technology acquisition pathways exist.

Furthermore, protective measures such as export controls, inbound and outbound investment reviews, and research security practices, will differ in scope, scale and feasibility, depending on what technology area or scientific discipline is addressed.

Clear points of leverage in critical and emerging technologies are rare. There's limited opportunity at present for effective export controls in areas such as biotechnology and quantum computing, as well as for going much beyond what is currently in place for artificial intelligence and quantum sensing.

To maximize the odds of success for what is doable, coordination and collaboration among the tech leading democracies will be essential.

The quick and concerted actions by the tech leading democracies on imposing export control on Russia in response to its renewed invasion of Ukraine, show that such cooperation is feasible.

The much more difficult discussions between the U.S., Dutch, and Japanese governments regarding restrictions on sales of semiconductor manufacturing equipment to end users in China,

underscore the challenges to cooperation when the economic stakes are higher and the objectives of the controls are different.

These challenges are twofold. One is that there are divergencies between the United States and many allies on the contours of the China challenge. And by extension what actions are then most effective to addressing that challenge.

Regarding export controls, the task at hand is for U.S. officials to secure broader buy-in from allies for the use of export controls as a strategic tool designed to constrain technology development, technology indigenization, and specific end uses.

Third, encouraging science thought that better alignment in both areas is realistic and achievable.

I'll conclude with a brief overview of the recommendations for Congressional action in my written testimony. They fall into two categories.

The first is to bolster the Department of Defense in three ways. One, the Bureau of Industry and Security should have an expanded mission to include the national security equities related to regulating and protecting U.S. technology supply chains for more cohesive economic statecraft.

Two, the Department of Commerce should be a full-fledged member of the U.S. Intelligence community so that it can become the U.S. government hub for economic and technology intelligence analysis.

And three, the Commerce Department needs to be provided with the fiscal and human resources it needs to execute its mission.

Even putting aside the two recommendations I just provided, the resources currently at the Department's disposal are nowhere near enough to match the outsized role it plays in economic statecraft and national security policy.

The second category is to strengthen the U.S. government's capacity for multilateral collaboration. Here also, I have three recommendations.

One, is for Congress to establish a cadre of tech diplomats. These officials would be the vanguard for implementing the international aspects of U.S. technology policies, including cooperative research agreements, human capital exchanges, infrastructure development, and export controls. So, the building blocks for a large core of technologically savvy diplomats are already in place, such as the new Cyber and Tech Bureau, and the Regional Technology Officer program.

Two, Congress should establish the position of a special envoy for export controls. The remit of the special envoy should be to enhance international cooperation on export controls.

And finally, Congress should promote the creation of a technology alliance. I strongly believe that maximizing the odds for success in strategic competition will require the core group of tech leading democracies to create a steering committee for technology policy.

This grouping of countries could cooperate in areas including research and development, supply chain resilience, countering economic coercion, harmonizing export controls, coordinating industrial policies, and much more.

Thank you very much. I look forward to your questions.

CHAIRMAN BARTHOLOMEW: Thank you very much. Ms. Kilcrease?

**PREPARED STATEMENT OF MARTIJN RASSER, MANAGING DIRECTOR, DATENNA INC.**

Testimony before the U.S.-China Economic and Security Review Commission
Hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"
Panel III: Policy Tools for the United States and Its Allies and Partners

Martijn Rasser
Managing Director, Datenna, Inc.

April 13, 2023

Chairman Bartholomew, Vice-Chairman Wong, and other members of the commission, thank you for the opportunity to appear before you. The views I express today are my own, not of my employer. My views were shaped during my nearly four years as a senior fellow and subsequently as director of the technology and national security program at the Center for a New American Security.

**Acknowledgments:**
I wish to thank John Costello, Tim Fist, Sam Howell, Hannah Kelley, Emily Kilcrease, Megan Lamberth, Ryan Morhard, Emily Weinstein, and Kevin Wolf, whose insight and ideas are reflected in this document.

**Introduction**
Technology is at the center of the global strategic competition and a key enabler of economic, political, and military power. On this, leaders in Washington and Beijing agree. Chinese President Xi Jinping has repeatedly made this point in speeches. U.S. President Biden's 2022 National Security Strategy states so explicitly. This tenet is now crystallizing a fundamental shift in how U.S. leaders are conceiving of technology strategy and executing technology policies.

Export controls are a key component of this new strategy. To understand the role of economic statecraft, it is important to first take a step back and view these measures in the broader context.

**Promote, Protect, Partner**
On September 16, 2022, U.S. national security advisor Jake Sullivan gave a speech outlining a strategy with four pillars to renew and maintain U.S. technological leadership. In essence, this strategy has three thrusts: promote, protect, and partner. The 'promote' agenda comprises two pillars: investing in America's science and technology ecosystem and nurturing top STEM talent. The 'protect' agenda is about safeguarding U.S. technological advantages. The fourth pillar comprises the 'partner' agenda—deepening and integrating U.S. alliances and partnerships. Throughout, the focus is on three families of technologies. Computing-related technologies such as semiconductors and artificial intelligence, biotechnologies and biomanufacturing, and clean energy technologies.

The promote agenda is the most straightforward of the three. It includes investments in R&D, education, and S&T infrastructure, but also changes to immigration processes to attract and retain foreign talent. A new American industrial policy is a cornerstone of this agenda.

The protect agenda relies on longstanding tools to counter unwanted tech acquisitions—export controls most notably—but the prior premise of maintaining relative advantage over China is

upended. The most important part of Sullivan's speech was codifying that the new baseline is to maintain as large of a lead as possible in certain technologies, with advanced logic and memory chips served up as the example. Another part of this agenda will be restrictions on outbound investments, expected to be announced in an executive order later this year.

Finally, the partner agenda considers how the United States should collaborate with allies and strategic partners. This is a sensible and pragmatic approach. It doubles down on one of America's great, unmatched strengths: its vast network of friends, which are predominantly tech-leading democracies. It also reflects the reality that the United States rarely has all the pieces of the puzzle for any tech area of consequence, given the global diffusion of technology and requisite knowledge. Tech partnerships are a strategic necessity.

**Chipping Away**

Semiconductors, or chips, are case in point to show how this new tech-focused geopolitical strategy is taking shape. Chips are a foundational technology essential to the functioning of modern society, being important components in products such as consumer electronics, medical devices, supercomputers, and military systems. Recent legislation and policy action touch on all three agendas.

The marquee item in the promote agenda is the CHIPS and Science Act. The semiconductor-focused portion of the sprawling bill provides $52 billion in manufacturing investment tax credits, research and development, and workforce training. The bulk of the funds, $39 billion, will go toward incentives for new semiconductor fabrication facilities, or fabs, in the United States. U.S. political leaders and national security pundits have fixated on fabs, and for good reason. In 1990, the United States had a 37 percent share of global semiconductor production. By 2022, that share had dropped to 12 percent. The incentives prompted Taiwanese firm TSMC and U.S. firm Intel to announce construction of new fabs in Arizona and Ohio, among a slew of investments by other manufacturers and suppliers.

The other big salvo in the technology competition was in the protect agenda. On October 7, 2022, the Biden administration imposed wide-ranging semiconductor-related export controls on China. These measures captured what Sullivan had said the Biden administration would do a few weeks earlier: an effort to halt China's ability to develop and use specific AI applications by prohibiting sales of specific advanced chips, limit its ability to develop supercomputers for China's military by prohibiting the shipment of technology and software, and thwart Beijing's ambitions to develop an advanced indigenous semiconductor industry by restricting U.S. firms from shipping certain types of production equipment and barring U.S. persons from providing services such as maintenance and upgrades to equipment already in China without a license.

On the 'partner' front, the Biden administration has been active. The United States is pursuing chip-related efforts in the Quad (with Australia, India, Japan), in the U.S.-EU Trade and Technology Council, via a fledgling grouping dubbed the 'Chip 4' (with Japan, South Korea, Taiwan), and bilaterally with India, Japan, and South Korea, among others. And administration officials have convinced their Dutch and Japanese counterparts to follow suit on export controls on chip production equipment, although the details have yet to be announced.

**A Protect Agenda for the Times**

What Sullivan signaled in his speech, and what the Biden administration implemented with its October 7 rule, is, in the words of export control expert Kevin Wolf, a transformational shift in the use of export controls from one tied to narrow non-proliferation objectives to "a strategic tool". The scope and timing of these actions should be considered in this framing. Specifically, the purpose of the controls is to restrict China's ability "to produce advanced military systems including weapons of mass destruction; improve the speed and accuracy of its military decision making, planning, and logistics, as well as of its autonomous military systems; and commit human rights abuses." The near-term impact will be significant. How effective these actions will be over the longer term is less clear, however. A major factor will be to what extent the Dutch and Japanese governments follow suit in imposing controls on semiconductor manufacturing equipment.

That the United States acted unilaterally in imposing these export controls is an overriding critique. In this instance, the Biden administration may well succeed in securing the desired buy-in from partners. Obtaining *post facto* support is not a sustainable way of operating, however. The U.S. government should craft a better way forward by building on the precedent of the plurilateral export controls and sanctions levied on Russia in response to its renewed invasion of Ukraine.

The first step is emphasizing that the existing four multilateral export control regimes—the Nuclear Suppliers Group, the Australia Group, the Wassenaar Arrangement, and the Missile Technology Control Regime—are not designed for strategic technology competition and that their approach to 'dual use' items are outdated. Another complicating factor is that Russia is a member of three of these groupings. Moscow is likely to thwart meaningful work in these forums, which require consensus among its members.

The goal then should be to initiate a new multilateral export controls regime. One purpose should be to address nonproliferation concerns that the existing regimes won't be able to address if Moscow disrupts their functioning. The overriding objective, though, should be to codify the measures needed to deal with the reality that the concept of 'dual-use' is largely obsolete and that technological leadership is a defining feature of strategic competition. Several concepts for such a regime have already been proposed.

**Getting to Yes: Addressing the China Challenge**

The fundamental hurdle to crafting more aligned and effective export control policies among the leading techno-democracies remains diverging views on the nature of the China challenge. Unless and until the governments of U.S. allies and key partner countries are more aligned with the United States on assessments of the scope and scale of the security challenges posed by the Chinese Communist Party's laws, policies, and actions, coordinated policies to address those challenges will be sporadic and difficult to achieve.

The overarching priority for U.S. policymakers should be to foster greater convergence. Administration officials and members of Congress must focus on explaining the analysis and rationale underpinning America's technology policies toward China. Signs that perspectives on the China challenge are beginning to converge are encouragingly increasingly common. For example, European Commission President Ursula von der Leyen gave a clear-eyed and practical speech on March 30, calling for a new European strategy towards China. Japan updated its National Security Strategy to label China an unprecedented strategic challenge and to boost defense spending. This comes on the heels of its Economic Security Law to protect Japan's economy from hostile actors.

Regarding export controls, the task at hand is for U.S. officials to secure broader buy-in from allies for the use of export controls as a strategic tool designed to constrain technology development, technology indigenization, and specific end uses such as training certain AI models and human rights abuses. Here too, there are encouraging signs that a workable consensus is budding. In a March 17 interview with Japanese news outlet Nikkei Asia, Dutch trade minister Liesje Schreinemacher noted that "when it comes to national security and to restricting certain technology coming into the wrong hands, we [democracies] really have to cooperate. I want to have as many countries and specifically democratic countries on board when it comes to these export restrictions." Such pronouncements bode well for building a comprehensive collaborative approach by the techno-democracies.

**Toward a Tech Alliance**

The 'partner' agenda is where the boldest action is still needed. A new export control regime will require deep coordination on tech policies where it does not yet exist. Collaboration is also needed in a broad range of areas including standard setting, defining and promoting norms for technology use, energy security, and supply chain resilience. A new grouping—an 'alliance' of tech-leading democracies—is needed to foster agreements and coordinate action among governments, with input from leaders in industry and civil society.

Existing groupings such as the G-7, OECD, or NATO cannot readily be adapted—they either don't have all the right members, are too large, or their original purpose doesn't fit the purview of coordinating tech policy at the highest level of statecraft. Nor do Washington's bounty of minilateral and bilateral efforts fit the bill. Semiconductor-related policies are a good example of how current engagements fall short.

The main issue is the highly globalized nature of the semiconductor value chain. Simply put, current dialogues don't have all the relevant players at the table at the same time. This is inefficient, and potentially counterproductive. Take the example of the proposed 'Chip 4' alliance of Japan, South Korea, Taiwan, and the United States. Can such a grouping make meaningful progress on supply chain resilience without key European countries taking part?

Another challenge is one of capacity. The proliferation of dialogues and initiatives mentioned above focused on semiconductors alone are a challenge to manage and institutionalize for a bureaucracy as large as the U.S. government, let alone those of partners with less resources. Consolidation will be necessary to avoid having these well-intended efforts fade into irrelevance through inertia.

Creating a tech alliance would be challenging yet is eminently feasible. The foremost condition—recognition of the need for coordinated multi-nation approaches to technology policy—is there. And the building blocks for such a grouping are already in place, with the United States alone already engaged in a multitude of efforts. Concrete proposals exist for what a larger tech steering committee should look like and what its agenda should be, with work taking place behind the scenes to refine these concepts further.

**Navigating Complex Tech Matters Together**

Coordination and collaboration among the tech-leading democracies will be essential to ensuring that the promote and protect agendas of modern technology statecraft are effective. Technological capabilities and requisite know-how are diffused and oftentimes there is no clear technology leader

and multiple viable technology acquisition pathways exist. Furthermore, protective measures—export controls, inbound and outbound investment reviews, and research security practices—will differ in scope, scale, and feasibility depending on what technology area or scientific discipline is addressed. Clear points of leverage, such as a complete reliance for key inputs on a single or small number of foreign sources—China's dependence on a handful of American, Dutch, and Japanese companies for semiconductor manufacturing equipment, for example—are rare.

Even a cursory overview of key technology areas—artificial intelligence, quantum information science, and biotechnology, technologies that the Commission inquired after—underscores the challenge in crafting effective economic statecraft policies. At present, the feasibility of controls beyond specific AI-relevant hardware is limited. There is potential to place limits on providing compute-as-a-service, such as provided by cloud service providers, blocking the proliferation of datasets needed for certain narrow AI applications, and placing parameters on what datasets can be made publicly available in the future. Compute governance measures in the future could include building hardware security features into the chips themselves, such as a 'kill-switch' that renders them unusable if unauthorized usage occurs. While preliminary research on the latter is underway, much work remains to be done for this to be a viable option.

Chinese entities are already using cloud computing infrastructure to train AI models with Nvidia A100 chips that are subject to the October 7 rule, according to reporting by the Financial Times. As a first step, Congress should work with the White House and industry representatives to stipulate stronger 'know-your-customer' regulations to mitigate the risk of foreign actors of concern skirting export controls by accessing compute through other means.

Quantum information science—comprising the subfields quantum sensing, quantum computing, and quantum communications—presents other challenges to designing and implementing export controls. Only quantum sensing, advanced sensors that detect changes in motion, and electronic and magnetic fields, are currently subject to some export controls. The capabilities in this subfield are most mature and the national security risks, such as the potential to negate stealth technologies and improve navigation and timing capabilities, are better understood.

Quantum computing is nascent and an area where premature export controls could thwart technological development. Scientists are pursuing 12 known modalities, or methods, to produce qubits, the basic unit of information in quantum computing. While the so-called superconducting qubit and trapped ion modalities are the most common and appear most promising now, it is unclear which method will prove most effective or even if it is preferable to promote just one method. Placing limits too early could thus cut off promising research.

For now, researchers such as Sam Howell of the Center for a New American Security and Edward Parker of RAND Corporation posit that the most promising areas for further controls are to expand existing end user controls. Targeting specific applications of quantum computing and quantum communications, and eventually integrated quantum systems such as quantum computers and communication networks could become feasible once quantum technology generally is sufficiently matured.

The most important geopolitical implications of advancements of biotechnology will relate to how things are produced. Bio-manufacturing enables the production of chemicals, materials, food, and other inputs into the economy without relying on fossil fuels. A world reliant on bio-based

manufacturing is one with potential for dramatically different inter-dependencies, with several implications for economic and national security.

Misuse of advanced biotechnology is also a major concern. Constraining dangerous developments in biotechnology could prove to be vexing. Advancements in the field are such that the barriers to entry are low. The required equipment is inexpensive and widely available, while the needed knowledge can be attained at many universities around the world. Breakthroughs in generative AI, algorithms that can create novel content from training data, could be used to design biological and toxin weapons quickly and cheaply.

The opportunities to craft useful export controls in biotechnology are limited. As the bioeconomy expands, it will be critical that biosecurity and biosafety is a top consideration, and that steps are taken to regulate and gain visibility at the right junctures. Additionally, many of the capabilities that the United States has relied on to navigate COVID-19 will be essential to mitigating risk and impact of misuse of biotechnology, including biosurveillance

One of the most valuable resources in biotechnology development is also the most difficult to control: data. Genetic data, from both humans and non-humans, has significant implications for national security, health, and innovation. In the health domain, personal genetic data, both in isolation and in aggregate, has contributed to life-saving treatments, but also raises important privacy concerns. Already, around the world, there are databases containing genetic data from tens of millions of people. Likewise, non-human data is essential to unlocking advancements in the bioeconomy, including to leverage bio-manufacturing to produce products essential for defense, economic security, and to fight climate change.

The Chinese government seeks to develop the world's largest bio-database and Chinese firms are buying and collecting genetic data around the globe. The United States, in partnership with the techno-democracies, need to counter this effort in three ways. First, U.S. lawmakers should restrict the sale of genetic data of U.S. persons going forward. Second, Congress should incentivize the creation of robust sources of non-human biological data, especially in the genetic sequencing of microbes and plants, which drive innovation in the bioeconomy. Third, U.S. policymakers can implement export controls on the suite of technologies that will enable the use of biological data, including in AI, quantum computing, and semiconductors most prominently.

The risk of adverse impacts to the respective national security and national interest of the techno-democracies due to developments in these emerging technologies is significant. China in particular is devoting outsized resources to breakthroughs in each of these areas. The risk of bad outcomes will be higher still if the United States and its allies do not work together to craft a viable 'protect' strategy in these technological and scientific disciplines.

**Needed Change at Home**

Policymakers must bolster and adjust elements of the U.S. government to craft and execute its overall national technology strategy and the 'protect' agenda. The executive and legislative branches each have important actions to take. First and foremost, the President should articulate the need and objectives for a comprehensive strategy for technology competition. Without this framing, it is challenging to stimulate effective legislation, prioritize resources, and rally society. Second, the President should appoint a deputy national security advisor for technology competition to lead the

process for developing the strategy and stand up new policy and analytic teams to manage strategy implementation.

Congress should increase funding for relevant departments and agencies and initiate a partial reorganization of the federal government to improve its ability to marshal the country for technology competition. Government offices central to implementing the protect agenda, such as the Department of Commerce Bureau of Industry and Security, are under-resourced and would benefit from expanded authorities. And Congress can take action to improve the government's capacity to engage with its allies and partners on matters of technology policy.

**Recommendations for Congressional Action Pertaining to Export Controls**
Congress has ample opportunity to gird U.S. capabilities in strategic technology competition to maximize the odds that the interests of the United States and of those of its allies and trusted partners are promoted and protected. The Department of Commerce, with its role in enforcing export control laws and cooperating with and supporting other countries on export control issues, should be the highest priority for action.

The United States Congress should:

- **Expand the mission of the Bureau of Industry and Security (BIS).** The Department of Commerce needs structural and organizational reform. BIS focuses largely on export controls. It should, however, play a much larger role in taking on the national security equities related to regulation and protection of U.S. technology supply chains. By centralizing these authorities in a single office, the U.S. government can more effectively execute economic statecraft. The Department of the Treasury's Office of Terrorism and Financial Intelligence could serve as a useful model for such a reorganization, given how it straddles the economic and national security arenas and is designed to tackle nontraditional national security threats.
- **Designate the Department of Commerce as a U.S. Intelligence Community member.** While department officials have regular access to classified information to inform their decision making, the department lacks a full-fledged intelligence analysis component. This office should not only support internal missions that require national security information but become a hub for economic and technology intelligence analysis within the U.S. government. One of its main mission areas should be to study the long-term economic implications of export controls. To lead the new analytic office, Congress should create the position of assistant secretary for intelligence.
- **Address Department of Commerce resource constraints.** The department's current resources, fiscal and human, do not reflect its growing importance in protecting U.S. technology advantages, addressing supply chain vulnerabilities, and ensuring long-term economic competitiveness. Throughout modern U.S. history, Congress has created, funded, adapted, and restructured department to deal with challenges and threats the country faced, such as the National Security Act of 1947 and the creation of the Department of Homeland Security. Stepping up to support the Department of Commerce won't be as dramatic, yet the impact may be as consequential.

Congress has an important role to play in forging alignment among the techno-democracies on cooperative and beneficial technology policies ranging from research partnerships to supply chain

resilience initiatives to export controls. There is substantial opportunity to strengthen the U.S. government's capacity for multilateral collaboration on these issues.

The United States Congress should:

- **Establish a cadre of tech diplomats.** These officials would be the vanguard for implementing the international aspects of U.S. technology policies, including cooperative research agreements, human capital exchanges, infrastructure development, and export controls. Some of the building blocks for a large corps of technologically savvy diplomats are already in place: the Department of State's office of the special envoy for critical and emerging technology and its regional technology officer program, and the Department of Commerce's digital attaché program.
- **Establish the position of a special envoy for export controls.** The remit of the special envoy should be to enhance international cooperation on export controls. This function will be essential to cementing the long-term collaboration required to maintaining and updating export controls. The special envoy could reside in the Department of Commerce or the Department of State.
- **Promote the creation of a technology alliance.** Technological leadership will be the cornerstone for a country's ability to safeguard its interests and to compete on the global stage. In an era of increasingly diffused technological prowess and globalized supply chains, executing U.S. technology strategy will require closer collaboration with other tech-leading democracies. A steering committee of the world's tech-leading democracies—Australia, Canada, Finland, France, Germany, India, Israel, Italy, Japan, Netherlands, South Korea, Sweden, United Kingdom, and United States, for example—could cooperate in areas including research and development, supply chain resilience, countering economic coercion, harmonizing export controls, and coordinating industrial policies. Actionable concepts for institutionalization and detailing an agenda already exist.

**Conclusion**

Questions of technology have never mattered more in geopolitics. How countries conduct technology policy will have outsized impact on how they fare in global strategic competition. Political leaders have long recognized that technological prowess harnesses advantages in economic competitiveness and impacts international security. But now for the United States technological leadership in areas such as computing and biology is a national security imperative and export controls will play an essential role in securing that leadership.

The strategy to gain and maintain that leadership will touch every level of American society, with investments in people, research, and infrastructure that can transform the U.S. economy. It will also color U.S. relations with countries around the world, friend and foe alike. How the strategy is executed matters tremendously. At stake is America's capacity to empower its people, compete economically, and secure its national interests.

## OPENING STATEMENT OF EMILY KILCREASE, SENIOR FELLOW AND DIRECTOR, ENERGY, ECONOMICS AND SECURITY PROGRAM AT THE CENTER FOR A NEW AMERICAN SECURITY

MS. KILCREASE: Chairman Bartholomew, Vice Chairman Wong, and Commissioners, thank you for the opportunity to provide testimony today.

My testimony focuses on the role that investment security can play in addressing threats to U.S. national security, including risks related to the PRC's efforts to acquire defense and dual-use technologies in support of its military modernization efforts.

And, I am testifying in my personal capacity. My perspectives on investment security are deeply informed by my prior service in the federal government, including most recently serving as the Deputy Assistant U.S. Trade Representative for Investment, among other roles in the economic and national security policy spaces.

I mention this experience as a reminder for us as we consider the necessary expansion of economic security measures.

But, we must also keep mind the value that open markets and open investment roles can have for U.S. prosperity, U.S. economic growth, and ultimately, U.S. national security.

The strength of our nation is deeply intertwined with the strength of our economy. And, we must preserve those aspects of the open economy that have served us well, as we also strive to put in place appropriate guardrails to prevent the exploitation of our open system by foreign adversaries.

And, I've been asked to speak today on those guardrails related to inbound and outbound investment. And, let me start with the CFIUS process.

As the Commissioners well know, the Committee on Foreign Investment in the United States, or CFIUS screen certain foreign investments in the U.S. domestic market to assess the impact of such investment transactions on U.S. national security.

And, the Congress had the wisdom to implement a series of reforms to CFIUS in 2018. These reforms included expanded CFIUS jurisdiction to include new types of transactions, including those related to venture capital and real estate, a streamline process requirement and strengthen enforcement in international coordination functions of CFIUS.

And, today my assessment is that the CFIUS process is generally working well, due in no small part to these reforms as well as to the hundreds of dedicated public servants working across the government to faithfully execute the CFIUS mission, including reviewing hundreds of transactions each year that never make the headlines.

Having said that, I can offer three areas for the Commission and the Congress to consider in order to further strengthen and refine the CFIUS process. All of which are explained in more detail in my written testimony.

First, Congress should establish new authorities to list emerging technologies as critical technologies for the purposes of investment screening.

Today's legal framework in which CFIUS defines quote/unquote critical technologies be referenced to export controlled technologies, generally makes sense.

But, CFIUS would benefit from increased flexibility to designate a broader range of emerging technologies as critical technologies, including those that may not be suitable for listing under export control authorities.

This is particularly true as the United States moves away from distinguishing between commercial and military technologies and towards a broader ecosystem approach to maintaining as large a lead as possible over China in key tech ecosystems.

The proposed expansion of CFIUS authority would primarily have implications for CFIUS jurisdiction over venture capital investments into U.S. startups, as well as the ability of CFIUS to require mandatory notifications of certain transaction involving emergency tech.

Second, Congress should pass comprehensive data privacy and data security legislation. CFIUS has become a tool of convenience to address systemic risks related to data, simply because it happens to have authority to address these concerns in the context of the foreign investment transactions that it reviews.

But, CFIUS is designed to be a tool of last resort, not a tool of convenience. Addressing data security and data privacy risks across the U.S. economy is a more comprehensive, more secure policy response, and one that frees up precious resources for CFIUS to focus on as core mandate.

And third, Congress should bolster CFIUS' resources and capabilities to engage in international outreach. The United States has had success in working with other countries to establish their own in bound investment screening authorities.

And, as Chinese foreign investment in the United States has sharply dropped, it is critical that the United States ensure that China's not simply moving its defense technology acquisition efforts to other countries. And, a strong international coordination program can address this gap. Let me turn now to the question of regulating U.S. investment in China, or outbound investment control.

And here, I want to acknowledge Sarah Bauerle Danzman of Indiana University, who has been my coauthor on previous reports on this subject and my intellectual partner in developing many of the ideas in my testimony.

Any future outbound investment mechanism should be focused squarely on addressing China's indigenous development of critical technologies. And, to achieve this, there are two gating principals for designing a new set of outbound investment controls.

First, let's focus on smart money. China has plenty of access to capital, so any new controls should focus not on passive loads of U.S. dollars, but on smart money or capital flows that are accompanied by managerial expertise that can help build critical technology ecosystems in China.

Second, focus on highest risk national security relevant technologies. Not all technologies and certainly not all investment flows, particularly those into consumer goods or commodity products.

This primarily means the focus on investment flows to support the development of technologies that would be controlled if they were built in the United States.

For example, if a U.S. company cannot export a particular semiconductor to China, it equally should not be permitted to invest in a Chinese company seeking to make that same kind of chip.

With those gating principals in mind, the government can consider a range of tools to address the outbound investment concerns, including a mix of notification requirements, restrictions on investments, in particular high-risk entities, bright line prohibition on investments in Chinese companies making highly sensitive technology, such as those that would fall into the U.S. arms embargo, and ultimately, a sector-based screening process.

This recommended combination of tools does not result in a generally applicable investment screening investment screening regime that will cover all outbound U.S. investments, or all destinations, or even all investment flows to China. Such a broad approach would likely be counterproductive and exceed what is necessary to de-risk the investment relationship. Instead, these recommendations are intended to methodically build an effective and enforceable set of targeted new controls that the government can realistically administer, that the private sector can understand and comply with, and that allies and partners can use as a model for their outbound investment mechanisms.

And finally, I want to conclude by emphasizing that last point, the need for coordination with allies and partners. As my colleagues here have mentioned, the United States is a technology leader in many areas, but it is rare that it is a sole producer of any particular technology.

Ultimately, the United States should pursue a broad coordination mechanism with key allies and partners to coordinate its economic security tools so that technologies of shared strategic importance are protected across a range of commercial activities.

Thank you again for the opportunity to provide testimony today, and I look forward to your questions.

**PREPARED STATEMENT OF EMILY KILCREASE, SENIOR FELLOW AND DIRECTOR, ENERGY, ECONOMICS AND SECURITY PROGRAM AT THE CENTER FOR A NEW AMERICAN SECURITY**

APRIL 13, 2023

TESTIMONY BEFORE THE U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

Hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"
Panel III: Policy Tools for the United States and Its Allies and Partners

# The Role of Investment Security in Addressing China's Pursuit of Defense Technologies


BY

**Emily Kilcrease**

*Senior Fellow and Director*
*Energy, Economics, and Security Program*
*Center for a New American Security*

## I. Summary of Testimony

Chairman Bartholomew, Vice Chairman Wong, and Commissioners, thank you for the opportunity to provide testimony before the Commission.[1] A summary of the recommendations included in this testimony is included below, followed by the supporting analysis.

In order to strengthen the ability of the U.S. government to mitigate national security risks associated with inbound and outbound investments that may contribute to China's military modernization efforts, including its efforts to obtain foreign defense and dual-use technologies, Congress should consider the following actions.

**Committee on Foreign Investment in the United States (CFIUS)**

- Establish new authorities to list emerging technologies as critical technologies for the purposes of investment screening, as a limited addition to the existing FIRRMA definition of "critical technology."
- Reduce CFIUS burden of addressing risks only indirectly related to foreign investment by passing data privacy and data security legislation.
- Strengthen the role of the Office of Legal Council to provide a check on possible CFIUS mission creep.
- Amend the Foreign Risk Review Modernization Act of 2018 (FIRRMA) to allow the Secretary of the Treasury to delegate approval authority for sharing transaction-specific information with key allies to strengthen cooperation.

**Outbound investment controls**

- Establish a set of outbound investment controls focused on addressing national security risks associated with China's indigenous development of critical technologies, including notification requirements, entity-based restrictions, bright-line prohibitions on investments involving certain high-risk indigenous technology capabilities, and ultimately a sector-based screening process.
    - Implement new controls through a phased approach that allows the government to build its knowledge base, expand institutional capacity, and coordinate with allies and partners.
    - Establish a broad notification requirement for U.S. investments in Chinese companies making technologies that would be controlled if made in the United States, as well as a select set of other technologies that have not yet been specified on U.S. control lists.

[1] This testimony reflects the personal views of the author alone. As a research and policy institution committed to the highest standards of organizational, intellectual, and personal integrity, the Center for a New American Security (CNAS) maintains strict intellectual independence and sole editorial direction and control over its ideas, projects, publications, events, and other research activities. CNAS does not take institutional positions on policy issues and the content of CNAS publications reflects the views of their authors alone. In keeping with its mission and values, CNAS does not engage in lobbying activity and complies fully with all applicable federal, state, and local laws. CNAS will not engage in any representational activities or advocacy on behalf of any entities or interests and, to the extent that the Center accepts funding from non-U.S. sources, its activities will be limited to bona fide scholastic, academic, and research-related activities, consistent with applicable federal law. The Center publicly acknowledges on its website annually all donors who contribute.

The author would like to acknowledge Tim Fist, Martijn Rasser, and the CNAS artificial intelligence team for their collaboration during the preparation of this testimony, as well as Sarah Bauerle Danzman for her intellectual contributions to the recommendations related to outbound investment authorities, many of which were previously discussed in "Sand in the Silicon: Designing an Outbound Investment Controls Mechanism" jointly published by CNAS and the Atlantic Council.

- Establish bright-line prohibitions on U.S. investments in Chinese companies producing items that meet the technical specification of items listed on the U.S. Munitions List or for military or space purposes on the Commerce Control List.

- Expand the Chinese Military-Industrial Complex (NS-CMIC) sanctions program to include all types of investments into designated companies and to allow for designations of a broader range of entities engaged in China's indigenous development of critical technologies.

- Implement a sector-based outbound investment screening process, starting with the semiconductor sector.

- Incorporate strong transparency and due process requirements, taking lessons learned from the CFIUS context.

- Do not implement any new authorities until a robust public consultation is conducted, including through hearings and a public comment period.

- Establish a new office under the supervision of the Assistant Secretary of the Treasury for Investment Security to coordinate a new interagency process for outbound investment authorities.

**International coordination on investment security**

- Fully resource the international engagement functions of the Departments of the Treasury and State.

- Create new requirements for CFIUS to assess and report to Congress on the impact of the CFIUS process on foreign investment flows from allies and partners, including an assessment of the effectiveness of the exempted foreign state authorities and the frequency and impact of mitigation agreements on investors from allies and partners.

- Encourage full use of existing fora, such as the U.S.-EU Trade and Technology Council, to coordinate export controls and investment screening policies with allies and partners.

- Pursue a broad coordination mechanism with allies and partners that would identify technologies of shared strategic importance and align export controls and investment controls authorities to protect such technologies.

## II. Overall Investment Climate

### Chinese Investment in the United States

**New foreign direct investment (FDI) flows into the United States by Chinese investors have fallen dramatically in recent years.** Coming out of the 2007-2008 financial crisis, Chinese investment in the United States saw a sharp spike rising from a baseline of almost zero to $27 billion in 2016. However, 2016 was a distinct and unusual peak, as these investment flows have since fallen steadily, decreasing to $15 billion in 2017 and then declining to the level of $294 million by 2021, the most recent year for which data is available from the Bureau of Economic Analysis.[2] All FDI flows into the United States showed declines in the 2015 – 2020 period, including marked declines in the first year of the COVID pandemic. However, global FDI flows into the United States, including those from the Asia Pacific region, have rebounded well in 2021,

[2] Bureau of Economic Analysis, *China – International Trade and Investment Country Facts*, data on "Investment expenditures – first year expenditures." Data last published on July 21, 2022 and available at: https://apps.bea.gov/international/factsheet/factsheet.html#650.

making the continued drop in Chinese FDI a notable outlier. The declining trends held across merger and acquisition activities as well as greenfield investments. Mergers and acquisitions peaked at $26 billion in 2016 and have now fallen to $254 million. Greenfield investments peaked at $1 billion in 2015 and fell as low as $36 million in 2019.[3]

**The direct investment position of China in the United States (*i.e.*, the FDI stock that has accumulated over the years) shows a near freeze in Chinese investments overall.** The direct investment position was $13 billion in 2013, rising to a peak of $63 billion in 2017 and declining to a range of $52-54 billion in following years through 2021.[4] This logically flows from the sharp decline in new FDI flows, as the net position of China's FDI stock in the United States will not increase so long as new FDI flows have dried up.

**Chinese venture capital investment in the United States follows the same general patterns, rising from near zero prior to 2010 and potentially peaking in 2018.** In 2018, 249 funding rounds for U.S. startups included a Chinese venture investor, with these investors investing an estimated $3.2 billion.[5] Several factors likely dampened flows post-2018, including the passage of strengthened investment screening authorities in the United States and later the COVID pandemic. However, dealmaking has not completely disappeared. Since late 2018 through April 2023, there was a Chinese lead investor in funding rounds worth approximately $20 billion for U.S.-based businesses across all sectors, according to Crunchbase data.[6] The exact amount attributable to the lead Chinese investor for each round is not available.

### U.S. Investment in China

**The U.S. direct investment position in China has risen steadily in recent years, growing from $60 billion in 2013 to $118 billion in 2021.**[7] FDI flows have varied over the same time period, with a high of $11 billion in 2014 and generally staying in the $6 billion to $9 billion range. In 2021, FDI flows dropped to under $3 billion, which was likely driven by China's Zero-Covid policies in place at the time. The total FDI flows into China in 2021 were $181 billion, and flows into the Hong Kong Special Administration Region accounted for an additional $141 billion, reflecting that China has access to a wide range of FDI sources other than the United States.[8] U.S. investment in China includes significant amounts of greenfield investment, in addition to merger and acquisition activity, in contrast to Chinese investment in the United States, which does not include large amounts of greenfield investment. U.S. investors have also been active in China's nascent venture capital space, investing upwards of $60 billion of venture capital since 2010.[9] In recent years, U.S. venture investments in China have appeared to slow.[10] Chinese investors have become increasingly active in venture capital, including in high profile sectors such as artificial intelligence (AI), indicating the availability of venture capital to Chinese start-ups from sources beyond the United States.[11]

## III. Effectiveness of CFIUS

[3] The Bureau of Economic Analysis has suppressed data on greenfield investments in 2020 and 2021 following standard practice of statistical agencies to not publicly release data that may inadvertently disclose data of individual companies. In other words, levels of greenfield investment have dropped so far that it is difficult for statistical agencies to report them.
[4] Bureau of Economic Analysis, *China – International Trade and Investment Country Facts*, data on "Foreign direct investment position in the United States on a historical-cost basis by country of ultimate beneficial owner." Data last published on July 21, 2022 and available at: https://apps.bea.gov/international/factsheet/factsheet.html#650.
[5] Thilo Hanemann, Daniel H. Rosen, Mark Witzke, Steve Bennion, and Emma Smith, "Two-Way Street 2021 Update: U.S.-China Investment Trends" (U.S.-China Investment Project conducted by the Rhodium Group and the National Committee on U.S. China Relations, May 2021).
[6] Author calculations using Crunchbase data.
[7] Bureau of Economic Analysis, *China – International Trade and Investment Country Facts*, data on "U.S. direct investment position abroad on a historical-cost basis." Data last published on July 21, 2022 and available at: https://apps.bea.gov/international/factsheet/factsheet.html#650.
[8] United Nations Conference on Trade and Development, "Fact Sheet #9: Foreign direct investment" (UNCTAD Handbook of Statistics 2022). Available at: https://unctad.org/system/files/official-document/tdstat47_FS09_en.pdf
[9] Thilo Hanemann, Mark Witzke, Charlie Vest, Lauren Dudley, and Ryan Featherston, "An Outbound Investment Screening Regime for the United States?" (U.S.-China Investment Project conducted by the Rhodium Group and the National Committee on U.S. China Relations, January 2022).
[10] "A Daunting Arsenal," *The Economist*, April 1, 2023.
[11] Emily S. Weinstein and Ngor Luong, "U.S. Outbound Investment into Chinese AI Companies" (Georgetown University Center for Security and Emerging Technology, February 2023).

## Overview of CFIUS

**The United States has a well-established legal framework for screening certain foreign investments into U.S. businesses in order to address the national security risks that may arise from such transactions.** These authorities are implemented by the CFIUS, an interagency body chaired by the Secretary of the Treasury.[12] CFIUS has broad authority to respond to risks arising from foreign investments covered by its jurisdiction (*i.e.*, covered transactions.)[13] It can do this through the negotiation – or in some cases, imposition – of terms on a transaction to mitigate identified national security risks. Where mitigation cannot overcome the national security concerns, CFIUS may recommend that the President suspend or prohibit the covered transaction. The CFIUS program, implemented on a day-to-day basis by hundreds of civil servants working across the executive branch and subject to high levels of political accountability, is functioning well. The analysis and recommendations offered in this testimony aim to further strengthen the CFIUS process, with the ultimate objective of ensuring that it focuses its limited resources on transactions of highest national security risk, including those that may aid China's military modernization efforts.

## FIRRMA Reforms

**In 2018, FIRRMA reformed CFIUS in several key respects, including through an expansion of its jurisdiction to review new types of investment transactions.** Prior to FIRRMA, CFIUS had the authority to review controlling investments, in which a foreign person gained control of an existing U.S. business.[14] This jurisdiction generally covered traditional mergers and acquisitions activity and applied across the U.S. economy, regardless of what sector the U.S. business operated in. It did not, however, include venture capital investments, an area of growing concern due to rising levels of Chinese venture capital investment in the United States. To address this gap, FIRRMA provided CFIUS authority to review a defined class of non-controlling investments (*i.e.*, covered investments), defined on the basis of rights that the investor would obtain through the investment as well as the type of U.S. business that was the recipient of the investment.[15] The intent of Congress was to capture those investments in which the investor had an active, even if non-controlling, role in the U.S. business, while carving out from jurisdiction purely passive investment flows. This new jurisdiction did not apply across all sectors and was instead limited to covered investments into U.S. business involved in critical technology, critical infrastructure, or sensitive personal data, as defined in detail in the implementing regulations.[16]

**FIRRMA also expanded the CFIUS jurisdiction to review greenfield real estate transactions, in response to concerns about foreign acquisitions of land in close proximity to sensitive military facilities.** CFIUS agencies, led by the Department of Defense, undertook an extensive rulemaking process to scope this new jurisdiction to capture those areas of real estate that were determined to present proximity concerns, while scoping out real estate for which investment transactions were unlikely to present a national security risk.[17] CFIUS has the ability to refine or expand the real estate jurisdiction through future rulemakings, should the need arise.

**FIRRMA also made productive updates to the CFIUS process, including related to streamlining filing requirements, strengthening mitigation agreements, and bolstering enforcement capabilities.** Notably, CFIUS for the first time received authority to mandate notification of certain transactions involving foreign government investors or U.S. businesses working on critical technology.[18] The voluntary nature of the

[12] For an overview of the CFIUS interagency process, see the CFIUS website at: https://home.treasury.gov/policy-issues/international/the-committee-on-foreign-investment-in-the-united-states-cfius.
[13] See 31 CFR § 800.213 (*covered transaction*).
[14] See 31 CFR § 800.224 (*foreign person*), 31 CFR § 800.208 (*control*), and 31 CFR § 800.252 (*U.S. business*).
[15] See 31 CFR § 800.211 (*covered investments*).
[16] See 31 CFR § 800.211 (*covered investments*), 31 CFR § 800.215 (*critical technology*), 31 CFR § 800.214 (*critical infrastructure*), and 31 CFR § 800.241 (*sensitive personal data*).
[17] See 31 CFR § 802 for the full regulations regarding CFIUS and real estate transactions.
[18] "Provisions Pertaining to Certain Investments in the United States by Foreign Persons," Department of the Treasury, Office of Investment Security (Federal Register Vol. 85, No. 179, September 15, 2020). Available at: https://www.govinfo.gov/content/pkg/FR-2020-09-15/pdf/2020-18454.pdf.

CFIUS process has generally worked well, as investors are strongly incentivized to file with CFIUS in order to receive regulatory safe harbor from further government review. Mandatory notifications, however, provide a critical ability for CFIUS to have greater visibility into a subset of transactions that may be more likely to raise national security concerns, strengthening its overall enforcement posture. The mandatory notification requirements for critical technology transactions are linked to export control authorities, in that a notification is required if the U.S. business makes a critical technology that the foreign investor would require an export control license to access.

**Recognizing the importance of partners and allies in addressing investment-related national security risks, FIRRMA provided new authorities to facilitate international cooperation.** This includes the ability to share transaction-specific information, where appropriate, as well as more general direction to establish processes to share trends and threat information. FIRRMA also created the legal flexibility to exempt certain foreign persons from the expanded areas of CFIUS jurisdiction. CFIUS has implemented this flexibility through the excepted foreign state determinations that allow qualified investors from a small handful of close allies to bypass CFIUS review for covered real estate and covered investment transactions.[19]

**In parallel to these changes to the legal framework, CFIUS undertook an extensive diplomatic effort to encourage allies and partners to establish their own investment screening regimes.** Prior to this time, the United States had generally not prioritized investment screening in its diplomatic engagements, in part out of concern that new regimes could inadvertently create investment market access barriers for U.S. firms abroad. However, as the U.S. investment market became increasingly closed for Chinese firms, there was growing awareness that China could seek comparable access to sensitive technologies through investments in other countries. Strong U.S. investment screening would thus have weaker effect on the ultimate objective of denying China those technologies it needed to modernize its military, if the United States acted alone. The diplomatic effort to encourage investment screening regimes in key allies and partners was supported by intensive technical assistance work to share U.S. investment screening best practices. These efforts led to a wave of new investment screening mechanisms established or existing mechanisms strengthened.[20]

### Assessing the Effectiveness of CFIUS in Addressing China's Technology Acquisition Efforts

**Generally, CFIUS has been effective in addressing investment-related risks associated with technologies that can be used for military modernization in China or other adversary countries.** Chinese companies have largely been shut out of the U.S. investment market for key technology areas, such as advanced semiconductors and aerospace. Technologies that have well-established relevance to military objectives present relatively easier cases for which CFIUS can assess national security risks. CFIUS has a harder time, however, articulating risks associated with emerging technologies whose full applications are not yet known. It must also increasingly assess national security concerns beyond just technology transfer and consider the implications of China gaining greater market share and capacity in certain technology areas – both emerging and legacy technologies - which presents a separate risk assessment challenge. These challenges, plus increasing caseloads and stress on the CFIUS process, are areas for Congress to address to ensure that CFIUS remains an effective tool for limiting China's access to U.S. technologies with potential military applications.

## CHALLENGES WITH EMERGING TECHNOLOGIES

[19] For information on CFIUS excepted foreign states, see the CFIUS website at: https://home.treasury.gov/policy-issues/international/the-committee-on-foreign-investment-in-the-united-states-cfius/cfius-excepted-foreign-states.
[20] "Acquisition- and ownership-related policies to safeguard essential security interests: Current and emerging trends, observed designs, and policy practice in 62 economics," Research note by the Secretariat of the Organization for Economic Cooperation and Development (OECD) (OECD, May 2020).

**Addressing risks associated with emerging technologies presents unique challenges for CFIUS.** Risk assessments become inherently more speculative when considering applications that a technology could have rather than those it does have. U.S. companies may be making advances in pushing the emerging technology frontier forward as a general matter, but it may be difficult for CFIUS to articulate a credible risk scenario that ties such advances directly to contributions to China's military modernization. At the same time, U.S. national security leaders are increasingly recognizing that U.S. leadership in certain emerging technology areas will be foundational to America's future military preeminence, as well as its economic security. National Security Advisor Jake Sullivan has identified certain emerging technology areas that are "force multipliers" and in which U.S. leadership is a "national security imperative," including quantum information systems, artificial intelligence, and biotechnology, among others.[21] The CFIUS Executive Order issued on the day before Sullivan's remarks emphasized these same emerging technology areas, confirming that CFIUS will be used to protect U.S. advantage in these areas.[22]

**The question remains, however, where CFIUS will draw a line between applications of emerging technologies that are commercial in nature and those that may make a meaningful contribution to China's military modernization.** In fact, it appears plausible that no line will be drawn at all, and that U.S. policy is moving towards a more absolute approach in which access to any U.S. capabilities in key emerging technology areas will be seen as presenting a national security risk. Indeed, U.S. policy seems to be moving in this direction. Rather than seeking to control specific technologies of concern, the United States has shifted to attempting to halt the progress of entire technology ecosystems in China. Notably, the U.S. export controls issued in October 2022 related to chips, AI, and supercomputing are the first practical implementation of the strategic vision laid out by Sullivan, as they seek to cap China's advancement in these sectors.[23] While it is difficult to assess how far CFIUS specifically has moved in this direction, given the limited information available publicly on CFIUS determinations, U.S. export control policy has clearly moved to a broader ecosystem approach.

**This broader ecosystem approach requires the government to rethink the longstanding links between its investment screening and export control authorities.** CFIUS has traditionally defined "critical technology" through reference to the export control authorities, rather than developing its own lists of sensitive technologies. In order for a technology to be considered a critical technology for CFIUS purposes, the technology must have been identified and listed by the export controls agencies on one of the U.S. export control lists (*e.g.*, the U.S. Munitions List).[24] Prior to FIRRMA, this definitional issue had little practical impact. CFIUS had – and continues to have – full jurisdiction to review any covered control transaction, regardless of whether the U.S. business engaged in critical technology or not.[25] Under FIRRMA, however, the definition of critical technology took on heightened importance in two ways. First, the new CFIUS jurisdiction over covered investments was limited to only certain types of U.S. businesses, including those that engaged in critical technology. If, for example, a Chinese investor made a venture capital investment into a promising U.S. AI start-up, this investment would only be caught by CFIUS jurisdiction if the start-up's technology was export controlled. If it was not – any many emerging technologies may not be - the U.S. government has no legal jurisdiction to review the investment transaction. Second, the new FIRRMA authorities to mandate notifications of certain transactions to CFIUS also hinged on the definition of critical technology. These changes gave new importance to the legal links between export control authorities and CFIUS.

[21] Jake Sullivan, "Remarks at the Special Competitive Studies Project Global Emerging Technologies Summit" (Washington, DC, September 16, 2022). Available at: https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/09/16/remarks-by-national-security-advisor-jake-sullivan-at-the-special-competitive-studies-project-global-emerging-technologies-summit/.
[22] "Executive Order on Ensuring Robust Consideration of Evolving National Security Risks by the Committee on Foreign Investment in the United States" (September 15, 2022). Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/15/executive-order-on-ensuring-robust-consideration-of-evolving-national-security-risks-by-the-committee-on-foreign-investment-in-the-united-states/.
[23] Emily Kilcrease, "How to Win Friends and Choke China's Chip Supply," *War on the Rocks*, January 6, 2023.
[24] See 50 USC § 4565(a)(6) and 31 CFR § 800.215.
[25] See 31 CFR § 800.210 (*covered control transaction*).

**Tight linkages between export control and investment screening authorities generally make sense.** If a technology is sensitive for national security reasons, then the government should protect it regardless of the form of commercial transaction that may expose it to foreign adversaries, whether that is an investment or an export. Alignment between the various authorities facilitate compliance efforts in the private sector, which is the first line of defense for any set of controls. It also makes more efficient use of limited bureaucratic resources, given the technical expertise and staff time required to assess the feasibility of any new controls. For these reasons, maintaining a strong alignment between export control technology classifications and investment screening authorities continues to be good policy.

**However, there may be limited instances in which CFIUS has an interest in reviewing investment transactions involving uncontrolled technologies, particularly as the United States moves towards a broader ecosystem approach to the technology competition with China.** Specifically, certain venture capital investments into U.S. companies developing emerging technologies may present national security concerns if such investments provide privileged access to expertise and capabilities that could be used to advance a foreign adversary's indigenous technology development. In emerging technology areas, this broader capabilities question may have national security relevance, even if the technology of the U.S. business itself is not controlled. International investment remains an important means of diffusing advanced technology expertise, and advances in emerging technologies areas may equally be made by start-ups receiving venture funding as they are from more established firms.[26] Certain transactions involving start-ups and emerging technologies may be falling outside of CFIUS jurisdiction, due to the limitations included in FIRRMA's definition of critical technology.

### CASE STUDY: ARTIFICIAL INTELLIGENCE

**The AI ecosystem provides a useful case study for where export controls and investment screening authorities may be differently positioned to address risks associated with emerging technologies.** A country's capabilities in AI derive from its access to powerful computing power, the availability of large amounts of training data, and the ingenuity of its engineers to develop and train AI models. Export controls apply in different ways to these three categories of computing power, data, and talent. Computing power, or chips, are the easiest to address through export controls, as the export control authorities have a long practice of defining technical specifications of chips with national security relevance. For example, the United States imposed new controls on advanced AI chips as part of the October 2022 export controls package. Addressing concerns around access to data likely requires broader data privacy and data security legislation, as current AI models are built using publicly available data and thus export controls are unlikely to prevent access to that which is already available to the public. As AI systems exhaust publicly available data, controls on the export of private data sets may need consideration, as part of a broader U.S. push on data security.

**More complicated questions arise when assessing risks that may arise from the development and training of AI models.** General-purpose AI systems have recently broken into the headlines and sparked public curiosity with the release of large language models, such as ChatGPT. These general-purpose AI systems can approximate human cognitive abilities and learn new skills through analyzing data. These types of systems are trained through ingesting large amounts of data and learning how to produce accurate outputs from that data. For example, ChatGPT can draft a decent essay on U.S.-China strategic competition by ingesting think tank and other reports available online and synthesizing that information into a logical structure and argument.[27]

[26] "Managing Access to AI Advances to Safeguard Countries' Essential Security Interests" in *OECD Business and Finance Outlook 2021: AI in Business and Finance* (OECD Publishing, Paris, 2022).
[27] The workforce replacement effects of such developments on the think tank community, and the attendant risks to national security, have yet to be determined.

**Today's general-purpose AI systems remain rudimentary, generating false facts or "hallucinations" and are not yet close to approximating the full range of human cognition.**[28] But signs are already emerging of the dangers that these systems can present, and this risk will grow as the systems – and the underlying computing power – continue to grow. Existing large language models can be used, for example, to spread disinformation online, launch cyber attacks at a much faster scale than a human can alone, and generate disturbing pornographic images.[29] Large scale AI models, whether general-purpose systems or narrow AI systems focused on particular tasks, could be used for a range of military purposes, such as developing novel toxins, mapping the trajectory of hypersonic missiles, or simulating nuclear weapons testing.[30] The ability to achieve advances in the military AI domain can be supported through advances in general AI capabilities, and specifically the expertise, computing infrastructure, and institutional capacity to train and refine large scale models. Leading AI experts have called for a pause in the release of more powerful AI models until governments and industry develop more robust safety systems to mitigate this broad scope of risks and ensure that AI systems will have positive societal effects.[31]

**AI governance will implicate a wide range of legal, ethical, and societal factors, and export controls will be only one of many governance tools needed to ensure the safety and stability of AI systems.** While one could envision the establishment of export controls based on the overall computational power of an AI model, many if not all of the most powerful models are intended to be made open source. An open-source model is inherently impractical to control, as it is available to anyone with an online connection. It may also fall under the publications exception to U.S. export controls, which carve out unclassified software or technology that has been made available to the public without restriction.[32] Additionally, the development of AI models will be based on the value-laden judgements of the developers and institutions that build them, in some ways similar to – but more powerful than – how social media platforms have evolved. Export controls, which govern the transfer of technology out of a U.S. firm, cannot tell an AI company which values to have. While policymakers should continue assessing which parts of the AI ecosystem may be amenable to export controls, there are likely to remain significant areas in which export controls should not be the first line of defense to protect against risks.

**Investment controls are differently situated, in that they can address a broader range of concerns that can arise institutionally within a firm and by virtue of the firm's governance or investment structure.** For example, certain foreign investment interests could negatively impact an AI start-up's willingness to abide by emerging AI governance standards or to implement voluntary safety and stability standards. These types of corporate decisions cannot be caught via export controls but could nonetheless have significant impacts on U.S. national security. Large scale AI models are currently run by a small handful of large technology firms that can fund the massive expense of building the models, including the need for large numbers of expensive computing chips. However, start-ups can access comparable capabilities by, for example, buying an AI model developed by another firm and fine-tuning it for their own purposes. Chinese venture investors remain active in the U.S. AI start-up ecosystem, involved in over $2 billion worth of funding rounds for U.S. AI companies since the passage of FIRRMA, though the sensitivity of the invested companies is unclear based on existing data.[33] More broadly, the United States retains a lead over China in developing both general purpose and narrow AI systems, indicating that the United States will remain an attractive target for Chinese investors absent U.S. policies to regulate their engagement.

**AI provides one case study for why the CFIUS process would benefit from additional authorities, but other emerging technology areas may present similar concerns.** To provide flexibility to capture venture

[28] GPT-4 System Card, OpenAI, March 23, 2003. Available at: https://cdn.openai.com/papers/gpt-4-system-card.pdf.
[29] "Opwnai: Cybercriminals starting to use ChatGPT," Check Point Research, January 6, 2023. Available at: https://research.checkpoint.com/2023/opwnai-cybercriminals-starting-to-use-chatgpt; "Eshoo Urges NSA and OSTP to Address Unsafe AI Practices," Office of U.S. Representative Anna G. Eshoo (D-CA), press release, September 22, 2022.
[30] Fabio Urbina, Filippa Lentzos, Cédric Invernizzi, and Sean Ekins, "Dual use of artificial-intelligence-powered drug discovery," *Nature Machine Intelligence*, 4, March 2022.
[31] Cade Metz and Gregory Schmidt, "Elon Musk and Others Call for Pause on A.I., Citing 'Profound Risks to Society,'" *The New York Times*, March 29, 2023.
[32] 15 CFR § 734.7.
[33] Author calculations based on Crunchbase data.

capital transactions involving these emerging technologies, Congress should authorize a limited expansion of the definition of *critical technology*. This could be accomplished through a targeted amendment to the Export Control Reform Act of 2018, authorizing Commerce to create a new export control classification number (ECCN) for investment purposes, complemented by a conforming amendment in FIRRMA to include this new category in the definition of *critical technology*. The investment ECCN would be additive to existing ECCNs and allow for the listing of emerging technologies that the government has an interest in reviewing in the investment context but that may not be suitable for an export control. The investment ECCN should be seen as a backstop tool used in limited, ad hoc circumstances, rather than a new requirement for CFIUS or Commerce to populate a new list of technologies. It should also only apply to a small handful of countries which present the highest risk with respect to emerging technologies, such as those countries listed under the EAR's military end user authorities or in the EAR's country group D5, which lists countries under an arms embargo.[34] In most cases, if CFIUS identifies a technology of interest, it will also be appropriate for Commerce to list it under traditional export controls, and the current legal framework already provides channels for this sort of coordination. The investment ECCN approach allows CFIUS to maintain consistency and alignment with export controls while providing flexibility to address a broader range of emerging technology risks.

## BANDWIDTH CONSTRAINTS OF CFIUS

**In 2021, the most recent year for which Treasury has reported data, CFIUS reviewed 164 short-form declarations and 272 notices.**[35] For context, in 2018 (the year of FIRRMA's passage), CFIUS reviewed 229 notices, meaning that the number of transactions that CFIUS is reviewing has nearly doubled.[36] The number of difficult reviews also remains high, and it is important to note that it is the difficult reviews that consume most of the time of CFIUS. In 2021, 63 transactions were withdrawn and refiled, indicating that either the transacting parties or CFIUS required further time to assess risks or negotiate a mitigation agreement.[37] In contrast, in 2015 (a year in which Chinese investment in the United States was rapidly increasing), only 8 transactions were withdrawn and refiled.[38]

**The numbers show that CFIUS has been under strain since before FIRRMA and that the additional transactions brought in post-FIRRMA continue to exacerbate challenges with processing transactions in a timely fashion.** Importantly, these trends impact investment from friendly countries as well as that from adversary countries. While transactions involving investors from China regularly rank in the top three filing countries, so do those involving investors from Japan and Canada.[39] It is critical that investments from friendly countries get in and out of the CFIUS process expeditiously. Doing so means that a robust CFIUS process remains consistent with the long-standing open investment policy of the United States and that the U.S. economy continues to benefit from these types of investments. It also frees up resources for CFIUS to focus on transactions that present genuine national security risks, including ramping up its efforts to find transactions that have not been notified to CFIUS. Certain adjustments that FIRRMA made to the CFIUS process, such as the creation of a short-form declaration process to expedite certain reviews, are helpful but the numbers show that there is still a long way to go. Ensuring adequate staffing, not just in Treasury but across the CFIUS agencies and supporting intelligence community components, is critical.

## DATA SECURITY AND DATA PRIVACY

[34] See 15 CFR § 744.21 and 15 CFR § 738 supplement no. 1.
[35] "Committee on Foreign Investment in the United States Annual Report to Congress" (Report period: CY 2018, public/unclassified version). Short-form declarations are subject to a 30-day review period and involve fewer informational requirements. Notices involve more extensive submission of information, and an initial 30-day review period can be extended to a 45-day investigation period or further.
[36] "Committee on Foreign Investment in the United States Annual Report to Congress" (Report period: CY 2021, public/unclassified version).
[37] 2018 CFIUS Annual Report.
[38] "Committee on Foreign Investment in the United States Annual Report to Congress" (Report period: CY 2015, public/unclassified version).
[39] 2021 CFIUS Annual Report.

**Part of the solution to CFIUS's bandwidth issues should come from easing the burden on CFIUS to address risks that are only partially or indirectly related to foreign investment, and here data security is a prime example.** CFIUS spends significant time assessing risks related to the potential exposure of sensitive personal data, or other forms of sensitive data, to foreign adversaries. CFIUS is required to assess whether existing authorities are adequate and appropriate to resolve any national security concerns arising from the covered transaction. Indeed, CFIUS is intended to be a tool of last resort, serving as a backstop when foreign investments present particular risks that cannot be addressed by other authorities available to the U.S. government. Too often, however, CFIUS is forced into the uncomfortable position of being the first line of defense when it comes to protecting sensitive data, since no comprehensive authority for data privacy or data security yet exists. It has become a tool of convenience to impose a patchwork of protections for sensitive data held by companies that just so happen to be receiving a foreign investment.

**CFIUS is fundamentally unsuited to address broader concerns over data privacy and data security.** The ongoing TikTok saga highlights this dilemma. The Chinese ownership of TikTok undoubtedly presents national security concerns, including with respect to sensitive personal data.[40] However, there is no law on the books preventing any of TikTok's U.S. competitors from selling very similar data sets to an overseas partner, and the data broker market is unfortunately robust.[41] Congress can help by passing comprehensive data privacy and data security legislation. Data privacy objectives should include giving individuals greater control over what data is collected about them online and how that information is sold or used. Data security objectives should address the national security concerns that can arise from the bulk transfer of sensitive data to a foreign adversary. Data privacy and data security have overlapping objectives and stronger data privacy will inherently reduce data security risks through minimization of the personal data on the open market. Data privacy and data security legislation is important in its own right but will also help return CFIUS to its intended purposes of addressing foreign investment risks rather than dealing with data risks writ large.

### THIRD-PARTY RISKS AND THE NEED FOR INTERNATIONAL COLLABORATION

**CFIUS expends significant energy in addressing third-party risks, in which national security risks arise not from the foreign investor directly but from the foreign investor's relationships with adversary countries.** For example, if a European company is seeking to buy a U.S. business engaged in critical technology and the European company also has substantial operations in China, CFIUS may assess that the transaction presents national security concerns arising from diffusion of technology to China via the European investor. As foreign investment risks directly from China have declined with the overall drop in Chinese investment in the United States, third party risks have gained more prominence in the CFIUS assessment process. Third-party risks present a dilemma for CFIUS. On the one hand, these risks can be genuine and severe. On the other hand, CFIUS ideally would not be addressing these risks, if the export control and investment screening process of allies and partners were more closely aligned with those of the United States. With stronger alignment, the United States could have greater comfort that transfers of technology, expertise, and capabilities to allies and partners – including those that occur as part of an investment – would not lead to the diffusion of these assets to China. Instead, the United States could rely on the economic security authorities of partners and allies to effectively address these risks, reducing the pressure on CFIUS to do so.

**Strengthening coordination with allies and partners can take different forms, depending on the maturity of the allies and partners' screening mechanisms.** For partners like the Five Eyes countries and the European Union, cooperation can take more advanced form, such as coordinating specific transaction reviews or sharing classified risk assessments. For these partners, the Secretary of the Treasury has the ability to authorize the sharing of transaction-specific information as needed, though in practice this does not

[40] Committee on Energy and Commerce, U.S. House of Representatives, "TikTok: How Congress Can Safeguard American Data Privacy and Protect Children from Online Harms," March 23, 2023.
[41] Captain Steven J. Arango, U.S. Marine Corps, "Data Brokers are a Threat to National Security" (U.S. Naval Institute *Proceedings*, December 2022, vol. 148/21/1,438).

happen regularly. Congress could encourage further information sharing by permitting the delegation of the information-sharing authorization to the Deputy Secretary level, as this official is deeply engaged already on most complex transaction reviews. More broadly, Congress should ensure that the Departments of Treasury and State have sufficient resources to regularly conduct technical outreach and engage in sustained cooperation on investment screening with key allies and partners. Ultimately, the United States should pursue a broad coordination mechanism that provides a forum for allies and partners to identify technologies of shared strategic interest and to align both export control and investment screening authorities to strengthen joint protection of these technologies.[42]

**Strengthening coordination with allies and partners should also include intentional efforts to ensure that the CFIUS process is not impeding friendly investment flows into the United States.** Congress can strengthen its oversight role here by instituting a new requirement for CFIUS to assess and report to Congress on the impact of the CFIUS process on foreign investment flows from allies and partners. This should include assessment of whether these flows have been negatively impacted by FIRRMA's expansion of CFIUS jurisdiction and whether FIRRMA's tool to address this, including the exempted foreign state program and the declaration process, are being effectively utilized. The reporting requirement should also address the impact of mitigation agreements on the investments of allies and partners, with the aim of ensuring that these mitigation agreements are genuinely focused on risks arising from the transaction and attributable to the foreign investor, rather than broader systemic risks.

**Congress may also want to consider strengthening the role of the Office of Legal Counsel (OLC) within the CFIUS process, in order to ensure that CFIUS remains tightly focused on risks arising from covered transactions.** When dealing with risks such as data security and third-party exposure to China, CFIUS risks straying from its core mission (*i.e.*, risks arising from foreign investment in the United States) and being used as a tool of convenience to address broader systemic risks. CFIUS already has certain mechanisms to ensure that its actions are consistent with its legal mandate, including the strenuous interagency consensus process and the requirement for all transactions to be signed off on by high-level political appointees. OLC provides guidance on the most complex transactions as well as those that will be recommended to the President for action. Moreover, the Department of Justice, in which OLC resides, is a voting member of CFIUS and actively engaged in all CFIUS functions. Strengthening OLC's role would thus be an intensification of existing practice, rather than an entirely new process. Involving OLC in a broader range of transaction reviews involving mitigation agreements can provide an independent check on possible mission creep and lessen the chance that mitigation is chilling benign foreign investment flows.

## IV. Risks Associated with U.S. Investments in China[43]

While the United States has a robust process for addressing risks associated with foreign investment into the United States, it is less well positioned to address national security risks associated with U.S. investments into China. U.S. investments in China can present a range of foreign policy challenges, including support for companies implicated in systemic human rights abuses, offshoring of critical supply chains, and furtherance of China's indigenous technology development aims.

**Each of these policy concerns requires a different response, and a broad-based set of outbound investment controls may not be appropriate in all cases.** Human rights concerns, for example, may be addressed in a more targeted manner through the continued use of financial sanctions and Entity List designations, both of which have been used increasingly in recent years for human rights related reasons.[44]

[42] Emily Kilcrease, Senior Fellow and Director of the Energy, Economics, and Security Program at the Center for a New American Security, "Challenging China's Trade Practices," testimony before the U.S.-China Economic and Security Review Commission, April 14, 2022.
[43] Commentary and analysis in this section draws heavily from the author's paper with Dr. Sarah Bauerle Danzman, "Sand in the silicon: Designing an outbound investment controls mechanism" jointly published by CNAS and the Atlantic Council. Further detail is available in that paper.
[44] Emily Kilcrease and Michael Frazer, "Sanctions by the Numbers: SDN, CMIC, and Entity List Designations on China" (Center for a New American Security, March 2, 2023).

Tools such as the Uyghur Forced Labor Prevention Act will be critical to reduce global demand for goods made with forced labor. Offshoring of critical supply chains is most effectively addressed through policies that address the underlying economic drivers leading to offshoring. Blocking offshoring transactions is a blunt instrument that does nothing to make it commercially viable for firms to produce critical goods in the United States. A disciplined industrial policy is a more durable policy to encourage the development of secure, resilient supply chains. The passage of the CHIPS and Science Act and the Inflation Reduction Act to spur the development of chips and clean energy sectors in the United States are examples of how the United States might bolster supply chains by addressing the economics of why firms have in the past chosen not to manufacture in the United States. Enhanced government capacity to analyze supply chains and innovative financing mechanisms to support the expansion of critical manufacturing capacity domestically are also critical.[45]

### Designing Outbound Investment Controls

**Risks arising from capital flows that support China's indigenous development of critical technologies can and should be addressed through outbound investment controls.** In prior work, my co-author Dr. Sarah Bauerle Danzman and I outline five principles that should guide the development of a new outbound investment mechanism. We recommend that new outbound investment tools be:

- targeted at transactions that present the highest national security risk;
- clearly defined and understandable to private-sector participants, who will be responsible for the first line of compliance;
- non-duplicative of existing tools that address national security risks associated with global economic activities, including inbound investment screening conducted CFIUS, export controls, list-based export sanctions programs, and the CHIPS and Science Act of 2022;
- scoped proportionately to the administrative capacity available to effectively administer a new mechanism; and
- designed to enable meaningful conversations with allies about adopting similar regimes.

**To achieve these objectives, outbound investment controls should be crafted to serve as a complement to existing export control authorities.** Export controls can be thought of as a three-legged stool, comprised of list-based controls (*e.g.*, the Commerce Control List), end user controls (*e.g.*, the Entity List), and end use controls (*e.g.*, military end use). Each of these legs of the stool are intended to capture different types of technology flows and will work best when used in tandem. In this context, investment controls can be thought of as the fourth leg in the stool, regulating the flow of capital that can support the indigenous development of technologies that would be controlled if they were developed in the United States. For example, a U.S. exporter may be prohibited from exporting an advanced semiconductor to China, but there would be no legal prohibition on a U.S. investor investing in a Chinese company to produce a comparable chip. Designing an outbound mechanism in this way provides an important scoping parameter for the types of technologies and sectors that will be covered.

**In addition to the types of technologies covered, an outbound investment mechanism will need to define the types of investment transactions covered.** Outbound investment controls should focus on "smart money" or investment flows that are accompanied by managerial expertise or other intangible benefits that may advance China's indigenous technology capabilities. For example, an advanced manufacturing operation requires not just technology, but also management that knows how to orchestrate complex supply chains, attract and retain skilled workers, and operate efficiently in a cost-competitive environment. These skills, which can be broadly characterized as "management expertise," are critical to the success of a sector but are not possible to capture through export controls. At the same, allowing U.S. investments that have these associated benefits to support the advancement of critical technology sectors in China is not in the U.S.

[45] Emily Kilcrease and Emily Jin, "Rebuild: Toolkit for a New American Industrial Policy" (Center for a New American Security, September 8, 2022).

interest. Is it this precise gap that an outbound investment mechanism can address. Passive capital flows that do not include management expertise should not be included in any outbound investment mechanism, as China's economy has sufficient capital or could easily obtain capital from other global sources. A focus on smart money echoes prior testimony before the Commission given by Adam Lysenko, who noted that regulation to target investments that involve contribution of "proprietary technical knowhow, valuable networking ties, or other forms of differentiated support" is more likely to have a "tangible impact."[46]

**Focusing on indigenous technology development, complementarity to export controls, and smart money can provide an overarching framework for designing an outbound investment mechanism.** To fill in this framework, the government should implement new controls through a phased approach that allows time to build institutional capacity and coordinate policies with allies and partners. This should include a mixture of notification requirements, entity-based restrictions, bright-line prohibitions on investments involving certain high-risk indigenous technology capabilities, and ultimately a sector-based screening process.

**A first phase would include the establishment of a mandatory notification regime.** Gaining visibility into the full scope of investments occurring remains difficult. Existing data sources provide only incomplete information on the investment transaction types and volumes, as well as the flow of information, technology, and expertise that may occur as part of the investment transaction. It is also difficult to ascertain from existing data sources what the technical capabilities are of the Chinese business receiving the investment. These data issues are exacerbated with private deal flows, including venture capital flows, which face fewer public disclosure requirements than publicly listed companies. A notification regime can fill these gaps but would need to be subject to strict confidentiality requirements (*e.g.*, exemption from Freedom of Information Act disclosures) in order to build public confidence that the confidential information collected would appropriately protected.

**A notification regime must specify what types of investment transactions are covered, as well as what kinds of Chinese businesses.** A broad capture of investment transaction types is appropriate for this information-gathering phase. While ultimately, any controls should be implemented on the basis of the smart money principle noted above, the government may not have sufficient visibility into investment flows at present to determine where to draw the line between smart money and passive investments. Alternatively, investment transaction types could be scoped down using concepts drawn from the CFIUS context, such as *controlling transaction* or *covered investment*. That is, if the U.S. investor gains a controlling share, or specified governance rights that fall short of control but indicate an active role for the investor, in a Chinese company, then the notification requirement would be triggered.

**Notifications should not be required for all U.S. investments in China, but only for those investments into a Chinese firm that produces, designs, tests, manufactures, fabricates, or develops any item or items that would be controlled under U.S. export controls if originating in the United States.** This captures those technologies that the U.S. government has already determined may present national security risks. In addition, there may be justification for adding technologies beyond those already controlled, particularly in the emerging technologies space. For example, the concerns noted in the above section on CFIUS about general purpose AI models could equally apply in the outbound investment context, even if it is difficult to capture these concerns via export controls. The White House's Critical and Emerging Technologies List may provide a starting point for the identification of other technologies that merit inclusion in the notification requirements, though that list does not provide sufficient technical detail to be used in its current form.[47] Any technologies that the government seeks to cover that go beyond those already listed under export control authorities should be outlined in detail through a rulemaking process.

[46] Adam Lysenko, "U.S. Investment in China's Capital Markets and Military-Industrial Complex," testimony before the U.S.-China Economic and Security Review Commission, March 19, 2021.
[47] National Science and Technology Council, Fast Track Action Subcommittee on Critical and Emerging Technologies, "Critical and Emerging Technologies List Update," February 2022. Available at: https://www.whitehouse.gov/wp-content/uploads/2022/02/02-2022-Critical-and-Emerging-Technologies-List-Update.pdf.

**Beyond notifications, there are further steps that the government could take in the near term to address obvious inconsistencies in existing law or policy and that do not require additional information gathering.** The administration could establish a prohibition on U.S. investments in any Chinese firm that produces, designs, tests, manufactures, fabricates, or develops any technology that meets the technical specification of a technology that is subject to a U.S. arms embargo with respect to China. This would capture Chinese companies making items listed on the U.S. Munitions List, as well as space and military items listed on the Commerce Control List. This can be accomplished through regulatory changes to the International Trafficking in Arms Regulations (ITAR) and the Export Administration Regulations (EAR).

**The administration or Congress could authorize the expansion of the Chinese Military-Industrial Complex (NS-CMIC) sanctions program.** This program currently restricts U.S. persons from buying or selling publicly traded securities of the designated entities and is limited to entities operating in the defense and related materiel or cyber surveillance sectors in China. This program could be expanded to include all investment categories, beyond just publicly traded securities. A broader range of sectors critical to China's military modernization, such as chips, could be included in the program. It could be further strengthened by establishing an internal policy process within the administration to automatically consider cross-listings between entities designated under the NS-CMIC program and those on the Entity List. An expanded NS-CMIC program could serve as a useful option between the current NS-CMIC authorities, which have had limited impact on the designated entities, and more severe financial sanction, such as a full blocking sanction or specially designated national designation, which would be a highly escalatory step. To maximize the effect of an expanded NS-CMIC program, the administration should issue public guidance on what types of entities may ultimately be listed, in order to shape private sector incentives when making future investment decisions.

**Over time, as institutional capacity is built to implement outbound investment controls, the mechanism should be expanded to implement sector-based screening.** Sector-based screening should be additional to the expansion of the NS-CMIC sanctions program and bright-line prohibitions related to arms-embargoed technologies but should be significantly narrower than the notifications requirements. A core part of a screening process would be to permit the government to negotiate mitigation terms to address national security risks that may arise from an outbound investment, or to recommend that the President prohibit transactions where warranted. These reviews will therefore be inherently more time intensive and consequential that a notification regime and the jurisdiction should be scoped accordingly to permit effective administration of a screening process. Given the criticality of the semiconductor sector to U.S. national security, this sector should be prioritized in a sector-based screening mechanism, including design, fabrication, manufacturing equipment, design software, and packaging.

**Designing an effective outbound investment screening process would include**:

- Borrowing the concepts of *covered controlling transactions* and *covered investments* as defined in CFIUS to scope jurisdiction for the types of transactions covered, adjusting as needed based on information learned during the notification regime;
- Mandating screening for investments across the chips sector,
- Establishing prospective authorities only and not applying jurisdiction retroactively;
- Granting regulatory "safe harbor" from further review once the government concludes action on a transaction; and
- Clarifying how the outbound investment authorities will relate to the guardrail provisions under the CHIPS and Science Act that prohibit the recipients of federal subsidies from expanding their chips operations in China.[48]

[48] "Commerce Department Outlines Proposed National Security Guardrails for CHIPS for America Incentives Program," Department of the Commerce, press release, March 21, 2023. Available at: https://www.commerce.gov/news/press-releases/2023/03/commerce-department-outlines-proposed-national-security-guardrails.

**A core element of an effective screening mechanism will be a rigorous risk assessment process.** Generally, the analytic process for assessing national security risk under CFIUS will be a good guide for an outbound investment mechanism, including the requirements to analyze the component parts of threat, vulnerabilities, and consequences. An outbound investment risk assessment should consider relevant national security factors, such as

- contribution of the U.S. investment to China's indigenous technology development;
- relevance of the technology to U.S. national security interests;
- availability of alternative foreign sources of capital for the proposed investment;
- capability of U.S. investors to offshore key capabilities to circumvent U.S. outbound investment controls; and
- willingness of key allies to implement similar controls.

While CFIUS conducts its transaction risk assessment anew each time, there may be benefits to setting more clear policies around how risk will be assessed in an outbound investment context. An outbound investment mechanism could implement a policy of a "presumption of denial" for any investment that is made into a Chinese company making chips that a U.S. company would not be able to export to China. For example, a presumption of denial policy would be logical for investments into any companies fabricating chips at the technical threshold laid out in the October 2022 export controls (*e.g.*, 14 nanometers for logic chips.)

**An outbound investment mechanism can draw important lessons from existing CFIUS procedures, particularly around transparency and due process, to ensure that the process is implemented in a manner consistent with an open investment environment.** The administration should issue guidance on the types of national security risks that it will consider when reviewing outbound investment transactions. The recent CFIUS Executive Order provides an excellent template, as it identifies a range of technologies and risk factors that CFIUS considers. Risk assessments for specific transactions would be necessarily classified, but public guidance such as the CFIUS Executive Order are important steps to provide clarity and transparency into an otherwise opaque process. Like CFIUS, an outbound mechanism should have mandated timelines for the government to complete review of a transaction. Strict timelines allow transacting parties to make commercial decisions based on a more predictable regulatory process. In the event that the government identifies risks with a particular outbound investment transaction and seeks to take adverse action (*e.g.*, to prohibit the deal), it should provide due process to the transacting parties, including providing them with the unclassified basis for the determination as well as an opportunity to respond. Finally, Congress will have an important oversight role to play, including to ensure that the outbound investment function is fully resourced. Like the current CFIUS process, Congress should have the ability to request briefings on specific transactions once the administration has concluded its review. This process has served CFIUS well in providing accountability to Congress while avoiding particular transaction reviews from becoming politicized (as a general matter, though there are a handful of notable exceptions).

**Organizationally, the Department of the Treasury is best situated to lead a new outbound investment process.** The Treasury experience chairing CFIUS, as well as its lead role in implementing U.S. sanctions, give it unique strengths and insights when it comes to tracking international investments and global financial flows. Congress should create a new office to lead an interagency outbound investment process and place it under the leadership of the Senate-confirmed Assistant Secretary for Investment Security. The outbound investment authorities should not be located within the CFIUS process. As noted earlier, the CFIUS process is already under significant strain and Congress should seek to reduce rather than increase the burdens on CFIUS. The Department of Commerce should also be given a leading role, given the recommended structure of designing the outbound mechanism as a complement to existing export control authorities. An interagency process to support the outbound investment process should be established, including the same set of agencies that currently participate in the CFIUS process (*i.e.*, the Departments of Defense, Energy, Homeland Security, Justice, State, and the White House Offices of Science and Technology

Policy and of the U.S. Trade Representative). This group of agencies provides deep expertise on risks associated with economic ties to China and represents the range of diplomatic, economic, and national security equities that should be considered when implementing an outbound investment mechanism. The Office of the Director of National Intelligence should be tasked to provide threat assessments in support of the outbound investment process.

### Legislative or Executive in the Lead

**An unresolved question in the debate remains whether new outbound investment authorities will be implemented via executive order or through legislation.** Some of the recommendations in this testimony, such as expansion of the NS-CMIC program or updates to the EAR and ITAR, can easily be accomplished via executive action and do not require Congressional action. The International Economic Emergency Powers Act (IEEPA) likely provides sufficient authority for the President to establish the full scope of recommended actions, including a sector-based screening mechanism. A legislative solution would ultimately provide a more durable policy response, as executive orders can be rescinded by subsequent administrations. Legislation also avoids the mission creep that has been associated with recent use of IEEPA for a range of China-related threats, many of which present serious national security and foreign policy concerns but may not strictly speaking constitute "emergencies" as originally envisioned in IEEPA. Brennan Center research has noted that the President's use of IEEPA is "virtually unchecked," calling in to question whether the extensive use of IEEPA as a routine foreign policy measure erodes the checks and balances between the executive and legislative branches.[49] For these reasons, legislation would be more appropriate from a procedural perspective, though the current legislative proposals do not align with the substantive recommendations in this testimony.

**Under either a legislative or an executive approach, no new authorities should be established prior to a rigorous public debate.** At a minimum, legislation, executive orders, and regulations should be released in proposed form and should not be made effective until after an adequate public comment period. Commission and Congressional hearings on outbound investment screening should be continued, to advance the public debate on the need for and appropriate design of these new authorities.

### Anticipating the Unintended Consequences of Outbound Investment Controls

**If designed or implemented without careful consideration, new outbound investment controls can present serious risks to U.S. competitiveness.** An overly broad mechanism could stifle the ability of U.S. firms to engage in FDI. Firms engage in FDI for a variety of reasons, including to serve customers in the domestic market in which they are making the investment. For example, a fast-food restaurant will need to invest in a foreign market in order to sell its burgers there. Similarly, for a wide range of non-sensitive goods, FDI can allow U.S. firms to produce in a cost competitive manner closer to the end customer, enabling them to more effectively reach the 96 percent of the world's consumers that live outside the borders of the United States, including those in China.[50] Many FDI flows do not present national security concerns and can benefit U.S. economic growth, and care should be taken to ensure that beneficial flows can continue unimpeded. Research from the Rhodium Group estimated that certain outbound investment proposals could capture 43 percent of U.S. investment flows into China.[51] Such a broad scope trends towards decoupling in a blunt way that may not be connected to genuine national security risks and that may ultimately disadvantage U.S. commercial interests by closing off an important global market.

[49] Andrew Boyle, "Checking the President's Sanctions Powers" (Brennan Center for Justice, June 10, 2021).
[50] Small Business Administration, Export Products Business Guide, available at https://www.sba.gov/business-guide/grow-your-business/export-products#:~:text=Nearly%2096%25%20of%20consumers%20live,power%20is%20in%20foreign%20countries.
[51] Hanemann et al., 2022.

**Further, outbound investment risks are highly concentrated in a small handful of countries and do not present on a global basis.** An outbound investment mechanism should focus on countries of high risk, to avoid a chilling effect on U.S. investment ties with the rest of the world. The U.S. FDI position worldwide is $6.5 trillion, of which only $118 billion is in China.[52] U.S. outbound investment tools should reflect these basic facts and be designed to avoid disrupting the large amount of FDI flows that do not involve China. Specifically, in contrast to the CFIUS process that provides authority to screen all foreign investments into the United States, an outbound investment process should be limited to a defined list of foreign adversaries, such as those countries subject to the EAR's military end use and end user restrictions (*i.e.*, Burma, Cambodia, PRC, Venezuela, Belarus, and Russia).[53]

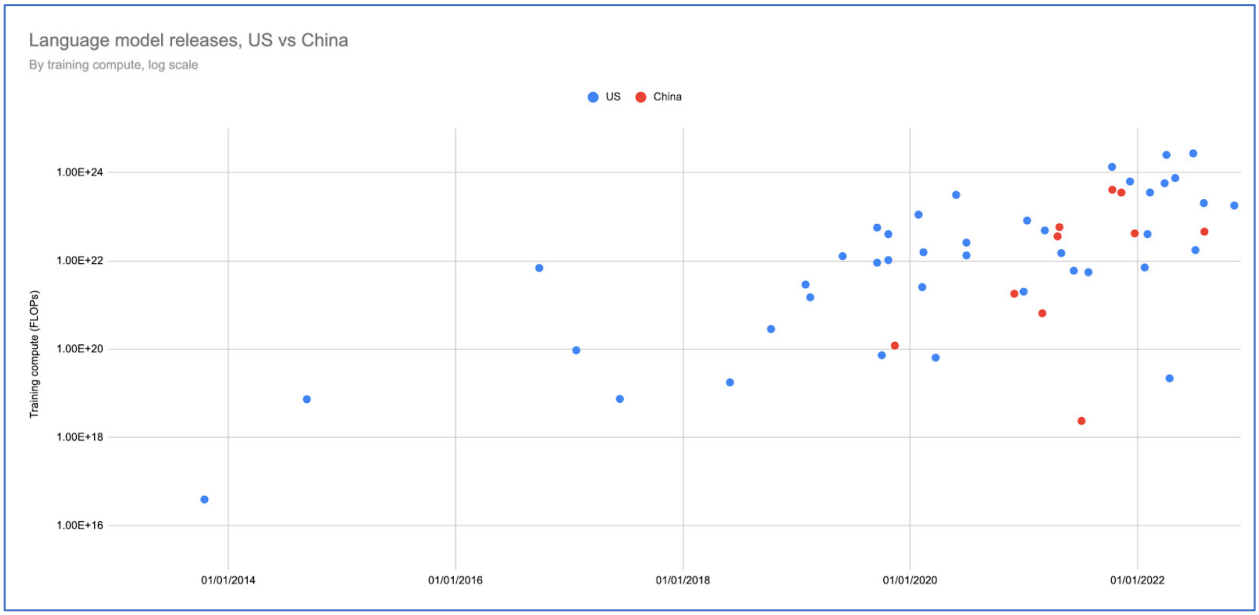
**A tailored outbound investment mechanism that is squarely focused on transactions of high national security risk can avoid these pitfalls.** A disciplined design can also avoid another potential unintended consequence, which is that other countries mimic a broad U.S. mechanism and the proliferation of such mechanisms create new barriers to U.S. investors abroad. The United States has been a recognized leader in developing an inbound investment screening process that builds confidence in the open investment climate by developing a well-tailored regime to guard against genuine national security risks. This has allowed the United States to credibly engage with other countries and encourage them to develop similarly targeted inbound investment regimes, limiting the risk that such regimes would be used to block U.S. investors abroad. A similar approach for outbound investment would ensure that the United States can continue to attract beneficial foreign investment in the United States and that other countries will not block their investors from seeking such investments.

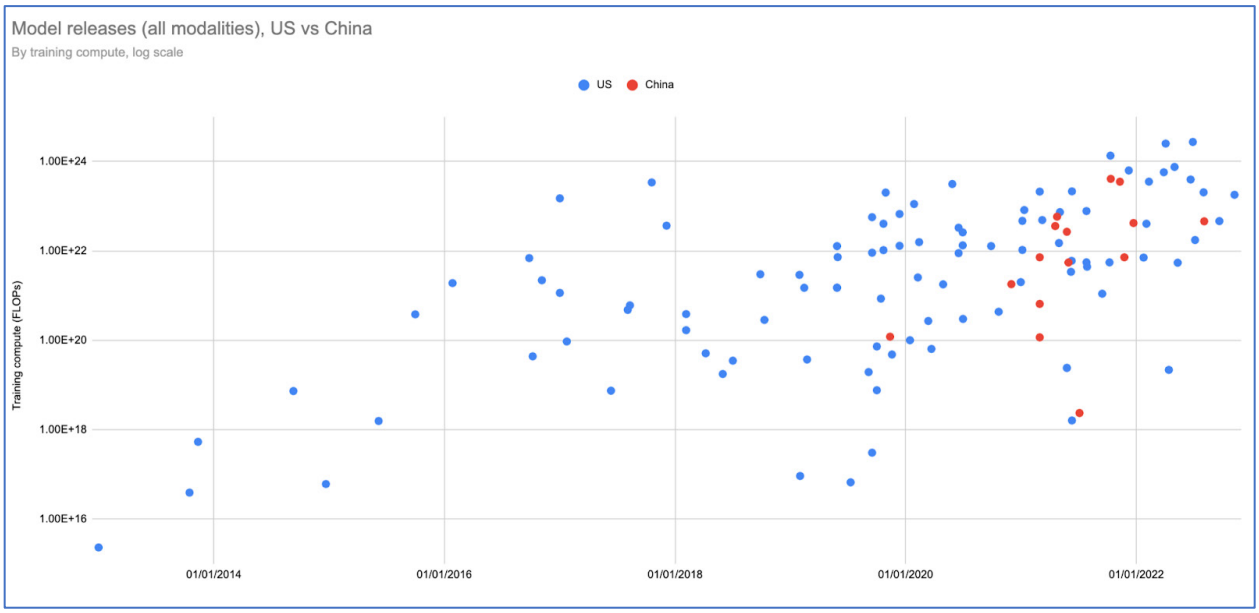
**U.S. commercial interests will be damaged if the United States acts unilaterally in implementing an outbound investment regime.** Capital and expertise can flow easily across borders and non-U.S. investors can quickly step in to backfill any space left by U.S. investors in the China market. Just as export controls are most effective when implemented by all key producer nations, investment controls will work best if done with allies and partners that are also critical sources of capital and expertise. Certain allies and partners have established or are moving towards developing an outbound investment screening regime, including South Korea, Taiwan, and the European Union.[54] The United States must work closely with these and other partners to align outbound investment screening mechanisms, as well as to ensure consistency between these mechanisms and existing export control and inbound investing screening tools. Congress can support these efforts by fully resourcing the international engagement functions of a new outbound investment office or offices. Doing so will be critical for ensuring U.S. national security, as well as preventing the further fragmentation of the open global trading system.

###

## Appendix: U.S. and China AI Model Releases[55]

[52] Bureau of Economic Analysis, *China – International Trade and Investment Country Facts*, data on "U.S. direct investment position abroad on a historical-cost basis." Data last published on July 21, 2022 and available at: https://apps.bea.gov/international/factsheet/factsheet.html#650.
[53] 14 CFR § 744.21.
[54] Chad Bown and Yilin Wang, "Taiwan's Outbound Foreign Investment, Particularly in Tech, Continues to Go to Mainland China Despite Strict Controls," Peterson Institute for International Economics, February 27, 2023. Available at: https://www.piie.com/research/piie-charts/taiwans-outbound-foreign-investment-particularly-tech-continues-go-mainland. Ursula von der Leyen, President of the European Commission, "EU-China Relations" (Mercator Institute for China Studies and the European Policy Centre, March 30, 2023). Hanemann et al., 2022.
[55] Data compiled from publicly available information by Tim Fist, Fellow, Center for a New American Security.


Language model releases, US vs China
By training compute, log scale
US
China
Training compute (FLOPs)
1.00E+24
1.00E+22
1.00E+20
1.00E+18
1.00E+16
01/01/2014
01/01/2016
01/01/2018
01/01/2020
01/01/2022


Model releases (all modalities), US vs China
By training compute, log scale
US
China
Training compute (FLOPs)
1.00E+24
1.00E+22
1.00E+20
1.00E+18
1.00E+16
01/01/2014
01/01/2016
01/01/2018
01/01/2020
01/01/2022

## PANEL III QUESTION AND ANSWER

CHAIRMAN BARTHOLOMEW: Great. Thank you all for your interesting testimony. We're going to start with Commissioner Borochoff.

COMMISSIONER BOROCHOFF: Thank you. This panel is one close to my heart. I'm enjoying what you're telling me on the one hand, but also frustrated because like all of you, it's clear there's a loud drumbeat that probably Commerce is the entity that needs to get a lot of attention, a lot of support from the federal government.

We were hearing that, we've been hearing it for a year. It's difficult for BIS to do its job. You know, I appreciate what each of the three of you just said.

One of the things that you, Mr. Hull, mentioned in your testimony, is something that for a year has been fascinating me, and that's the whole issue of the VIEs. And, I'd like you to comment, if you would, as to your position on what should be done about them?

I mean, maybe -- should we not be allowing them to do business with us? They changed their names, so you don't know who owns them. We don't have a Sarbanes-Oxley for overseas.

So, go ahead.

MR. HULL: Thank you, Commissioner. I agree. It's a very vexing question. And, I think I talk about it a little bit on the entity list as well.

So, in addition to VIEs, you have an entity listing where it puts the subsidiary, the address, and then the shell game happens where one or both of those change.

In terms of getting at it, in terms of VIEs, it's tricky. Because a lot of times, as you know, they go to the Caribbean, the laws there are very, very difficult to penetrate.

I think one of the things we ought to think about really, is how much of a burden do we want to put on exporters?

We did so in the wake of 9/11. We had banks that know your customer rules. Do we want to put the burden on exporters?

If you're looking to send it, you have a diligence obligation to do that. Because you're right, there's no easy piece of legislation or regulation that I can think of sitting here, and I thought about it before sitting here of course, that is a silver bullet to solve that.

And, I really wish I had a better answer for you. But, it's -- when you're able to play the shell games, and you're able to go to jurisdictions where getting information is quite difficult, you're then relying on the good faith of the exporter, you're relying on the intelligence community.

Both are good things to rely upon. But, it doesn't give me a lot of comfort that we're stopping 100 percent of what we need to stop.

COMMISSIONER BOROCHOFF: Thanks. And then I have a question for you, Mr. Rasser. I love a lot of your recommendations.

I'm particularly interested in, aside from just the idea of giving more money to Commerce and beefing them up, the two -- I'd like you to just elaborate a little bit on your reasoning, because I'm curious how it would work.

Number one, how would making the Commerce Department a member of the IC help directly?

And then secondly, would you elaborate a little more on what a tech diplomat would do, and would they be part of Commerce?

MR. RASSER: Thank you for your question. One big reason for making the Department of Commerce a member of the IC would be budget.

Right, it would be another budget stream that would be added. But then, more so the integration with the rest of the community.

There's a lot of valuable pieces of information that reside across the IC that the Commerce Department does have access to. But, it particularly lacks the ability to analyze that through its own lens.

And, I think that's something that's critically lacking. And, would allow the Department to make more effective decisions when it comes to export controls, entity listings, and so forth.

To your question on tech diplomats, I see that really being under the purview of the Department of State. Several other countries, including some of our allies such as Australia and Denmark, for example, are already setting up these types of capabilities.

They have forward deployed tech ambassadors, including here in the United States. And, not only do they engage effectively with the host governments, but also with the local business communities, in Silicon Valley here in the United States, for example.

I think this is a capability that is, unfortunately, very much lacking in the United States right now. We simply do not have enough people serving in the federal government that can talk about a wide range of technologies.

You don't have to be a deep substantive expert. But, you want people that can understand the implications of certain developments in artificial intelligence, biotech, quantum computing, and so forth.

That will also help us corral allies and strategic partners to have collaborative policies to counter China.

COMMISSIONER BOROCHOFF: Which all three of you have talked about, and so many people today have talked about the need to work with allies.

Thank you very much for those answers.

CHAIRMAN BARTHOLOMEW: Great. Thank you. Commissioner Friedberg.

COMMISSIONER FRIEDBERG: Thank you very much. Mr. Hull and Mr. Rasser, it seems that there are, there's a spectrum of possible mechanisms for export control. From unilateral at one extreme and multilateral at the other, and plurilateral in between.

So, I had questions for both of you, and then one question I'd like you both to try to answer. Mr. Hull, you say that we should be prepared to be unilateral where we must. And so, my question was, well, where might that be? And, how effective could we be? Mr. Rasser, you make reference to a multilateral mechanism. Although I'm not sure if it's really multilateral in the kind of all-encompassing membership.

But, how would we achieve convergence? The larger the number of states in the group, it seems the more difficult that would be.

And then on plurilateral, this is a question for both of you. How would that be organized? I mean, it seems like there are at least two ways. One, you try to have a core group of countries. Maybe the G7, that are going to have a high degree of agreement.

The other way would be maybe to imitate and replicate what's been done on semiconductors. Which would involve having a kind of pickup team on whatever the technology was that was trying to be controlled.

So, Mr. Hull, first to you.

MR. HULL: Thank you, Commissioner. In terms of unilateral, I'll give you the example of when we used the foreign direct product rule against Huawei.

We did a lot of assessment of the semiconductor manufacturing equipment market. We looked at it and sliced it and diced it as best we could using all sources of information.

And, we determined that U.S. companies had a sufficient part of the market. If memory serves, it was north of 90 percent.

So, we assessed that we could use a unilateral control that would be effective. And, you know, to flip that around, you think about the October controls where we have a significant amount of the market, but the Dutch and the Japanese have a lot as well.

So, it really is a technology by technology or a country by country-based thing. But, the Huawei foreign direct product is really the best example I can think of.

I'm happy to let Mr. Rasser answer and then we can talk about plurilateral then.

COMMISSIONER FRIEDBERG: Okay. Thank you. Mr. Rasser and then back.

MR. RASSER: Okay. Yeah, I'll start with the question on convergence. I think that's one of the fundamental issues that the United States faces right now.

You know, I mentioned that I see some encouraging signs. That there's greater alignment between the United States and our key allies on the nature and the scope of the China challenge. I thought President von der Leyen's speech a couple of weeks ago was very clear-eyed, very practical. That reflects the type of thinking that I think we would want to see amongst our allies. Similarly, the Dutch trade minister made some very specific remarks regarding the need for cooperation amongst the tech leading democracies in export controls specifically.

But then, of course, you had the remarks as reported, by the French president. Which are very much not, I think, in alignment with how Americans see it, and frankly, a lot of Europeans either.

What it will take for the United States to get our allies there, it will probably be more forthcoming into our thinking on why we are using export controls in this new manner. Really laying out what that then means for the long-term strategic competition.

COMMISSIONER FRIEDBERG: So, what would a plurilateral mechanism look like? How would that work?

MR. RASSER: Well, so Emily Kilcrease, for example, has laid out a very good framework for that. Kevin Wolf and Emily Weinstein have made similar proposals.

You know, I personally have been thinking about this more in the context of, you know, broader tech alliances, as I've been calling it. Where you would have a grouping of like-minded countries that not only tackle the export controls, but also look at the promote side of the agenda. Right? Because that way you can address -- there's always a trade off with restrictions on exports and investments.

So, at the same time, using that grouping too then also address the promote side of the agenda. New investments in facilities and research and development, addressing human capital shortages.

COMMISSIONER FRIEDBERG: Thank you. Mr. Hull?

MR. HULL: And just briefly. And, perhaps a definitional adjustment. When I say multilateral, I'm talking about the formal regimes of Wassenaar Group.
Plurilateral, you know, sort of an ad hoc grouping of country-based -- countries based on technology.

I'm skeptical that a new regime, again, and as Mr. Rasser pointed out, the recent comments by the French president lead me even further into my corner of, we're going to have a hard time coming up with a regime based on consensus.

But, there are a number of things as again, as we saw in October, where two, three, four countries control a significant portion of this market. And, if you can get agreement with them, you can do a whole lot that doesn't have to go through 35 other countries.

COMMISSIONER FRIEDBERG: Thank you.

CHAIRMAN BARTHOLOMEW: Okay. Commissioner Glas.

COMMISSIONER GLAS: Many thanks to all of you for testifying before us today. And also, I was deeply appreciative of the number of recommendations, the quality of recommendations, and the thought that has gone into these recommendations in particular, since this has been such a hot topic for the Commission and in Congress and in the Administration.

I have a couple of questions. First, Mr. Hull, given your experience as the Acting Undersecretary, you talked about, in your testimony, about better coordination with industry.

And, you know, if you had a magic wand, what would that exactly look like? Because it's very delicate, right? Given the fact that we may have to take action that industry doesn't like.

And then, just generally, all of you had the benefit, some of you have worked in government, have had the benefit of hearing each other's recommendations. Which ones are you like, gosh, I totally agree with that. That would also be high on my list.

So, I would love to start with you, Mr. Hull.

MR. HULL: Well, thank you for the question. I guess if I could wave a magic wand, I would make it so you could have that frank discussion with industry and say, we are going to put controls on this technology.

Here are the parameters we're considering. Here's how we're looking at doing it. And, if we could avoid the stockpile problem entirely.

But, that really is the key to all of this. I mean, it would be great to be able to have that frank exchange and say, here's exactly what we're thinking about. Tell us the kinks in your supply chain that we're not thinking about.

And, as I said in my testimony, companies are great coming in after the fact and saying, well gosh, we have this facility in Vietnam that's going to be affected by this.

I wish that could happen a little bit sooner. Again, not to be too hard on industry. I understand industry wants the predictability it wants.

But, to answer your question, if I had the magic wand, I would be able to have that full and frank exchange. The other piece, and of course this is unlikely ever to happen, I truly believe that there are, that most of industry really wants to be helpful in here.

And, I hate to use the old national security cliché, if you saw what I saw, if you know what I know, you would probably agree.

But, I really, I wish industry would recognize that folks in the government who are putting restrictions on, really are operating in good faith. And, they're doing it based on their best judgment of what intelligence and law enforcement and other data show.

It's not a desire to kneecap industry. I wish industry would recognize that.

MS. KILCREASE: I'm happy to start with the broader question. I'll note, as the Commissioners may have, that Cordell and I actually independently came up with a very similar recommendation around delinking the CFIUS definition of critical technologies from export control definitions.

I do think that's a worthy conversation to have. That linkage has served us well. But, I think we've seen that it's -- there is a gap there, particularly when it comes to emerging technologies that are very difficult to define in the type of technical specification that you need in order to list it on the Commerce control list.

That we may need a broader purview when we're thinking about capabilities that reside within a company, which might include technical capabilities, but might include a lot of other sorts of capabilities as well.

I'll also highlight Martijn's recommendation around the tech envoys. I mean, I think a lot of this emphasis on international coordination, some of it will be based out of Washington, but a lot of that is going to be spade work by embassies overseas.

And so, the more that we can build that capability and understand the technical capabilities overseas, I think the better served we'll be as we try to stand up kind of a broader economic security strategy.

MR. RASSER: Yeah. In terms of the recommendations that, I think, have the greatest chance of being implemented, I think our -- the one specific to the Department of Commerce.

I really think the U.S. government needs to think about the current environment much like we did in how we acted in response to the start of the Cold War, with the National Security Act of 1947. Or, how we responded to 9/11 with the establishment of the Department of Homeland Security, for example.

We're at a similar inflection point where, I think, a partial restructuring of the U.S. government is warranted. Specifically, the Department of Commerce, but also more broadly thinking about how we can better position ourselves for strategic competition. Particularly one that has technology at its center.

And, to Emily's point, yeah, I think something like the, you know, the envoy position should be pretty straightforward. Considering how the Department could be an IC member, is pretty straightforward.

So, I'm typically very practical-minded. So, focusing on the smaller things that I think will have pretty good impact are the best place to start.

And that then hopefully, will get people to think more strategically, more long-term about other things that we can do to make sure that the U.S. ultimately prevails in this strategic competition.

CHAIRMAN BARTHOLOMEW: Thank you. I'm not sure, Commissioner Helberg, are you there?

If not, we're going to move on to --

COMMISSIONER HELBERG: Yes, I am.

CHAIRMAN BARTHOLOMEW: All right. It's your turn to ask questions.

COMMISSIONER HELBERG: Thank you so much to all of our distinguished, excellent witnesses for joining us today.

My question is, how, if you were to think big picture about -- some of you talked about restructuring the Department of Commerce. President Obama a few years ago had talked about consolidating a number of trade related agencies.

And now, you know, obviously we're talking a lot about these types of bureaucratic consolidations can actually yield a lot of benefits for intelligence purposes. We have the International Trade Administration. We have so many different trade related offices.

How would you rethink our various export control regimes, as well as import related controls that we have, such as the entities list, and would you expand the remit of some of these mechanisms to be more sectorial-based in order to be -- in order to have less of a whack-a-mole approach where we target specific entities, but, instead we target sectors as a whole?

And, I guess imbedded in that question is, can you think of very many examples where trade in highly sensitive technology areas with China is actually beneficial?

And, maybe we can start with Martijn and work our way through the rest of the witnesses.

MR. RASSER: Okay. Well, I'm probably best placed to address the last question that you asked, Commissioner Helberg. And, I'll defer to Emily and Cordell on some of the details of the other questions that you asked.

Yes, there is, you know, benefit to engaging with China on matters of science and technology. Just for one simple reason that we already have limited insight into how capable China is in a lot of areas.

And, that type of engagement provides us a window into how good they are at doing certain things. Now, we have to, of course, be very careful about how we structure those types of exchanges.

But, there is value in joint R&D, particularly in areas such as climate studies, energy storage, and potentially basic research in areas such as biotechnology. Particularly if we're focused on medicine and pharmaceuticals.

There's also the opportunity to maintain U.S. leverage in the sense of, you know, selling China commodity items that are still very important for the Chinese economy. But, it's also good business for U.S. corporations.

So, by reducing the incentives for Chinese firms to create indigenous alternatives that are by in large often still inferior to American products, we can prolong that dependency. And, at the same time provide growth for U.S. companies, and of course, for the private industry of our allies and strategic partners as well.

MR. HULL: And, I'm happy to touch on --

COMMISSIONER HELBERG: Yes. And, before the others -- before the others get to that question, if I could slightly reframe my question.

Would the witnesses believe that imports of sensitive Chinese technologies in the U.S. as well as outbound investments in sensitive Chinese sectors in China, are there specific examples where that benefits the U.S.?

And, I guess when I think about imports of sensitive Chinese technologies in the U.S., in nearly all of the -- I find a hard time thinking about an example that doesn't raise serious cyber security issues and privacy issues.

We had a previous panel that where one of the witnesses referred to, you know, the level of intellectual property theft that China's perpetrated against the U.S. as being, you know, the greatest transfer of wealth in human history.

And so, I guess I'm wondering, you know, instead of playing whack-a-mole, what are specific examples where importing sensitive Chinese technologies to the U.S., or exporting American capital in sensitive technological verticals, should that be restricted all together?

Or, are there specific examples where that, where those activities might actually benefit the U.S.?

CHAIRMAN BARTHOLOMEW: All right, if you guys can answer that quickly, please answer it quickly. Otherwise, I think we'll have to have the answers for the record.

But, is there any information, Mr. Hull?

MR. HULL: I struggle to think of a sensitive technology that we should import.

CHAIRMAN BARTHOLOMEW: Import or export.

MR. HULL: Or export.

CHAIRMAN BARTHOLOMEW: Okay. Mr. Rasser?

MR. RASSER: I'm equally hard pressed.

CHAIRMAN BARTHOLOMEW: Okay. Ms. Kilcrease?

MS. KILCREASE: Well, I'll give it a go. But, you know, I do think, when you think about particularly in the biotech sector, I think if there's a -- it depends on, what is sensitive technology.

But, if there's an emerging Chinese capability that cures cancer, I would happily import that into the United States.

CHAIRMAN BARTHOLOMEW: All right. Mr. Helberg, are you satisfied with the answer?

COMMISSIONER HELBERG: I am.

CHAIRMAN BARTHOLOMEW: All right. Great. Thanks. All right, Commissioner Mann.

COMMISSIONER MANN: Thank you. I am -- I too, am trying to think through the differences, and the implicit tensions between plurilateralism and a technology alliance.

But, is there a -- and, you've covered already the problems with the technology alliance of bickering among allies. But, is there a danger of setting up a regime in which those who are left out have then an impetus to do ever greater business with China?

Are there gray zone countries who, if left out of a regime, would then proceed on a stronger or tighter basis with China?

MR. HULL: I don't know that it would be a causal relationship. I mean, there obviously are a number of countries that are inching closer to China in a number of was, investment and otherwise.

I don't know that putting a new multilateral regime and excluding certain countries would drive them into the arms of the Chinese as it were.

I think, for the most part, most of those countries are probably creeping that way anyway. That's my assessment.

COMMISSIONER MANN: Could you give some examples, if possible?

MR. HULL: I think the United Arab Emirates has been getting closer to China over the last several years. I would probably expect some other countries in that region would possibly do likewise.

COMMISSIONER MANN: Mr. Rasser, thoughts?

MR. RASSER: The specific model for a tech alliance that I've been working on has specific mechanisms to include countries outside of the core grouping, depending on what issue is at hand.

And, even within that grouping, if you're looking at something like a 5G infrastructure, for example, the hardware, that would be a subgrouping.

But, if you're looking at issues such as energy storage, or tackling critical mineral supply chain resilience, that would be a much larger group of countries. And so, on an issue by issue basis, you would bring in other countries to work with that core grouping.

A very pragmatic approach, just the reality that, you know, some countries have skin in the game on almost everything. But, only in some cases will you have a very large group. Ultimately, it's all about the flexibility, and making sure that you have the right people at the table all the time. That's how I've been thinking about it.

COMMISSIONER MANN: And, how do we do that?

MR. RASSER: Well, the Center for New American Security produced a report in 2020 that lays out a framework for how that would function. And, the Center's hosted Track II dialogues since then to fine tune that idea.

So, I'm sure my former colleagues at CNAS would be happy to discuss that further with you.

COMMISSIONER MANN: Thanks. Ms. Kilcrease, any thoughts?

MS. KILCREASE: Well, I will happily take up Martijn's offer to share further CNAS research.

I will say, the country that comes to mind when you're talking about multilateral tech coordination, is India.

When you think about needing to draw the circle big enough where you catch the most producer nations, but small enough where you can really get stuff done, India is the test case for whether anything is really going to work. They have strong technological capabilities.

And, we've heard informally from some of our counterparts in other countries that any new formalized regime that doesn't include countries like India, might have a legitimacy problem, right. Because you're not capturing enough of the key technological democracies.

Now, can you structure something that gets India onboard? I think, is a really hard question.

So, we kind of think of them as the test case of a capable country, one that you definitely want to be structuring your engagements to draw them into more collaboration with the United States. But, that has to be done in a very careful manner.

COMMISSIONER MANN: Thanks.

CHAIRMAN BARTHOLOMEW: Commissioner Price.

COMMISSIONER PRICE: Thank you. And thank you all for your testimony. Ms. Kilcrease, I want to start with you.

In your testimony, you have a -- you talk about anticipating the unintended consequences of outbound investment controls. And, we've gotten at this a bit.

But, I'd like you to flesh out some more specifics of those that might not present a national security concern. Can you talk a little bit more about that?

MS. KILCREASE: Sure. Thank you for the question. It's important to keep in mind that foreign investment overseas by U.S. companies has been a driver of growth.

There's a variety of reasons why firms will invest in a foreign market. And, many times it's to serve the domestic market in which they are making an investment. Right?

So, we've got companies in China who are selling hamburgers. I think that's a fine activity to proceed. It benefits our companies and promotes economic growth and doesn't present national security concerns.

But, we have investors all over the world. And, so when we're talking about the question of outbound investment, we really need to vector in on high risk transactions so that those broader investment flows to Europe, to Latin America, to other Asian countries, can continue unimpeded, because those are not the types of flows that are presenting risk.

My worry, and I talk about this a bit in the written testimony, is that if we create a new outbound investment mechanism, it's too broad. It captures too many of these flows.
What we're doing, is we're hurting the competitiveness of U.S. firms. They're trying to reach the over 95 percent of consumers that live outside of U.S. borders.

We want them to be able to engage in that sort of economic activity. To drive that growth through their foreign investments. And, only put in place the guardrails when we need to do it. And here again, we come back to the question of multilateral coordination as well. Even if we're talking about the U.S. investment flows into China, if you only have a U.S. control there, then

you're easily going to have European or other Asian countries come in and backfill those sorts of investment flows.

So, all you'll be doing is hurting U.S. firms without actually impacting what our ultimate objective here is. Which is not to harm U.S. investment flows. It's to prevent China's indigenous tech development.

And so, we need to keep our eye on that and policy objective, to make sure that the targeted start up controls that we're putting in place really get at that without having the unintended consequences on U.S. firms.

COMMISSIONER PRICE: Thank you. Anyone else what to add anything?

(No response.)

COMMISSIONER PRICE: Okay. That's it.

CHAIRMAN BARTHOLOMEW: All right. Commissioner Schriver.

COMMISSIONER SCHRIVER: Thank you, Madam Chair. And, thank you to our witnesses for your excellent statements. Thank you all three for your pervious service in government.

I wanted to ask about the recommendation, Mr. Hull, which seemed a little tepid. You said to study a single licensing agency.

And, there hasn't been a whole lot of discussion about that. But, why not more full throated in your case?

MR. HULL: It really is my large -- largely my ignorance on the defense article side, on the State Department side. I feel like I know the Commerce side pretty well.

But, I think there's probably some unintended consequences, at least from my perspective on the State Department side.

COMMISSIONER SCHRIVER: Okay. A follow up to that, and this is probably a very unfair question. So, I'm going to apologize in advance for putting you on the spot.

I mean, I generally would be hesitant to say, the solution to a problem is to reorganize or create something new. But, one of the concerns I have is, you know, the Commerce Department for decades, probably centuries, actually, is in the business of promoting business.
In the case of China for decades it's been in the business of getting our companies there. Getting investment there.

So, from your service there, from our impressions, and it's okay if it's just sort of subjective impressions. I mean, isn't this kind of work sort of counterculture?

Is it -- not to impugn anybody's patriotism or professionalism, but, when you have leadership of the mindset of promoting business, is this the right place for this kind of work?

MR. HULL: I think it is. I'm with you. I am not for sort of wide-ranging, reordering of government. I just know that's expensive. It's a huge challenge.

I think the Commerce Department is quite capable. I think it needs, obviously, strong leadership both at the bureau level and at the Secretary level.

I think in the last couple of years, I think Secretary Ross and Secretary Raimondo have understood the challenge, the China challenge for what it is.

But, I take your point. And, there's a lot of variability based -- potential variability based on the personalities.

My own experience, I had a great relationship with the Secretary. I had a great relationship with the, my counter Undersecretary, who was responsible for trade promotion. And, we were able to work items out.

So, I think if you get the right people in there, you can. But, I think, over the last two administrations, I think, the Department has done a generally good job of trying to work that through.

But, I certainly recognize the tension. And, it is there. But, I think the Commerce Department, along with the inner agency, I mean, keep in mind, the export control decisions are State, Energy, Defense, and Commerce.

Folks often think Congress acts in a unilateral way with it. But, it is -- it is the inputs from the inner agency.

COMMISSIONER SCHRIVER: To be even more unfair then, those of you who did not serve at Commerce have an opinion on that?

MS. KILCREASE: I actually did serve at Commerce. So, I'm happy to weigh in here. And, I was in the International Trade Administration.

I think Cordell is basically right. I mean, it's making sure that the mandate is communicated all the way down the chain.

For example, there is the Industry and Analysis Unit within the International Trade Administration that has some really smart industry experts.

But, they need to know, and they need to be rewarded for implementing a strategic mission that is fundamentally different. It's one that's centered on industrial policy. It's one that's centered on economic security.

So, you need to have folks that understand those issues, who are working that from the staff level, and that are rewarded all the way up the chain.

Even like some very mundane stuff, like putting it in their performance metrics. Right, your performance metric is no longer necessarily just about exporters. It's about what risks are you preventing as well.

CHAIRMAN BARTHOLOMEW: Are you finished? Commissioner Wessel.

COMMISSIONER WESSEL: Thank you all for being here. I'll come in with a little more of Mr. Schriver's conversation.

And, I have tremendous frustration with where this all is. You know, we've all been dealing with this for years.

2018 Congress passed both FIRRMA and ECRA reforms. And, the implementation of that has left some questions.

I think, Mr. Hull, and thank you for your service, I met with, I believe, both you and Secretary Ross, on a couple of occasions about this.

And, you know, the question is, there is a tension within the Department of Commerce as was just noted, where on the one hand it's to promote the interests of U.S. business.

Ms. Kilcrease, you talked about investment abroad, sales abroad. And, at times, many times that, you know, runs head on into the business interests of U.S. companies in terms of national security.

There were press reports just in the last week or two of Nvidia designing chips around the export controls. So, it's a -- I don't really think it's whack-a-mole, it's just a, you know, slippery slope that businesses constantly are going to seek to take advantage of.

And, I think what's missing is a clear, consistent, comprehensive message from on high about what the expectations are for U.S. companies that do business in the U.S. as to how we expect you to advance and protect U.S. interests.

Understanding, Ms. Kilcrease, that they also have to respond to investors, et cetera. They have to understand where markets are.

Two years ago, this Commission recommended, in a similar sort of assessment of where we are, that there be a technology transfer review group created in the White House. That would centralize the thinking about this.

And, I know, Mr. Hull, that you know, Matt Pottinger, Matt Turpin, and others were involved, you know, with the work around Huawei with GCHQ and all the, you know, our European partners.

But, the various agencies have competing equities. And, for me, this has to be on high and it has to be consistent.

Those companies like Nvidia that are trying to, you know, get around the rules, those as you're well aware from administrating the -- administering the laws that are changing NAICS codes so that they would not be subject to various disclosure requirements, something has to change.

And, you know, again, we're five years after FIRRMA. CFIUS with the same frustrations, and I would say, a much higher threat vector or concern from China.

Shouldn't we move this up to the White House in terms of better direction, clear consistent message, and then BIS and others implement under that direction?

MR. HULL: Well, I'm certainly happy to start and --

COMMISSIONER WESSEL: Please.

MR. HULL: It's nice to see you again, Commissioner.

COMMISSIONER WESSEL: Yep.

MR. HULL: I think, having a large working group, I don't know whether centered in the White House makes sense, but I take the point of having a crosscutting working group talking through these things.

I would say, you know, to his credit, National Security Advisor Sullivan, in September of last year --

COMMISSIONER WESSEL: Agree.

MR. HULL: On high said, relative advantages are no longer sufficient.

COMMISSIONER WESSEL: Agree. But then Invidia tries to, you know. So, again, I want to make sure there is no question among American business, what is operating within the bounds of U.S. national security and what isn't.

MR. HULL: And, my understanding, and perhaps I have this wrong. Nvidia redesigned the chip to take it below the performance threshold specified in the control.

COMMISSIONER WESSEL: I believe that's correct.

MR. HULL: Okay. And so, that's -- that is the challenge any time you're doing dual-use export controls, is where do you find that cut line?

And, on Huawei, you know, to some criticism, of course, we decided that 5G was the cut line. Because, you know, assessing foreign availability, I have not been involved. I was even out of government for several years, on how that threshold was set.

But, I imagine that performance threshold was set with at least some availabil -- some thought to foreign availability in mind. I don't know that for sure. I'm just, based on my experience, that's my assessment.

So, if companies are taking it below the threshold at which the U.S. government has decided it is problematic, I have a hard time saying, industry you shouldn't do that. They're complying with the regs.

Now, if you're saying the regs ought to be tighter, you know, maybe we cut off, you know, certain sectors from exporting. I think that's a different conversation.

COMMISSIONER WESSEL: Okay.

MR. HULL: It's one that at least at this point in our history, nobody is -- nobody has taken up the mantel. But, I'd certainly be open to having that discussion.

I know they're thinking about it in the realm of outbound investment as well. But, I see I'm over time, so.

COMMISSIONER WESSEL: Okay. Thank you.

CHAIRMAN BARTHOLOMEW: Commissioner Wong.

VICE CHAIRMAN WONG: Mr. Hull, thank you for coming before us. You talk about, going back and following up on something that Commissioner Schriver asked about of perhaps consolidating the different lists into one agency.

You mentioned there were 226 commodity jurisdiction requests, I guess, maybe last year or in 2021. I've got to say, that doesn't sound like a lot to me.

You know, out of all the license requests there are only 226 requests coming into determine jurisdiction. Is that really a problem?

MR. HULL: I think it is. In my experience, those requests often take months. They often take inputs from other agencies.

They're very complex. And, keep in mind, that just decides where you file your license. That's not the license determination. That's not -- that's simply who gets to decide whether to grant the license.

So, I think particularly, if you're deciding whether it's a defense article or it's a dual-use item, it's probably something that our adversaries are interested in.

So, that was the basis for my saying, if we can eliminate those sorts of, those bottlenecks for lack of a better phrase, where we can. I think we ought to at least consider it.

But again, as I said to Commissioner Schriver, my ignorance on some of the ITAR stuff leads me to make a more tepid recommendation.

VICE CHAIRMAN WONG: Okay. But, it could be something short of consolidating these two regimes into one agency. It could be some new process rather than combining jurisdiction that if there is to be a request for clarification, perhaps you file in a different pro -- I don't know.

MR. HULL: I mean, certainly. You can think of a way in which you file at State. State determines it either has or doesn't have jurisdiction. It's not specially -- specially made for military intelligence. And then, refers the license over to Commerce.

I think you'd still have the same -- you'd have a similar delay. I don't know if you'd have the same delay.

VICE CHAIRMAN WONG: Do you have the data or aware if there's been an uptick in commodity jurisdiction requests?

Or would, you know, the --

MR. HULL: I don't know off the top of my head. I had in my head when I was there, 200 or so was around the area. But, I don't know that for certain.

VICE CHAIRMAN WONG: This next question is, I don't want this to be taken as any kind of commentary on any current or past official, because I'm just not in a position to pass judgment on officials at the Commerce Department.

But, there have been a number of recommendations or discussions from the panel on changing incentives, changing the culture. Ms. Kilcrease had mentioned this, modifying the mission statement, changing various org charts at -- between agencies or of the agency itself.

But, you know, putting aside legislative changes or changes in organizational structure, it's personnel that really has to drive missions.

If you had to identify the top position, or the top two positions at Commerce that, if you wanted to focus Commerce and its export control administration on the China question, on the China challenge, what are those two positions?

So, whether it's the Administration or Congress as they look for, you know, future personnel, what are the two most important positions? Let's say the two, the top two.

MR. HULL: I would say the Secretary. I mean, we've talked a number of times today about how messages from on high are important. I also think the Undersecretary for Industry and Security.

I think those are the two I would probably say are most important to meeting the China challenge from -- from the protect side of the house certainly.

MS. KILCREASE: I would add to that. I think obviously the Deputy Secretary role would be quite important.

When you think about the responsibilities that Commerce has across all of its bureaus when it comes to economic security, that includes traditional stuff like anti-dumping. It includes industrial policy.

It would include any new authorities related to ICTS imports, whether that's the executive order or if you restrict that. These are functions that are sprinkled throughout the Department of Commerce.

And, you need somebody in a senior leadership role who has the time and the dedication to really drive home what should be a more comprehensive economic security strategy with a focus on China.

And, I think the Deputy role is the person who can really take that hands-on approach, and make sure that all the different pieces of the Department are talking to each other.

VICE CHAIRMAN WONG: Because the Deputy is generally more focused on the internal management and priorities.

I mean, you know, no knock on any Secretary or any Cabinet Member, but, there's a lot of representational responsibilities.

It's the -- a lot of this falls to the Deputy when you're talking about driving new priorities.

MS. KILCREASE: That's right.

VICE CHAIRMAN WONG: That's it.

CHAIRMAN BARTHOLOMEW: All right. Thank you very much. I have what I think is a quick question for you, Ms. Kilcrease. And then a broader question for everybody.

The quick question is, what percentage of U.S. investment in China is smart money? You made a distinction.

MS. KILCREASE: Well, the problem is, we don't know. Which is why one of the other recommendations is a notification requirement.

What we don't have great visibility into are the private sector flows. I tried to address this when I was in government.

I tried to do it in an independent research capacity. It is hard to just understand exactly what rights attach to investment flows that would determine what is smart money and what is not.

That is why in our -- in my recommendations in the testimony I do focus on using the notification procedure to really gather that sort of information so we can get a better sense of,

you know, when an investment goes in, is it something that the U.S. investor is going to be actively involved in?

Or, are they really just trying to make money, and they're not really going to have any substantive involvement?

So, unfortunately, I don't know.

CHAIRMAN BARTHOLOMEW: Great. Thank you. My broader question is, right, technology moves quickly, and government moves slowly.

And so, every time I hear that we need to bring in additional parties, I think it's building on what Aaron said when he was talking about sort of multilateral or plurilateral.

But, I think that even as I look at, across the U.S. government, how do we do whatever it is in a way that picks up the pace and moves at the pace of technology?

So, I'll put in there, what are the skill sets that we need in our civil servants who are working in these agencies, do we have them?

What do we need people to be able to do? Is it Chinese language? Is it engineering? And, with all of those things, how do we encourage them to come work in the federal government when they can make a whole lot more money some place else?

MR. HULL: Well, I'll start with that. It is all of that. It is Chinese language. It is understanding the Chinese system. It is engineering.

From my perspective at BIS, we had a lot of engineers. And, across all of the specialties on the Commerce control list, they were very, very good. They understood the technologies. They were able to come and explain them to me, a lawyer by training.

So, I think -- I think the U.S. government has a lot of those folks already working for them. Of course, they could make a lot more money, you know, the very next day.

Short of paying them more, I'm not quite sure, other than appealing to patriotism. And, you know, for those who have served in government, it's pretty great.

I mean, you get to work on cutting edge things. And so, appealing to that sense of, lack of a better word, adventure and patriotism. That's all I can think of unfortunately.

CHAIRMAN BARTHOLOMEW: Mr. Rasser?

MR. RASSER: There's some things that we could do to make it easier for people to maintain their skills and their knowledge, such as doing rotations to research institutes outside of government, private industry.

So, for example, when I visited SpaceX Headquarters, there were two Air Force officers that were there, spending two years, you know, just on the production line working side by side with SpaceX personnel.

And, it's a tremendous way to stay up to date on what the state of the art is in that particular field. And, we could do that across the board.

Ultimately, you know, moving away from the very rigid promotion criteria that we currently have, allowing people to have more flexible work schedules, you know, a Monday to Friday, nine to five job doesn't fit for everyone.

And, if we can have more flexibility in when people work and where they can do that work, that could help a lot.

But, I think foremost, providing more opportunities for people to stay current on their knowledge and their skills in all the areas that you mentioned.

CHAIRMAN BARTHOLOMEW: Ms. Kilcrease?

MS. KILCREASE: I would add also, making sure they have the tools they need once they're in government, to do their job well.

I mean, it is surprising how often we'll hear from industry analysts in government that they don't have access to business intelligence databases. Or, they don't have just the types of, you know, they don't have the Bloomberg Terminal.

Or, they don't have the kind of market access analysis available to them that they really need when we're talking about economic security priorities. They need to have access to the same sort of information as the private sector does.

They also need to have the institutional or even informal relationships with experts outside government.

So, whether that's with building relationships with Universities, or FFRDCs, or think tanks for example. To put a self-interested recommendation out there, you know.

I think leveraging the expertise that is available outside the government, and having more robust ways to kind of spin that into the decision making, particularly from third-parties who don't have a financial stake in the decisions being made, can also be part of the solution.

CHAIRMAN BARTHOLOMEW: So, you mentioned that they don't have access to sources of information. And, I'm just wondering, how, if I'm a federal employee, and I don't have access to Bloomberg, how do I get it?

I mean, is there any mechanism? Who could help push to make sure that people have the access to data that they need in order to do their jobs?

MS. KILCREASE: A lot of it comes down to budget, candidly. Things like Bloomberg are quite expensive.

And, to be clear, I did have Bloomberg when I was in government. But, it's not widespread. And, it's hard to use, right.

So, it really does take, you know, the management at the office level, or at the desk level, making the commitment to spend the resources on it and to invest in the training to make sure that their analysts know how to use these resources well.

CHAIRMAN BARTHOLOMEW: Great. Anybody else?

(No response.)

CHAIRMAN BARTHOLOMEW: All right. Any other questions from people?

(No response.)

CHAIRMAN BARTHOLOMEW: If not, I want to thank our witnesses today for the excellent testimonies. You all have given us a lot to think about.

I want to acknowledge the work of our staff. Particularly Leyton who started working on this hearing, and then, much to my chagrin, moved to the Department of Treasury.

Ana and Charles, thank you all very much for all the work that you did to put this hearing together.

You can find the testimonies from today, as well as a recording of the hearing on our website, uscc.gov.

I'd like to note that the Commission's next hearing will take place on Thursday, May 4. That hearing will examine China's use of lawfare to subvert international laws and institutions. And influence foreign courts towards CCP goals.

With that, we are adjourned. Thank you very much.

(Whereupon, the above-entitled matter went off the record at 3:13 p.m.

**Question for the Record following the Commission's April 13 hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"**

*Please elaborate on the shortage of Chinese engineers and other skilled personnel mentioned in your testimony. What are the reasons for this shortage, and to what extent is this shortage related to problems in China's educational system?*

*Does China face a talent shortage in the field of software engineering, and if so, what impact will that shortage have on the PLA's acquisition of defense technologies in the future? What is the reason for this shortage and is it ultimately a surmountable problem for China?*

Christian Curriden, Defense Analyst, RAND Corporation, June 12, 2023

In 2017, Tencent and Boss (one of China's largest software firms and one of its largest job finding platforms) released a report on AI-related talent in which they identified about 300k AI experts around the world, a number which they claimed was far below demand. They also identified 367 AI universities capable of producing about 20k new AI students, 168 of which are in the U.S. and only 20 of which are in China (tied with England, and behind Canada at 22). The report in question mostly used data from employment and professional networking sites. Note that they arguably had a vested interest in pushing for more government investment in AI. Even so, this was an interesting finding from one of the biggest names in the Chinese software space.

Since then, China has worked to improve its education system with a particular focus on producing more software and AI experts. While these efforts have no doubt improved the situation, China's lackluster rural education system continues to struggle to prepare students, and more recent reports continue to complain about a lack of talent, especially in algorithm development. According to a 2022 report, AI talent continues to lag far behind demand, with less than half of the need for engineers/researchers met in many fields.

The PLA is worried about this lack of engineers, and at least in rocketry, prominent examples suggest that this has slowed some acquisition programs. The same is likely true for software. That said, it is difficult to quantify the degree to which this impacts PLA acquisitions. I'm not aware of any specific projects that were cancelled because of a lack of software engineering talent. It should also be noted that the DoD too has struggled to find all of the software talent it needs.

There are several reasons for this shortage. One is the increasing demand in the private sector for key talent, not just in China but around the world. While Chinese and global universities are increasing production of new engineers and researchers, building these programs takes time and may not keep up with burgeoning demand. Veteran project leaders, who often have over a decade of experience in the field, may take an especially long time to produce.

See:
http://www.tisi.org/Public/Uploads/file/20171201/20171201151555_24517.pdf
https://zhuanlan.zhihu.com/p/559483565

http://www.xinhuanet.com/fortune/2022-08/18/c_1128924450.htm
https://finance.eastmoney.com/a/202306122749298720.html
http://www.81.cn/2017zt/2018-05/05/content_8024438_3.htm
https://www.fhi.ox.ac.uk/wp-content/uploads/Deciphering_Chinas_AI-Dream.pdf
http://epaper.21jingji.com/html/2017-01/18/content_54928.htm

**Question for the Record following the Commission's April 13 hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"**

*Did China's 2019 landing on the dark side of the moon have any utility for the country's military research and development (R&D) or other military implications? How about its future moon-related activities?*

Kevin Pollpeter, Senior Research Scientist, CNA, May 26, 2023

Renewed focus on lunar exploration and the economic potential of the Moon has raised concerns over the potential of countries to establish control over the Moon and cislunar orbit, the space between the Earth and the Moon. China's potential plans for the Moon received prominence when the head of China's lunar exploration program, Ye Peijian, equated the Moon to the South China Sea, stating that "if others go there, then they will take over, and you won't be able to go even if you want to."[1] Although this comment may not reflect official policy, it nonetheless carried weight, given the source of the comment.

The primary security concerns of China's lunar exploration program have centered on its use of orbits around the Moon, in particular the Earth-Moon L2 La Grange point. Satellites put into a L2 halo orbit have a relatively stable orbit that allows for full surveillance and communication of the lunar surface, with near-constant communication to the Earth. In 2018, launched Queqiao, a data relay satellite designed to provide communication between China's ground stations on Earth and its Chang'e-4 lunar lander and the Yutu-2 lunar rover located on the far side of the Moon.

According to National Air and Space Intelligence Center analyst Jeff Gossel, placing a satellite at L2 could enable the PRC to fly around the far side of the Moon to attack US satellites in geosynchronous orbits. Currently, most U.S. sensors are not focused on deep space, making it possible that the attack could go undetected.[2] Gossel, however, has stated that the actual threat to U.S. satellites from attacks in this manner is small.[3]

[1] Malcolm Davis, "Space: The Next South China Sea," *The Maritime Executive*, Jul. 23, 2018, https://maritime-executive.com/editorials/space-the-next-south-china-sea.
[2] Patrick Tucker, "China's Moon Missions Could Threaten US Satellites: Pentagon," Oct. 16, 2018, *Defense One*, https://www.defenseone.com/technology/2018/10/chinas-moon-missions-could-threaten-us-satellites-pentagon/152084/.
[3] Patrick Tucker, "China's Moon Missions Could Threaten US Satellites: Pentagon," Oct. 16, 2018, *Defense One*, https://www.defenseone.com/technology/2018/10/chinas-moon-missions-could-threaten-us-satellites-pentagon/152084/.

June 5, 2023

# Questions for the Record
# following the Commission's April 13 hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes"

Answers by
Dr. Sarah Kirchberger

*Head of Asia-Pacific Strategy & Security, Institute for Security Policy at Kiel University (ISPK)*
*Vice President, German Maritime Institute (DMI)*
*Nonresident Senior Fellow, Atlantic Council*

1. Please list the scientific areas relevant to undersea warfare in which China and Russia are cooperating. Your testimony mentioned hydroacoustic research in the Arctic as one area of cooperation. Are there others?

Answer:
Polar hydroacoustic research cooperation between Russia and China is well documented on official Chinese and Russian institutional and news websites. Research by the Estonian scholar Frank Jüris points to an intense collaboration between Chinese R&D institutions with strong military ties and similar Russian counterparts on sensitive subjects including hydroacoustics, undersea communication, and fibre-optic hydrophone development in Arctic waters for use under the ice.[1] A recent press release by China's Harbin Engineering University (HEU) mentions the "3rd China-Russia Acoustics and Information Technology Forum held on May 6th, 2023 at the HEU, in which over a hundred experts from almost 40 research units within China and Russia participated to focus on "cutting-edge technologies in the field of polar acoustics and information technology" in the context of building the "Ice Silk Road". According to the press release this forum also included *polar underwater acoustic communication technologies* and *underwater robot technology*.[2] Undersea unmanned systems/robotics therefore seems to be another aspect of the research cooperation.
According to the report, Russian participating institutions included: "6 Russian universities and research institutes, including the Russian Far Eastern Federal University and the Russian Marinet Industry Center", while the Chinese counterparts included: "14 Chinese universities including Ocean University of China, Zhejiang University, and Tsinghua University, as well as the Institute of Acoustics of the Chinese Academy of Sciences and the China Polar Research Center." Further, experts from the No. 1, No. 2 and No. 3 Marine Research and South China Sea Survey Centers of the Ministry of Natural Resources reportedly participated, as well as representatives from the CSSC's 760th and 715th Research Institutes.[3]
Perhaps of note is that HEU, as a university with particularly close ties to the PLA that is counted among China's "Seven Sons of National Defense", is also reported here as having engaged in "extensive and in-depth international cooperation" in "ice-region ship technology" with the Russian Krylov State Research Center (a leading naval shipbuilding research institute in Russia) and the St. Petersburg State Marine Technical University. While the exact nature of the studied technologies is not disclosed, the report mentions that: "After years of research, a stable talent team, strong technical reserves, and good open, shared and cooperative relations have been formed in the field of China's polar equipment technology, and a series of important scientific research results have been produced." Note that this might refer to

nuclear icebreaker technology and other types of "polar equipment" not necessarily confined to the undersea domain. However, given China's recent research focus on ice-class submarine hulls as mentioned on p. 4 of my written testimony,[4] "ice-region ship technology" might include aspects of research that benefit an underwater focus, for instance with regard to developing ice class submarine hull designs, or for further developing nuclear propulsion plants, given that Russia's icebreakers are nuclear-powered. Krylov is engaged in in developing nuclear propulsion systems,[5] while China is engaged in a project to develop nuclear-powered icebreaker, whose propulsion unit if successfully developed might benefit various naval surface and potentially also subsurface shipbuilding projects. On the status of that project, Trym Eiterjord noted in February 2023 that the Russian icebreaker design firm Iceberg in 2022 showed an icebreaker design that seems to resemble the specifications of China's CNNC nuclear icebreaker project.[6]

2. Who if anyone is conducting open-source research on the datalinks the PLA needs to relay oceanographic information from sensors to ASW computing centers?

Answer:

The most detailed research that I have seen so far on the technical communication infrastructures (including electronic warfare, high-frequency communication, and SIGINT) that are deployed by China in the SCS as part of its ocean information network has been published by the former USN intelligence officer and US Military Attaché in Beijing, CDR (Ret.) J. Michael Dahm of MITRE. He has worked extensively on the technical infrastructures contributing to China's ocean information network, including the communication platforms ("E-stations") that are providing satellite uplinks, on other satellite communication infrastructures, data cables, electronic warfare, and signals intelligence technologies.[7]

**Endnotes**

[1] See Frank Jüris, "Sino-Russian Scientific Cooperation in the Arctic: From Deep Sea to Deep Space", in Sarah Kirchberger, Svenja Sinjen, and Nils Wörmer (eds.), *Russia-China Relations: Emerging Alliance or Eternal Rivals?* (Springer: Cham 2022), pp. 185-202, https://doi.org/10.1007/978-3-030-97012-3_10; pp. 189-90 and 192-195.
[2] For a report on the 3rd "China Russia Polar Acoustics and Information Technology Forum" on 6 May 2023, see Harbin Engineering University's press release "The Key Laboratory of Polar Ocean Acoustics and Technology Applications of the Ministry of Education was unveiled and established", Harbin Engineering University, 8 May 2023, archived version available at https://web.archive.org/web/20230601161440/https://english.hrbeu.edu.cn/info/1101/3515.htm.
[3] "极地海洋声学与技术应用教育部重点实验室在哈揭牌" [The Ministry of Education Key Laboratory of Polar Ocean Acoustics and Technology Application was inaugurated in Kazakhstan], Chinanews.com, May 6, 2023, archived version available at https://web.archive.org/web/20230508214114/https:/www.chinanews.com.cn/gn/2023/05-06/10002836.shtml.
[4] See e.g. 叶礼裕 YE Liyu, 王超 WANG Chao, 郭春雨 GUO Chunyu, and 常欣 CHANG Xin, "潜艇破冰上浮近场动力学模型 (Peridynamic model for submarine surfacing through ice)", 中国舰船研究 (Chinese Journal of Ship Research) 2018, 13(2), 51-59; YE Liyu 叶礼裕, WANG Chao 王超, CHANG Xin 常欣, ZHANG Hongyu 张洪雨, "冰桨接触的近场动力学模型 (Peridynamic model for propeller-ice contact)", 哈尔滨工程大学学报 (Journal of Harbin Engineering University), 2018, 39(2): 222-228.

[5] See the Krylov Institute's official webpages https://krylov-centre.ru/en/activities/marine-power-plants/ and https://krylov-centre.ru/en/activities/marine-power-plants/new_developments_and_customers/ for more detail on their work on nuclear propulsion systems.
[6] See Trym Eiterjord, "Checking Back in on China's Nuclear Icebreaker", *The Diplomat,* February 23, 2023, https://thediplomat.com/2023/02/checking-back-in-on-chinas-nuclear-icebreaker/.
[7] See in particular: J. Michael Dahm, Electronic Warfare and Signals Intelligence: A Survey of Technologies and Capabilities on China's Military Outposts in the South China Sea, Johns Hopkins Applied Physics Laboratory 2020, https://apps.dtic.mil/sti/pdfs/AD1128255.pdf; and J. Michael Dahm, High-Frequency Communications, Johns Hopkins Applied Physics Laboratory 2020, https://www.jhuapl.edu/sites/default/files/2022-12/High-FrequencyCommunications.pdf. On the communication platforms ("E-stations") has has deployed in the SCS for enabling data sharing, see his CSIS report, "Exploring China's Unmanned Ocean Network", CSIS, June 16, 2020, https://amti.csis.org/exploring-chinas-unmanned-ocean-network/. A good overview of J. Michael Dahm's open publications with key research results on this topic can be found on Dr. Andrew S. Erickson's blog, https://www.andrewerickson.com/2020/08/south-china-sea-military-capabilities-series-unique-penetrating-insights-from-capt-j-michael-dahm-usn-ret-former-assistant-u-s-naval-attache-in-beijing/.

**Question for the Record following the Commission's April 13 hearing on "China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes":**

> Please elaborate on the remark you made in your oral testimony regarding China's withholding of data in publicly-released research documents as a strategy to avoid such data informing future export controls imposed by the United States. How could the withholding of such data affect open-source research and regulation in areas like AI and quantum?

**Answer**

In my previous analysis of Chinese documents, leadership speeches, and media, I have noticed repeatedly that once a Chinese source is cited in a report of mine or another member of the think tank community, that source will sometimes be changed, censored, or even deleted entirely from the internet. The Chinese Government actively seeks to reduce the quality and quantity of information available to U.S. government policymakers and to any organizations – whether academic, journalistic, or corporate – who might be a source of information to the U.S. govt.

Think tanks often work hard to be transparent in their sourcing and methodology in an effort to be academically rigorous and to support follow up scholarly work. This is understandable, but perhaps deserves some cautious re-evaluation given China's approach.

The Bureau of Industry and Security works to keep secret the sources and methods by which it acquires the information for making enforcement decisions. This is true even when the information is not classified. This is entirely appropriate but sometimes causes frustration on the part of companies who do not have full context for the government's actions.

Recently, the Chinese government has begun a crackdown on the private sector firms that provide research to support legal due diligence efforts, including related to compliance with export control regulations. Much of the United States' approach to export controls and sanctions is intended to be precisely targeted at military end uses and end users but not commercial ones.

To the extent that China's efforts make that precision targeting impossible, the United States government should be willing to employ such measures imprecisely. For example,

some aspects of the October 7 export controls applied restrictions to the country of China as a whole, rather than just military end users and end uses.

The current extent of China's efforts to restrict access to open source information are noteworthy and troubling, but they do not at all diminish the urgency of the Bureau of Industry and Security improving its ability to harness open source information. There is far, far more information available than is being appropriately exploited, and far more than China's government is covering up or likely to successfully cover up in the future.

Gregory C. Allen

Director, Wadhwani Center for AI & Advanced Technology
Center for Strategic and International Studies

5/13/2023