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INNOVATION WARFARE

Jeanne Suchodolski, Suzanne Harrison, & Bowman Heiden*

Innovation, in particular, technology-based innovation, is the key driver for both economic competitiveness and national security. Other nations, with interests adverse to the United States, recognize this fact. In an increasingly interconnected world, nation states seek to accumulate innovation prowess, and hence economic strength as a key element of their geopolitical power. Improving the living conditions of one's citizens is a justifiable and laudable goal. However, especially savvy nation states, such as China, also pursue such ends as a mechanism to influence or diminish the national security and geopolitical power of the United States. These actions also threaten the post-WWII liberal economic order and worldwide peace and security. There is no need to inflict upon the world the carnage of war if geopolitical aims can be achieved via alternative competitive means.

This particular form of competitive strategy pursued by adversarial nation states and the targeting of America's innovation ecosystem can be labeled: "Innovation Warfare." Innovation Warfare is further defined as an executable doctrine with specific strategic goals and

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elements. The articulation of this doctrine is believed to be new and novel.

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I. INTRODUCTION

Innovation, in particular, technology-based innovation, is the key driver for both economic competitiveness and national security. Other nations, with interests adverse to the United States, recognize this fact. In an increasingly interconnected world, nation states seek to accumulate innovation prowess, and hence economic strength, as a key element of their geopolitical power. Especially savvy nation states also pursue such ends as a mechanism to influence or diminish the national security and geopolitical power of the United States.

There is no need to inflict upon the world the carnage of war if one's geopolitical aims can be achieved via alternative competitive means.

Several authors suggest China's long-term ambitions include unseating the United States as the world's economic and political leader.[1] More compelling than opinions, several United States ("U.S.") government and private studies document a systematic and coordinated effort by China to achieve technical and economic dominance through misappropriation of U.S. technology.[2] These efforts are additionally supported by a companion effort to weaken international economic institutions and norms designed to protect U.S. intellectual property and free trade.[3] The Chinese tactics include illegal means, and sophisticated use of legal means, to

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[1] *See, e.g.,* JONATHAN D.T. WARD, CHINA'S VISION OF VICTORY 104 (2019); ROBERT SPALDING & SETH KAUFMAN, STEALTH WAR: HOW CHINA TOOK OVER WHILE AMERICA'S ELITE SLEPT 12 (2019); GRAHAM ALLISON, DESTINED FOR WAR: CAN AMERICA AND CHINA ESCAPE THUCYDIDES'S TRAP? 107–32, 152 (2017) [hereinafter ALLISON]; GRAHAM ALLISON ET AL., LEE KUAN YEW: THE GRANDMASTER'S INSIGHTS ON CHINA, THE UNITED STATES, AND THE WORLD 16, 42–43 (2013) [hereinafter ALLISON ET AL.].

[2] *See, e.g.,* MICHAEL BROWN & PAVNEET SINGH, DEF. INNOVATION UNIT EXPERIMENTAL (DIUX), CHINA'S TECHNOLOGY TRANSFER STRATEGY: HOW CHINESE INVESTMENTS IN EMERGING TECHNOLOGIES ENABLE A STRATEGIC COMPETITOR TO ACCESS THE CROWN JEWELS OF U.S. INNOVATION 16 (2008), https://admin.govexec.com/media/diux_chinatechnologytransferstudy_jan_2018_(1).pdf [https://perma.cc/U9MG-YW9X]; SEAN O'CONNER, HOW CHINESE COMPANIES FACILITATE TECHNOLOGY TRANSFER FROM THE UNITED STATES (2019), https://www.uscc.gov/sites/default/files/Research/How%20Chinese%20Companies%20Facilitate%20Tech%20Transfer%20from%20the%20US.pdf [https://perma.cc/CMY9-Q7J7].

[3] *See* JIM MATTIS, SUMMARY OF THE 2018 NATIONAL DEFENSE STRATEGY OF THE UNITED STATES OF AMERICA, DEP'T OF DEFENSE 1–3 (2018), https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf [https://perma.cc/P78Y-UY6S]; *see also* Colum Lynch, *China Bids to Lead World Agency Protecting Intellectual Property*, FOREIGN POL'Y (Nov. 26, 2019), https://foreignpolicy.com/2019/11/26/china-bids-lead-world-intellectual-property-organization-wipo/ [https://perma.cc/8GNZ-WJY3] (reporting on China's attempt to head the World Intellectual Property Organization and quoting one intellectual property expert: "[w]hy would you want to put the fox in charge of the henhouse?").

misappropriate U.S. technology and weaken the U.S. innovation infrastructure including:

a) Leveraging the open university and laboratory ecosystem via direct sponsorship and engagement of Chinese nationals;[4]
b) Devaluing U.S. positions in patents and technology platforms;[5] and
c) Accessing private sector U.S. technology through acquisitions and ownership stakes in existing firms, funding of high-tech start-ups, and forced joint ventures and other contractual agreements as a prerequisite for entering the Chinese market.[6]

This particular form of competitive strategy targeting the innovation ecosystem in the United States is labeled by the Authors as "Innovation Warfare,"[7] and it is defined as an executable competitive strategy:

a) Reflecting an innovation, intellectual property, and technology strategy articulated and executed by the state (e.g. China);
b) Using illegal means, political means, and legal economic activities—of the type previously residing solely in the province of commercial enterprise, to achieve the state's objectives;
c) Employing these economic and innovation activities to achieve both economic geopolitical power and to enhance military capabilities; and

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[4] BROWN & SINGH, *supra* note 2.

[5] MATTIS, *supra* note 3.

[6] BROWN & SINGH, *supra* note 2.

[7] The Authors are aware that the term "warfare" can be read narrowly to mean the use of armed force, actions legally justifying the use of armed force, or actions taken ancillary to the prosecution of armed conflict. Objections exist to the use of the term "warfare" in other peacetime contexts, such as, "cyberwar" or "information warfare." For reasons further developed throughout this paper, the Authors nonetheless adopt this term in the context of "Innovation Warfare" to articulate the existence of an aggressive competitive strategy currently pursued by adversaries to the United States. This does not imply that pursuit of such competitive strategies is by itself, legal justification for armed conflict or intervention.

d) Functioning as a military, national security, and defense doctrine not solely as a reflection of the state's economic policy goals nor commercial competition in the ordinary course.

Innovation Warfare does not just threaten American jobs and economic prosperity. By simultaneously co-opting and weakening the innovation capabilities of the United States, China seeks to advance its rise to world power. China's prosecution of Innovation Warfare not only encompasses a rejection of a rules-based international order, but also poses an existential threat. A world where China dominates the technology landscape is not just about who earns the profits or prevails in an abstract geopolitical fight. According to the *National Security Strategy of the United States of America* ("*National Security Strategy*"), China pursues a world in which economies are less free, less fair, and less likely to respect human dignity and freedoms.[8] China's Innovation Warfare activities risk the type of economic and geopolitical aggressions that were a root cause of two World Wars.

America must urgently articulate and execute a defensive Innovation Warfare counterstrategy. At its core, Innovation Warfare strategies are about seizing control of the technological future(s), thereby securing a dominant economic and security position from which to accomplish other geopolitical aims. In view of that central observation and the necessity for a coherent response, this Article proposes a four-step approach to crafting and executing the needed Innovation Warfare counterstrategy:

1) Future-Oriented Technology Intelligence – Develop machine learning tools that identify the possible technological future(s) and drive towards the preferred future(s);
2) Strategic Technology Development – Optimize and scope federal research and development ("R&D") spending to seed the innovations necessary to attain the preferred future(s);

[8] WHITE HOUSE, EXEC. OFF. OF THE PRESIDENT, NATIONAL SECURITY STRATEGY OF THE UNITED STATES OF AMERICA 2 (2017) [hereinafter WHITE HOUSE], https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf [https://perma.cc/EDC4-RUCN].

3) Secure Technology Control Positions – Identify and secure control positions along the preferred future technology implementation path, including deploying and protecting intellectual property as an armament in the Innovation Warfare battlespace; and
4) Organize to Win – Develop cross-functional capabilities and inter-organizational coordination both within the government and across the public-private interface.

The capability to implement the Innovation Warfare counterstrategy already exists within the Department of Defense and among key U.S. public and private stakeholders. The missing link is a strategic plan and organization that brings together these existing capabilities. Such a plan not only neutralizes the Chinese Innovation Warfare efforts, but maintains the global technology leadership that is critical to U.S. national security and economic competitiveness. The Innovation Warfare counterstrategy defined in this Article provides this missing link.

The Article's three major topics describe in greater detail: innovation ecosystem vulnerabilities and doctrinal concepts; why existing recommendations, although meritorious, fail to articulate a coherent response; and new proposals and legal authorities for counterstrategies and government action. These three major topics are further subdivided and presented in five sections: a background describing the criticality of the innovation ecosystem to U.S. prosperity and security; China's economic ascent and prosecution of Innovation Warfare to achieve its geopolitical goals; the need for a comprehensive U.S. Innovation Warfare counterstrategy; the specific elements of an Innovation Warfare counterstrategy; and conclusions.

II. BACKGROUND

The United States became the world's largest economy following the Civil War.[9] The late nineteenth century saw a burst of

[9] ANGUS MADDISON, THE WORLD ECONOMY: HISTORICAL STATISTICS 259–61 (2003) (showing the U.S. economy became the world's largest economy shortly after 1870).

innovative technologies that became cornerstones of modern life.[10] "Great Inventions" such as the internal-combustion engine, electric light, electronic communications, and mechanized transportation fueled explosive growth that utterly transformed and elevated the standard of living for Americans.[11]

Just as important as the invention process was the development of the nation's industrial infrastructure.[12] Concurrent developments in business organizational design, distribution networks, legal frameworks, finance, and manufacturing enabled the delivery of these inventions and their attendant benefits to American society as new and useful products and services.[13] For the purpose of this Article, "innovation" is defined as the process of converting inventions into useful products and services, including developing the infrastructure necessary to do so.[14] American proficiency at the innovation process resulted in a period of economic expansion from 1870 to 1970: a period of a magnitude and duration not previously witnessed in world history.[15]

That the United States maintained such a sustained period of economic growth did not occur by happenstance. From the beginning, the United States facilitated an egalitarian, rule-based legal system designed to enable and de-risk the innovation process regardless of social class.[16] While the United States' economic

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[10] ROBERT J. GORDON, THE RISE AND FALL OF AMERICAN GROWTH: THE U.S. STANDARD OF LIVING SINCE THE CIVIL WAR 1–2 (2016).

[11] *Id.* at 4.

[12] Christopher Conte & Albert R. Karr, *The U.S. Economy: A Brief History*, DEP'T OF STATE, https://usa.usembassy.de/etexts/oecon/chap3.htm [https://perma.cc/ 3UAA-VN4X] (last visited Oct. 25. 2020).

[13] *Id.*

[14] This broader concept of innovation is the focus, rather than the narrower concept of technology. Whereas technology refers to scientific knowledge, innovation encompasses all of society's means of putting that knowledge into motion for society's benefit. Both the technical knowledge and the infrastructure and activities necessary to utilize that knowledge are relevant to economic growth, and hence of importance to national security.

[15] *See* GORDON, *supra* note 10, at 1–20.

[16] *See* ROBERT D. ATKINSON & STEPHEN J. EZELL, INNOVATION ECONOMICS: THE RACE FOR GLOBAL ADVANTAGE 3–6 (2012).

history reveals an ongoing struggle to balance laissez-faire, free market practices, and proactive government regulation, that same history also reveals a government bias towards action in industrial innovation policy.[17] The United States articulated and executed specific initiatives that facilitated this growth at pivotal points throughout the duration of this expansion.

An example of these initiatives includes the Interstate Commerce Act regulating the transportation sector and ensuring "just and reasonable" access to this critical element of the nation's economic infrastructure.[18] Prior to the First World War, the government formed the National Advisory Committee for Aeronautics ("NACA") to coordinate research in the emerging field of aeronautics and to catch up to technology leaders in Europe.[19] When cooperation amongst aviation industry participants subsequently proved difficult, Assistant Secretary of the Navy, Franklin Roosevelt, employed NACA to broker the formation of the Manufacturer's Aircraft Association and cross-license necessary patents.[20] During the 1920s, the government employed a similar tactic when it influenced the formation of RCA Corporation and patent pools to ensure American competitiveness and prevent foreign domination of the fledgling radio and electronic communication industries.[21]

The United States further strengthened its national research ecosystem during the 1930s by investing heavily in basic R&D in

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[17] *See* Conte & Karr, *supra* note 12.

[18] Interstate Commerce Act of 1887, Pub. L. No. 49-104 §§ 1–2, 24 Stat. 379 (1887).

[19] Elizabeth Suckow, *National Advisory Committee for Aeronautics Overview*, NASA (Apr. 23, 2009), https://history.nasa.gov/naca/overview.html [https://perma.cc/EER3-BB39].

[20] Alex Roland, *SP-4103 Model Research – Volume 1*, NASA (1985), https://history.nasa.gov/SP-4103/ch2.htm [https://perma.cc/F6WD-NYD9].

[21] PETER J. HUGILL, GLOBAL COMMUNICATIONS SINCE 1844: GEOPOLITICS AND TECHNOLOGY 121 (1999) (describing the U.S. Navy's efforts to prevent foreign domination of American radio communications by ensuring no one company had sufficient patent rights to a complete system).

anticipation of the coming World War.[22] After the war, the government leveraged its prior investment in wartime research and embarked on a policy of research in scientific investment as a cornerstone of the American economy.[23] That policy, as outlined in 1945, continued the national laboratory system, created the National Science Foundation, and established a system of federal research grants giving rise to the modern university research system.[24] That university research system, in turn, gave birth to modern clusters of innovation such as Silicon Valley, Boston, and Austin.[25]

The capabilities inherent in the American innovation ecosystem as a consequence of these previous efforts made the promise of landing a man on the moon realistic, even if audacious. The acquisition of the additional expertise needed to prevail in that race was essential for national security.[26] America's space program underwrote the development of many technological advances that further bolstered the innovation economy.[27]

Every source of American economic growth can be derived from the role of innovation and technological change.[28] The United States maintained its position as the world's largest economy for over 150

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[22] *See* GORDON, *supra* note 10, at 535–65 (arguing what he calls "The Great Leap," the period from 1920 to 1950 where the Great Depression masks the significant investment made in research as well as the rise in wages, fueled a second round of innovativeness and a recharge of the American economy).

[23] Vannevar Bush, *Science The Endless Frontier*, U.S. GOV'T PRINTING OFF. (July 1945), https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm [https://perma.cc/3AYE-V69Y] (arguing that a continual program of scientific research was essential to the United States).

[24] *Id.*

[25] MARGARET O'MARA, CITIES OF KNOWLEDGE: COLD WAR SCIENCE AND THE SEARCH FOR THE NEXT SILICON VALLEY 71, 74 (2005).

[26] Martand Jha, *This is How the Space Race Changed the Great Power Rivalry Forever*, NAT'L INT. (July 27, 2017), https://nationalinterest.org/feature/how-the-space-race-changed-the-great-power-rivalry-forever-21690 [https://perma.cc/RMD7-6KV5].

[27] Aldo Spadoni, *How Technology from the Space Race Changed the World*, NOW: NORTHRUP GRUMMAN (Apr. 9, 2019), https://now.northropgrumman.com/how-technology-from-the-space-race-changed-the-world/#:~:text=The%20list%20of%20technology%20from,space%20technology%20research%20and%20development [https://perma.cc/P93N-EY54].

[28] *See* GORDON, *supra* note 10, at 569.

years because of these industrial policies and initiatives.[29] The importance of innovation, and hence of pro-innovation initiatives, to the creation and sustainment of America's economic strength is evident from an examination of objective data.

One measure for evaluating the contribution of innovation to economic growth is Total Factor Productivity ("TFP").[30] In general, TFP captures the efficiency with which labor and capital investments combine to generate economic output.[31] Figure 1 depicts the historical averages over time for productivity growth in the U.S., wherein the contribution of labor is shown in white. The second component, shown in Figure 1 below, displays "capital deepening," which represents the rising capital investment per worker hour. Capital deepening accounts for things such as investment in tools and equipment.[32] Growth not otherwise accounted for by labor and capital must arise from some other economic input. This "residual" contribution is TFP, which is a proximate measure of the contribution of technology and innovation to overall productivity and economic growth.[33] As seen in Figure 1,

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[29] *Id.*

[30] *Total Factor Productivity, Glossary of Statistical Terms*, OECD (Dec. 1, 2005) [hereinafter OECD], https://stats.oecd.org/glossary/detail.asp?ID=3091 [https://perma.cc/RX24-23BZ]; *see also* Robert Solow, *Technical Change and the Aggregate Production Function*, 39 REV. OF ECONS. AND STATIS. 312, 312–20 (1957). Solow won the Nobel Prize for his work defining technological change a key economic growth factor in addition to influx of capital or improvements in the quality or supply of labor. Press Release, Royal Swedish Acad. of Sci., The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Noel 1987: Robert M. Solow (Oct. 21, 1987), https://www.nobelprize.org/prizes/economic-sciences/1987/press-release/ [https://perma.cc/PG5L-NH3B]. Subsequent research has criticized the metric as overly simplistic, but it remains a good proxy for the contribution of innovation and technological change to economic growth. *See also* ATKINSON & EZELL, *supra* note 16, at 294–95 (2012) (explaining the term's relation to innovation and further identifying the limitations of the approach).

[31] Roberto Cardarelli & Lusine Lusinyan, *U.S. Total Factor Productivity Slowdown: Evidence from the U.S. States* 3 (Int'l Monetary Fund Working Paper, WP/15/116, 2015).

[32] *Id.*

[33] *See* GORDON, *supra* note 10, at 15–16.

America's post-World War II expansion stemmed from a significant increase in TFP during the years between 1920 and 1970.

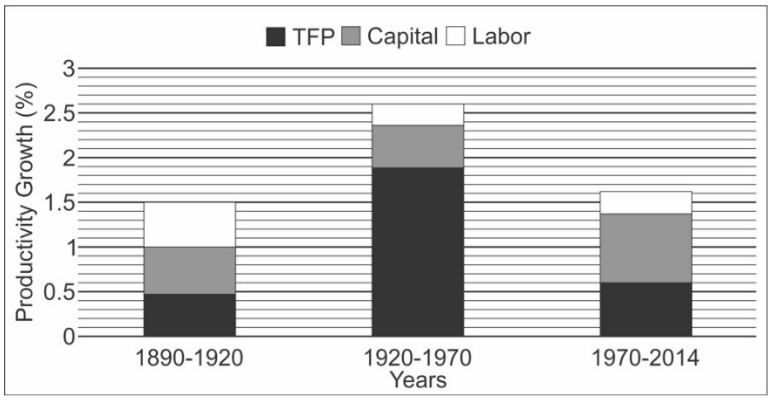

Figure 1. Contribution of TFP, Capital Deepening, and Labor to Productivity Growth[34]

Today, the U.S. remains the world's largest economy, but that position is under siege.[35] The U.S. is losing its leadership in the highest value-added sectors of economic activity and, with it, those jobs necessary to maintain the standard of living to which Americans have become accustomed.[36] Erosion of America's innovation capacity is one reason for this decline.[37] As seen in Figure 2, after 1970, TFP steadily declined to levels not seen since the First World War.[38]

[34] *Id.* (showing 2014 as the latest year for which consistent data is available).
[35] *See* ATKINSON & EZELL, *supra* note 16, at 32–33.
[36] *See id.*
[37] *Id.* at 33.
[38] *See* GORDON, *supra* note 10, at 547.

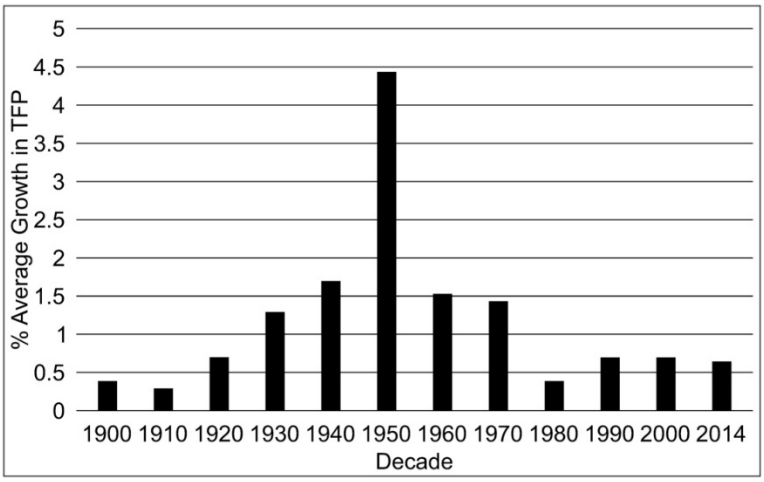

Figure 2. Average Percentage Growth in TFP by Decade[39]

TFP is an imprecise measurement of innovation activity in the economy. Given the importance of innovation to economic performance and the coarseness of the TFP measure, modern researchers have devised alternatives. Two popular innovation indices are the *Cornell Global Innovation Index* and the *Bloomberg Innovation Index*.[40] Each of these indices evaluates the capacity for innovation-driven growth based on multiple factors, such as the strength of the institutional framework, human capital and research, infrastructure, and business and market sophistication.[41]

These more sophisticated indices also show that the United States no longer leads the world in innovation.[42] Both the 2019 and

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[39] *Id.*

[40] *See generally* CORNELL UNIVERSITY ET AL., THE GLOBAL INNOVATION INDEX 2019 (2019) [hereinafter CORNELL UNIVERSITY ET AL. 2019], https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf [https:// perma.cc/2EMS-SNEC]; *see also* Peter Coy, *The Bloomberg Innovation Index*, BLOOMBERG (2015), https://www.bloomberg.com/graphics/2015-innovative-countries/#:~:text=Bloomberg%20ranked%20countries%20and%20sovereigns,country%20from%20zero%20to%20100 [https://perma.cc/4XFD-78G8].

[41] CORNELL UNIVERSITY ET AL. 2019, *supra* note 40, at xviii.

[42] *See id.* at xxiv; *see also* CORNELL UNIVERSITY ET AL., THE GLOBAL INNOVATION INDEX 2020 xxii (2020) [hereinafter CORNELL UNIVERSITY ET AL. 2020],

the 2020 editions of the *Cornell Global Innovation Index* place the United States third.[43] The most recent *Bloomberg Innovation Index*, published in 2019, ranked the United States eighth, rebounding back into the top ten from even lower rankings in previous years.[44]

Enhanced competitive capabilities of foreign economies is a second cause for America's relative decline.[45] That other economies become strong and raise the standard of living for their citizens need not be a detriment to the United States. Cordell Hull, the Secretary of State who led the creation of the post-World War II liberal international economic order, recognized the linkage between free trade and peace.[46] In his memoir, Hull wrote, "I saw that you could not separate the idea of commerce from the idea of war and peace . . . [and] that wars were often largely caused by economic rivalry conducted unfairly."[47] Hull believed that rebuilding the world's economies was key to preventing world wars.[48]

The combination of post-World War II trade liberalism and technology made it easier for people, ideas, and goods to move about the world.[49] Slow removal of barriers to trade and investment led to significant foreign investment and continued worldwide economic growth in the post-war years.[50] As shown in Figure 3, the gross

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https://www.globalinnovationindex.org/gii-2020-report [https://perma.cc/7BNN-F3SF]; *see also* Coy, *supra* note 40.

[43] CORNELL UNIVERSITY ET AL. 2019, *supra* note 40, at xxxiv; CORNELL UNIVERSITY ET AL. 2020, *supra* note 42 at xxii.

[44] Alexandre Tanzi, *U.S. and Canada Make Strides in Bloomberg 2019 Innovation Index*, BLOOMBERG (Jan. 28, 2019, 5:00 AM), https://www.bloomberg.com/news/articles/2019-01-28/u-s-canada-make-strides-in-bloomberg-2019-innovation-index [https://perma.cc/VDQ8-796U].

[45] *See* ATKINSON & EZELL, *supra* note 16, at 32.

[46] Douglas A. Irwin, *Trade Liberalization: Cordell Hull and the Case for Optimism* 5 (Council on Foreign Rels., Working Paper, 2008), https://cdn.cfr.org/sites/default/files/pdf/2008/07/CGS_WorkingPaper_4.pdf [https://perma.cc/63M5-WWT8].

[47] CORDELL HULL, THE MEMOIRS OF CORDELL HULL 84 (1948).

[48] *See* Irwin, *supra* note 46, at 8.

[49] Geoffrey Jones, *Restoring a Global Economy, 1950-1980*, HARVARD BUS. SCH. (Aug. 22, 2005), https://hbswk.hbs.edu/item/restoring-a-global-economy-19501980 [https://perma.cc/546D-LA8T].

[50] *Id.*

domestic product ("GDP") of the United States and many European countries began to rise during this period with China lagging and then catching up rapidly.[51]

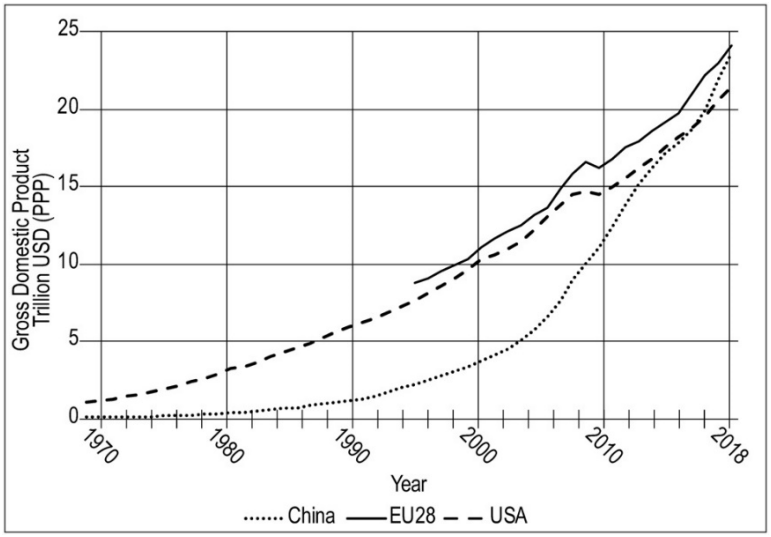

Figure 3. Comparison of GDP for Various Nations ($ Current PPP)[52]

Rising levels of wealth enabled economies to make greater investments in R&D over time. These investments put competitive pressure on the American innovation economy as other nations introduced new and useful products and services. As shown in Figure 4, the American share of total world spending on R&D activities has significantly declined from nearly seventy percent in 1960 to only twenty-eight percent in recent years.[53] China now spends nearly as much on R&D as does the United States.[54] The pace at which global R&D spending has increased reflects the

[51] *See* OECD, *supra* note 30.

[52] *Id.*

[53] COUNCIL ON COMPETITIVENESS, 2018 CLARION CALL: LAUNCH OF THE NATIONAL COMMISSION ON INNOVATION AND COMPETITIVENESS FRONTIERS 5 (2018), https://www.compete.org/storage/reports/2018%20clarion%20call%20final.pdf [https://perma.cc/T4U9-VQNK].

[54] *Id.*

knowledge and innovation intensiveness of the escalating economic competition among nations.[55]

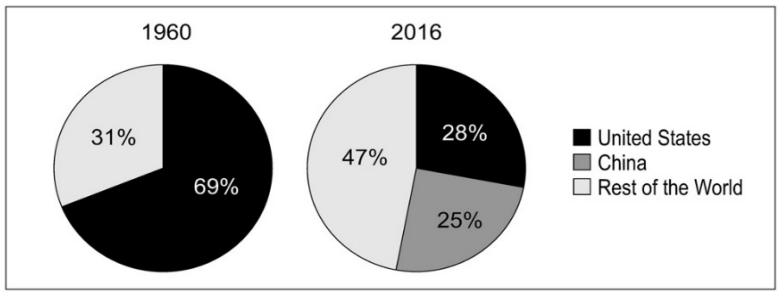

Figure 4. Proportion of U.S. vs. Worldwide R&D Spending[56]

Economic competition from other nations, if appropriately structured, can be a race in which all humanity wins.[57] Losing its position as the world's largest economy might not impact most Americans if their standard of living and institutional integrity remain intact.[58] While the government should always be concerned with strengthening American innovative capacity as a driver of economic prosperity, maintaining an economic leadership position has not always been coincident with worldwide political leadership. In the period spanning from 1870 to just prior to World War II, America's isolationist sentiments left it content to cede world political leadership to Great Britain.[59]

America's economic might enabled it to craft a late twentieth century liberal world order consistent with American values and ideals, fund a technological arms race with the Soviet Union, and

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[55] *Id*. at 6.

[56] *Id.* at 5.

[57] *See* ATKINSON & EZELL, *supra* note 16, at 15.

[58] Charles Kenny, *America is No. 2! And that's Great News*., WASH. POST: OPS. (Jan. 17, 2014), https://www.washingtonpost.com/opinions/america-is-no-2-and-thats-great-news/2014/01/17/09c10f50-7c97-11e3-9556-4a4bf7bcbd84_story.html [https://perma.cc/9AN9-TVCZ].

[59] *See, e.g.,* BETTY GLAD, CHARLES EVANS HUGHES AND THE ILLUSIONS OF INNOCENCE; A STUDY IN AMERICAN DIPLOMACY 232–36 (1966) (commenting that American isolationist sentiments and actions often underappreciated the necessity of relying upon Great Britain as a world political leader).

prevail in the Cold War.[60] The strength of the American economy enables continued funding of a military unmatched in its capabilities and ability to project power overseas.[61] The United States now sits as the global leader in a unipolar world as a consequence of this economic might.[62]

Innovation is the critical linchpin and driver of both military technical superiority and economic competitiveness, as shown in Figure 5. Deterioration of the American innovation ecosystem adversely impacts both national security and the economy.

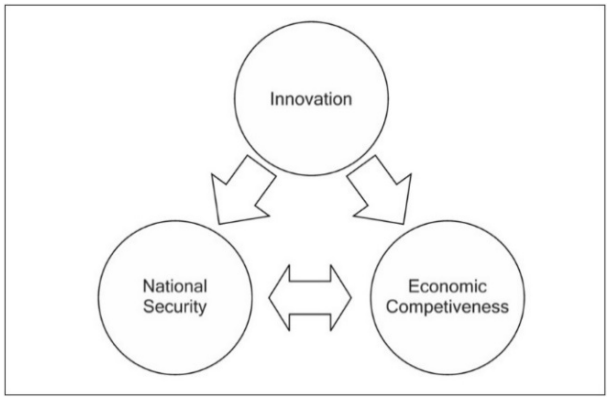

Figure 5. Innovation as a Driver of National Security and Economic Competitiveness

Deterioration of the American innovation ecosystem also adversely impacts the nation's ability to exercise international leadership. Congress, through legislation, has explicitly recognized this fact.[63] The nation's innovation base presents a target for modern

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[60] *See* G. John Ikenberry, *Power and Liberal Order: America's Postwar World Order in Transition*, 5 INT'L RELS. OF THE ASIA-PACIFIC 133, 133 (2005).

[61] *Id.*

[62] Peter Harris, *When Will the Unipolar World End?*, NAT'L INTEREST (May 27, 2019), https://nationalinterest.org/feature/when-will-unipolar-world-end-59202 [https://perma.cc/D9QB-E592].

[63] 50 U.S.C. §§ 1901(b)(c), 1902. Congress, in passing the David L. Boren National Security Education Act of 1991, stated that "the security of the United States is and will continue to depend on the ability of the United States to exercise international leadership," and further, "[t]he ability of the United States to

adversaries to manipulate in order to erode the nation's military or economic power. Softness in innovation capabilities poses a potential weakness that adversaries can exploit for their own geopolitical aims.

Unlike America's past economic rivalry with Great Britain,[64] adversaries' goals and means of achieving them threaten American culture, values, and national defense. The rise of foreign challengers (specifically China), the associated national security consequences, and the formulation of defensive counterstrategies form the substance of this Article.

III. CHINESE ECONOMIC ASCENDENCY AND GEOPOLITICAL GOALS

China's growing economic influence, trade policies, and tactics have significant implications for the U.S.[65] The actual size of the Chinese economy is the subject of debate amongst experts.[66] While Figure 3 shows that Chinese GDP, on a Purchasing Power Parity ("PPP") basis, exceeds American GDP, PPP measures overestimate China's economic power since prices for goods are significantly lower there.[67] Measured in U.S. dollars, China's GDP in 2018 was 65.3% of United States' GDP.[68]

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exercise international leadership is, and will increasingly continue to be, based on the political and economic strength of the United States, as well as on United States military strength." *Id.* §§ 1901(b)(1)–(2). The Act funded educational initiatives to better position the United States for economic and strategic competition in an increasingly global world. *Id.* §§ 1901(c)–1902.

[64] ALLISON, *supra* note 1, at 197 (noting that Britain acquiesced in part due to America's economic and political rise and in part due to a shared system of values, language, and political governance).

[65] WAYNE MORRISON, CONG. RSCH. SERV., RL33534, CHINA'S ECONOMIC RISE: HISTORY, TRENDS, CHALLENGES, AND IMPLICATIONS FOR THE UNITED STATES 1 (2019), https://fas.org/sgp/crs/row/RL33534.pdf [https://perma.cc/6RPC-VCR8].

[66] *Id.* at 9.

[67] *Id.* (noting there is some debate as to whether a PPP basis or U.S. dollar basis yields the truest picture of the size and purchasing power of the Chinese economy).

[68] *Id.*

Prior to 1978, China practiced a Soviet-style communist economic system.[69] China launched a series of economic reforms that encouraged the formation of new businesses and foreign investments following the death of Chairman Mao.[70] From 1979, when reform began, until 2017, China's real GDP grew at an average annual rate of ten percent.[71] This growth constituted the fastest sustained expansion by a major economy in history.[72] The increased purchasing power of Chinese consumers, and the sheer size of the Chinese market, led to an increase in bilateral commercial ties with the U.S.[73] China is currently America's largest merchandise trading partner, its largest source of imports, and its third-largest export market.[74]

The emergence of China as an economic power concerns U.S. policy and lawmakers, who believe China engages in unfair trade practices.[75] Many policymakers contend China engages in mercantilist practices such as undervaluing its currency and subsidizing domestic producers.[76] China's industrial policies also face criticism for erecting barriers to the participation of foreign firms and for undermining their competitiveness by failing to enforce and protect intellectual property rights.[77]

Each of these behaviors might be seen as unwelcome, but not uncommon, mercantilist activities. India, Brazil, Argentina, Thailand, Vietnam, and Russia were all recently ranked "Moderate-High" on a 2019 index of nations' mercantilist practices.[78] China, however, was noteworthy for being the only country ranked

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[69] *Id.* at 4.
[70] *Id.*
[71] *Id.* at 1.
[72] *Id.*
[73] *Id.*
[74] *Id*.
[75] *Id*.
[76] *Id*.
[77] *Id*.
[78] Caleb Foote & Stephen J. Ezell, *The 2019 Global Mercantilist Index: Ranking Nations' Distortive Trade Policies*, INFO. TECH. & INNOVATION FOUND. (Nov. 18, 2019), https://itif.org/publications/2019/11/18/2019-global-mercantilist-index-ranking-nations-distortive-trade-policies [https://perma.cc/L36U-X5F3].

in the uppermost, "High" category.[79] China handily outdistanced other nations to unambiguously claim the title of the "world's most innovation-mercantilist nation."[80]

The Chinese government views a growing economy as vital to lifting its citizens out of poverty and maintaining social stability.[81] One widely held view in trade policy circles is that China's rapid economic growth will integrate China into the world economy and bring mostly positive ancillary benefits to developed economies, such as the U.S.[82] Any deleterious impacts from China's economic rise and mercantilist trade practices were thought to be a temporary burden borne by a modest number of workers in limited market segments.[83]

A recent survey of economic research reveals such beliefs underestimated the job loss in developed economies.[84] Chinese mercantilist practices have caused harm that is more severe than previously forecasted.[85] Even more troubling, this recent research documents numerous studies showing that China's trade expansion practices negatively impact innovation in most developed nations—particularly in North America and Europe.[86] In particular, one study found that firms reduce R&D investment when they belong to industries that are exposed to foreign export competition of the type exhibited by China.[87] Even advanced economies, such as that of the

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[79] *Id*.
[80] *Id*.
[81] *See* MORRISON, *supra* note 65, at 1.
[82] Robert Atkinson, *Innovation Drag: China's Economic Impact on Developed Nations*, INFO. TECH. & INNOVATION FOUND. (Jan. 6, 2020), https://itif.org/publications/2020/01/06/innovation-drag-chinas-economic-impact-developed-nations [https://perma.cc/PS9Y-PPTP].
[83] *Id*.
[84] *Id*.
[85] *Id*.
[86] *Id*.
[87] Ufuk Akcigit et al., *Innovation and Trade Policy in a Globalized World*, 51 (Nat'l Bureau of Econ. Research, Working Paper No. 24543, 2018), https://www.nber.org/papers/w24543.pdf [https://perma.cc/3QVJ-SDLP].

U.S., suffer from a reduction in aggregate innovation if enough of these firms exist within their economies.[88]

Additional economic literature shows that restrictive trade policies and protectionism ultimately suppress innovation and adversely impact the long-term economic growth of the implementing country.[89] Restrictive trade policies increase the cost of local production and require local firms to raise prices or reduce investment in response.[90] Protectionist barriers also foreclose the import of potentially superior goods, thereby reducing the welfare of the local population who must settle for the consumption of a potentially inferior product.[91] Furthermore, in nations affected by these trade barriers, innovation-producing activities are retarded, thereby reducing the number of new products and services available both worldwide and in the barrier-erecting economy.[92] For this additional reason, one policy view is that countries, such as China, will abandon or recede from their mercantilist practices as they are ultimately self-defeating and harmful.[93]

Such beliefs make two potentially false assumptions. First, China has not engineered mechanisms to mitigate the negative consequences of their mercantilist practices. For example, why suffer from the absence of imports of superior products if one can simply abscond with the overseas technology and reproduce it at home? Second, China's behavior is ultimately that of a rational economic actor on the world stage; the nation's mercantilist motivations and objectives lie purely in the realm of economic policy divorced from other geopolitical objectives. The existence of non-economic objectives, however, renders China less amenable to altering its behavior in response to traditional free market forces, or

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[88] *Id*.

[89] Robert Atkinson, *Innovation Mercantilism's Dangerous Consequences for American Manufacturing*, INDUS. WEEK (Oct. 22, 2013), https://www.industryweek.com/the-economy/competitiveness/article/22006847/innovation-mercantilisms-dangerous-consequences-for-american-manufacturing [https://perma.cc/JD24-B8TM].

[90] *Id*.

[91] *See id*.

[92] *See id*.

[93] *See* ATKINSON & EZELL, *supra* note 16, at 215.

succumbing to pressure from post-World War II liberal economic institutions.

IV. INNOVATION WARFARE EXPLAINED

China's innovation-mercantilist practices must be examined in the broader context of China's stated global political objectives. Several authors suggest China's long-term ambitions include unseating the United States as the world's political leader.[94] Chinese writings about the "rejuvenation of the Chinese nation" and redressing the "Century of Humiliation" are ambiguous enough in meaning that they could be read to support such a premise.[95] The 2017 *National Security Strategy* notes that both China and Russia aim to challenge U.S. power and influence and to erode American security and prosperity.[96]

China electing to pursue such aims via non-military means is consistent with its own published national security treatises.[97] One widely read Chinese treatise laid out a framework for "unrestricted warfare," in which pursuit of national security will no longer depend on military might, but will expand to all manner of non-violent

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[94] *See, e.g.,* WARD, *supra* note 1, at 19; SPALDING & KAUFMAN, *supra* note 1; ALLISON, *supra* note 1, at 107–32, 152; ALLISON ET AL., *supra* note 1, at 16, 42–43.

[95] *See* KAREN M. SUTTER, CONG. RSCH. SERV., IF10964, "MADE IN CHINA 2025" INDUSTRIAL POLICIES: ISSUES FOR CONGRESS, https://fas.org/sgp/crs/row/IF10964.pdf [https://perma.cc/7QT7-87DN] (last updated Aug. 11, 2020); WARD, *supra* note 1, at 99 (noting that the Made in China 2025 policy document is one example wherein the Chinese government stated it seeks to transform China into a global manufacturing leader and "lay the foundation for rejuvenation of the Chinese nation"). The "Century of Humiliation" refers to the century of western colonial influence in China following the first opium wars. *See* Alan Rappeport, *19th Century 'Humiliation' Haunts China-U.S. Trade Talks*, N.Y. TIMES (Mar. 27, 2019), https://www.nytimes.com/2019/03/27/us/politics/china-opium-wars-trade-talks.html [https://perma.cc/2LUH-F633].

[96] WHITE HOUSE, *supra* note 8.

[97] *See generally* QIAO LIANG & WANG XIANGSUI, UNRESTRICTED WARFARE (1999).

conflict having the same or similar destructive potential as war.[98] The treatise states:

> For a long time, both military people and politicians have become accustomed to employing a certain mode of thinking, that is, the major factor posing a threat to national security is the military power of an enemy state or potential enemy state. However, the wars and major incidents which have occurred during the last ten years of the 20th century have provided to us in calm and composed fashion, proof that the opposite is true: military threats are already often no longer the major factors affecting national security. Even though they are the same ancient territorial disputes, nationality conflicts, religious clashes, and the delineation of spheres of power in human history, and are still the several major agents of people waging war from opposite directions, these traditional factors are increasingly becoming more intertwined with grabbing resources, contending for markets, controlling capital, trade sanctions, and other economic factors, to the extent that they are even becoming secondary to these factors.[99]

These same authors go on to say the "use of national defense as the main target of national security for a nation actually seems a bit outmoded, and at the least is quite insufficient."[100] There is no need to inflict upon the world the carnage of war if one's geopolitical aims can be achieved via other competitive means. "The Chinese have figured out that if they just stay with 'peaceful rise' and just contest for first position economically and technologically, they cannot lose."[101]

The theoretical concept of synchronizing and marshalling all aspects of national power, short of conventional armed hostilities, is not new. George Kennan, the principal architect of the U.S. strategy in the Cold War, christened such practices as "political warfare."[102] These competitive grand strategies manifest as a gray zone of conflict, blurring conventional black and white definitions of war

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[98] *Id.* at 95.

[99] *Id.*

[100] *Id.* at 96.

[101] *See* ALLISON ET AL., *supra* note 1, at 16.

[102] KATHLEEN J. MCINNIS & MARTIN A. WEISS, CONG. RSCH. SERV., IF11127, STRATEGIC COMPETITION AND FOREIGN POLICY: WHAT IS "POLITICAL WARFARE"? (2019), https://fas.org/sgp/crs/row/IF11127.pdf [https://perma.cc/4NPE-2U5].

and peace.[103] They nonetheless represent chronic and potentially dangerous tensions with significant stakes. The United States now recognizes that it exists in a great power competition with China.[104] China is challenging the liberal world order led by the United States, and also challenging, if not outright rejecting, the values of human dignity and freedom enshrined in this world order.[105]

The Chinese government's grand political warfare strategy is an economic one.[106] China is a recognized master at using economic instruments to achieve geopolitical goals.[107] According to the *Congressional Research Service*, China uses its wealth to advance its security interests in the Pacific, formalize integration with the economies of other nations, and exert increasing influence on international institutions such as the United Nations, International Monetary Fund, and the World Bank.[108] China's official government development plan for the years 2020 to 2049 aims to transform China into the world leader in innovation.[109] Building and enlarging its economy through innovation continues to be at the heart of the Chinese strategy, since technology and innovation are drivers of both economic growth and national security.[110]

Within China's grand political economic strategy is evidence of not only mercantilist trade protection practices, but also of a sophisticated sub-strategy specifically targeting American technology and innovation. The Defense Innovation Unit Experimental ("DIUX") and the U.S.-China Economic and Security Review Commission each conducted a review of Chinese technology transfer activities aimed at acquiring American

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[103] *See id.* at 1.

[104] *See* WHITE HOUSE, *supra* note 8.

[105] *See id.* at 2–3.

[106] WARD, *supra* note 1, at 104.

[107] ROBERT D. BLACKWELL & JENNIFER M. HARRIS, WAR BY OTHER MEANS: GEOECONOMICS AND STATECRAFT 8, 11 (2016).

[108] MCINNIS & WEISS, *supra* note 102, at 2.

[109] *Full Text of Xi Jinping's Report at 19th CPC National Congress*, CHINA DAILY (Nov. 4, 2017, 6:07 PM) https://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-11/04/content_34115212.htm [https://perma.cc/CD82-GAJP] (noting in section IV the plans for Chinese government's development plan).

[110] *See* WARD, *supra* note 1, at 95.

expertise.[111] The White House Office of Trade and Manufacturing Policy published an additional report on the topic in 2018.[112] All three reports had similar findings.[113] As the DIUX team noted, the emerging composite picture "illustrates the intent, design, and dedication of a regime focused on technology transfer at a massive scale."[114]

Technology acquisition efforts occur with equal vigor at home and abroad. American firms doing business with a Chinese firm do not engage in free market activities with a commercial counterpart. The Chinese economy is state-led.[115] The Communist Party retains control over most Chinese industries and companies, including those at the top of the Fortune Global 500.[116] Leaders of Chinese firms must be members of the Communist Party.[117] The industrial espionage and technology transfer activities waged by China and Chinese corporations effectively conscript American business into service as the research and development arm of the Chinese state.[118]

Figure 6 diagrams the vehicles for Chinese technology transfer from the United States as originally identified by the three reports. The figure contains some modifications from an original figure drawn in the DIUX report. The changes reflect additional, subsequently identified, vectors for transfer as further described below. While the DIUX report identified a highly aggressive and illegal cyber espionage campaign disproportionately larger than that of other countries, many of the technology transfer activities

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[111] BROWN & SINGH, *supra* note 2; O'CONNER, *supra* note 2.

[112] WHITE HOUSE OFF. OF TRADE & MFG. POL'Y, EXEC. OFF. OF THE PRESIDENT, HOW CHINA'S ECONOMIC AGGRESSION THREATENS THE TECHNOLOGIES AND INTELLECTUAL PROPERTY OF THE UNITED STATES AND THE WORLD (2008), https://www.whitehouse.gov/wp-content/uploads/2018/06/FINAL-China-Technology-Report-6.18.18-PDF.pdf [https://perma.cc/8PAR-AAUF].

[113] *See also* BROWN & SINGH, *supra* note 2; O'CONNER, *supra* note 2; WHITE HOUSE OFF. OF TRADE & MFG. POL'Y, *supra* note 112.

[114] *See* BROWN & SINGH, *supra* note 2, at 16.

[115] *See* WARD, *supra* note 1, at 113.

[116] *Id.*

[117] GEORGE S. YIP & BRUCE MCKERN, CHINA'S NEXT STRATEGIC ADVANTAGE: FROM IMITATION TO INNOVATION 30 (2016).

[118] *See* WARD, *supra* note 1, at 113.

leverage mechanisms not barred by law.[119] Principle among these are foreign direct investment, venture capital investment, talent acquisition, licensing (coerced and voluntary), and open-source data mining.[120]

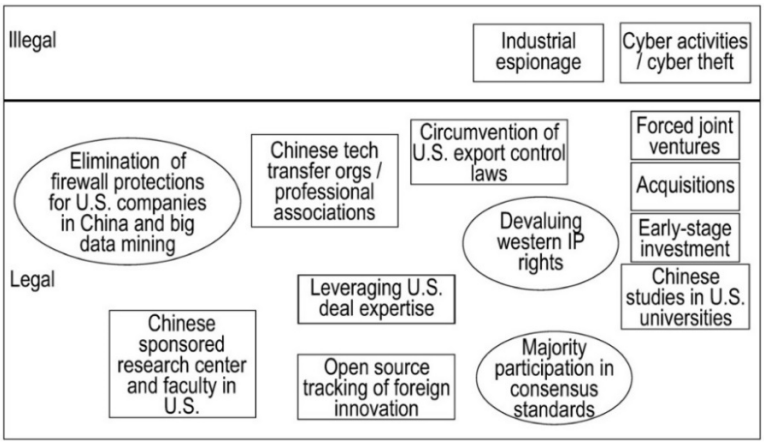

Figure 6. Chinese tactics for appropriating U.S. technology and intellectual property[121]

The Authors' research identified additional vectors utilized by the Chinese to transfer technology from the United States to China. These additional vectors are drawn as ovals in Figure 6. Because these new observations are not previously discussed elsewhere, the observations are described in greater detail below.

Chief among these newly emerging vectors of technology acquisition is an increasing lack of data security for American firms

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[119] *See* BROWN & SINGH, *supra* note 2, at 16.

[120] *Id.* at 16–22.

[121] *See* BROWN & SINGH, *supra* note 2, at 16; WHITE HOUSE OFF. OF TRADE AND MFG. POL'Y, *supra* note 112, at 4; *see also* OFF. OF THE U.S. TRADE REPRESENTATIVE, EXEC. OFF. OF THE PRESIDENT, FINDINGS OF THE INVESTIGATION INTO CHINA'S ACTS, POLICIES AND PRACTICES RELATED TO TECHNOLOGY TRANSFER, INTELLECTUAL PROPERTY, AND INNOVATION UNDER SECTION 301 OF THE TRADE ACT OF 1974 9 (2018), https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF [https://perma.cc/7MFT-EYLJ] (documenting the various ways China coerces intellectual property from U.S. Companies and intimidates and prevents those companies from asserting their intellectual property rights).

doing business in China.[122] A recent report on U.S. Department of Defense supply chain security tallied seven Chinese laws that compel disclosure of firms' technical information to the Chinese government or corporate partners.[123] An additional Chinese regulation in late 2019 forbade the use of secure internet networks, or virtual private networks ("VPNs"), commonly used by U.S. firms working in China to maintain the privacy and security of their information.[124] Not only are such networks banned, but the Chinese government concurrently announced that all internet traffic within the country would be monitored and mined using big data analytics.[125] A newly created national official shall oversee the data harvesting and analytics operation.[126] Whether the recent Phase I trade agreement has any impact on these practices and on the new regulation is unclear.

The Chinese also actively participate in U.S. consensus standards setting activities.[127] These mostly western-based organizations establish common technical interfaces between devices and common operating architectures.[128] Without such standards, computers would not be able to physically connect to

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[122] *See* TARA BEENY ET AL., SUPPLY CHAIN VULNERABILITIES FROM CHINA IN U.S. FEDERAL INFORMATION AND COMMUNICATIONS TECHNOLOGY 3 (2018), https://www.uscc.gov/sites/default/files/Research/Interos_Supply%20Chain%20Vulnerabilities%20from%20China%20in%20U.S.%20Federal%20ICT_final.pdf [https://perma.cc/AH46-EE93].

[123] *Id.* at 22.

[124] Steve Dickinson, *China's New Cybersecurity Program: No Place to Hide*, CHINA L. BLOG (Sept. 30, 2019), https://www.chinalawblog.com/2019/09/chinas-new-cybersecurity-program-no-place-to-hide.html [https://perma.cc/BHP9-7BCV].

[125] *Id.*

[126] *Id.*

[127] IPLYTICS, WHO IS LEADING THE 5G PATENT RACE? 4 (Nov. 2019), https://www.iplytics.com/wp-content/uploads/2019/01/Who-Leads-the-5G-Patent-Race_2019.pdf [https://perma.cc/ACQ8-YTWE] (documenting the top firms participating in telecommunications census standards, including the leading role of Chinese firms).

[128] MAUREEN A. BREITENBERG, THE ABC'S OF STANDARDS ACTIVITIES, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY 3–10 (2009), https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7614.pdf [https://perma.cc/3EUN-X5TZ].

monitors or logically transfer information to them for display. Consensus standards involve the participation of interested technology companies who share some details about their systems in hopes of influencing the resulting standards definition. Firms lucky enough to get their technology adopted as a standard might dominate the technological evolution of that interface and the resulting profits for years to come. The Chinese firm Huawei has the largest 5G patent portfolio, with the Chinese firm ZTE ranking fifth according to one recent report.[129] The top-ranked U.S. firm, Qualcomm, ranked seventh.[130]

In addition, China has promoted copying of American innovations by systemically devaluing the intellectual property rights of western entities. China recently bid to lead the World Intellectual Property Organization, a move widely regarded as placing the breadth and scope of the world's intellectual property portfolios at risk.[131] The country's penchant for filing immense numbers of patent applications may serve primarily as a basis to invalidate others' rights rather than a sincere desire to acquire such rights for themselves.[132] China has also devalued western intellectual

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[129] IPLYTICS, *supra* note 127. Note that these statistics are based on self-declarations, not confirmed standard essential patents.

[130] *Id. (*reporting that U.S. participation in 5G standard setting bodies is lower than that of competing firms with Qualcomm's level of attendance ranking fourth amongst all participants). Huawei had the largest attendance at standard setting meetings. *Id.* These numbers demonstrate that Chinese firms grasp the strategic importance of standard setting activities and also recognize that participation in those forums provides the legal means to both access and influence developing technologies. *Id.* Note that 5G standard essential patents ("SEP") declarations are self-reported, so actual SEP portfolios could differ greatly.

[131] Lynch, *supra* note 3.

[132] Under U.S. and other international patent laws, the prior publication of an invention in another country may serve to bar an inventor from obtaining patent protection on the same or similar invention in their own, home country. *See, e.g.,* 35 U.S.C. §§ 102, 103. Defensive publication, the preemptive publishing of knowledge as a means to prevent a competitor from obtaining patent rights, is a well-known business tactic. *See, e.g.,* Sara Boettiger & Cecilia Chi-Ham, *Defensive Publishing and the Public Domain*, *in* IPHANDBOOK OF BEST PRACTICES 879, 883 (2018), http://www.iphandbook.org/handbook/chPDFs/ch10/ipHandbook-Ch%2010%2001%20Boettiger-Chi-Ham%20Defensive%20Publishing.pdf [https://

property rights through restrictive laws on licensing. In particular, China limits the time a foreign rights holder has exclusive control over patented technology in domestic license agreements.[133] After expiration of the license, domestic firms are entitled to use licensed technology regardless of any residual intellectual property rights held by the licensor.[134] These activities do not constitute a direct technology transfer, but they do promote copying of American technology by neutering the legal protections surrounding it.

The White House labels the collection of China's technology transfer activities as "aggression."[135] Specifically, the White House notes that much of China's economic growth has been achieved through "aggressive" acts, policies, and practices that fall outside of global norms and rules (collectively, "economic aggression").[136] These technology transfer behaviors can be seen as a competitive strategy supporting China's grand political strategy, and not merely a form of market competition.

The sum of the aforementioned activities constitutes a particular form of competitive strategy targeting America's innovation ecosystem. This newly articulated doctrine, "Innovation Warfare," is defined as follows.

An executable competitive strategy:

a) Reflecting an innovation, intellectual property, and technology strategy articulated and executed by the state (e.g. China);
b) Using illegal means, political means, and legal economic activities—of the type previously residing solely in the province of commercial enterprise, to achieve the state's objectives;

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perma.cc/K4WM-K85P]; *4 Reasons Why Defensively Publishing Your Technical Disclosure is a Sound IP Strategy*, IP.COM, https://ip.com/blog/defensive-publishing-strategic-ip-strategy/ [https://perma.cc/SY4N-R7YY] (last visited Sept. 23, 2020).

[133] WHITE HOUSE OFF.OF MFG. AND TECH. POL'Y, *supra* note 111, at 7.

[134] *Id.*

[135] *Id*. at 1.

[136] *Id.*

c) Employing these economic and innovation activities to achieve both economic geopolitical power and to enhance military capabilities; and

d) Functioning as a military, national security, and defense doctrine not solely a reflection of the state's economic policy goals nor commercial competition in the ordinary course.

Innovation Warfare does not only threaten American jobs and economic prosperity. By simultaneously co-opting and weakening the innovation capabilities of the United States, China seeks to advance its rise to world power.[137] Over the course of history, there have been sixteen such times when one rising power sought to overtake an existing world power.[138] All but four of those historical events provoked armed conflict.[139] China's Innovation Warfare activities risk the type of economic and geopolitical aggression that were a root cause of two World Wars.[140]

China challenges and outright rejects the rules-based international economic order designed to keep the peace.[141] China's leadership sees these rules as "American" and made when the Chinese were not present at the table. China now seeks to rewrite these rules according to its desires.[142] China's rejection of rules-based economic principles, as embodied in the World Trade Organization ("WTO"), intellectual property treaties, and other agreements, is destabilizing.

China's prosecution of Innovation Warfare and its rejection of a rules-based order also poses an existential threat. A world where China dominates the technology landscape is not just about who earns the profits or prevails in an abstract geopolitical fight. China pursues a world in which economies are less free, less fair, and less likely to respect human dignity and freedoms, according to the

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[137] *See* WARD, *supra* note 1, at 95.
[138] ALLISON, *supra* note 1, at vii.
[139] *Id.*
[140] *Id.* at viii-xix, 67, Appendix 1.
[141] *See* MCINNIS & WEISS, *supra* note 102, at 1.
[142] *See* ALLISON, *supra* note 1, at 147.

National Security Strategy.[143] Chinese culture differs from American culture in profound ways.[144] Chinese internet and data mining products are not likely to embody American values of privacy and freedom of expression.[145] China already uses facial recognition technology, data mining, and other twenty-first century innovations to track and score its citizens' behaviors.[146] The Chinese government uses these measures to conform citizens' behaviors to a government-determined standard and to deny citizens who fail to conform freedoms and benefits.[147] Chinese companies were recently accused of inappropriately using backdoors built into telecommunications equipment to monitor the lives of people,

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[143] *See* THE WHITE HOUSE, *supra* note 8.

[144] SAMUEL HUNTINGTON, THE CLASH OF CIVILIZATIONS AND THE REMAKING OF WORLD ORDER 25, 223–25 (2003).

[145] Shaun Waterman, *Gary Shapiro Calls 5G 'Battleground' Between US and China*, VIA SATELLITE (Nov. 5, 2019), https://www.satellitetoday.com/innovation/2019/11/05/gary-shapiro-calls-5g-battleground-between-us-and-china/undefined [https://perma.cc/J6EA-MCRE]; SPALDING & KAUFMAN, *supra* note 1, at xii-xiv.

[146] Charlie Campbell, *How China Is Using "Social Credit Scores" to Reward and Punish Its Citizens*, TIME (2019), https://time.com/collection/davos-2019/5502592/china-social-credit-score/ [https://perma.cc/5Y5G-VF3N] (documenting a variety of tracking technologies, including facial recognition, and systems designed to create a complex reward and punishment system for Chinese citizens). While these efforts can be seen as a reflection of a culture wishing to stamp out disorder and fraud, as Campbell observes "they are undeniably intrusive." *Id.*

[147] *See* Louise Matsakis, *How the West Got China's Social Credit System Wrong,* WIRED (July 29, 2019, 3:35 PM), https://www.wired.com/story/china-social-credit-score-system/ [https://perma.cc/X7LU-GT5X] (arguing that initial reporting about the system was based on secondhand information and was intended "as a cautionary tale for" western uses of similar technologies). This updated reporting based on original language and better source reporting does, however, document a complicated interwoven system that can deny travel and other benefits. *Id*. As many as 13 million people are on the Supreme People's Court blacklist. *Id*. For a view of how Chinese citizens view the social credit system in the context of Chinese culture, see Xinyuan Wang, *Hundreds of Chinese Citizens Told Me What They Thought About the Controversial Social Credit System*, CONVERSATION (Dec. 17, 2019, 5:41 AM), http://theconversation.com/hundreds-of-chinese-citizens-told-me-what-they-thought-about-the-controversial-social-credit-system-127467 [https://perma.cc/DR8B-J65Z].

regardless of citizenship or location.[148] As the President and CEO of the Consumer Technology Association said in relation to the battle over telecommunications technology, "[o]ur children's standard of living, their way of life, will depend on how well we do . . . . [I]f we lose, we lose potentially, those other battles about who we are as a nation and our focus on individual liberty."[149] For at least each of these reasons, Innovation Warfare presents America with a threat against which it must defend itself.

V. THE NEED FOR A COMPREHENSIVE U.S. INNOVATION WARFARE COUNTERSTRATEGY

In recognition of the Innovation Warfare threat, defending the nation's innovation base against competitors became an element of the country's *National Security Strategy* in 2017.[150] A number of contemporary whitepapers and reports subsequently laid out thoughtful recommendations on how best to proceed.[151] Each of these reports, summarized below, concludes that the United States lacks a comprehensive counter-competitive strategy.[152] However,

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[148] *See* Bojan Pancevski, *U.S. Officials Say Huawei Can Covertly Access Telecom Networks*, WALL ST. J. (Feb. 12, 2020, 8:41 AM), https://www.wsj.com/articles/u-s-officials-say-huawei-can-covertly-access-telecom-networks-11581452256 [https://perma.cc/7D2H-H273] (describing Huawei's use of telecommunications backdoors to illicitly access private telecommunications traffic). The backdoors were put in place post-9/11 for use by law enforcement to conduct surveillance under warrant. Huawei denies the allegations. The U.S. claims to have proof. *Id.*

[149] Waterman, *supra* note 145 (speaking on the importance of 5G cellular technologies at DC5G).

[150] *See* WHITE HOUSE, *supra* note 8, at 21.

[151] *See* WARD, *supra* note 1, at 95.

[152] *See* BROWN & SINGH, *supra* note 2, at 4 ("The U.S. government does not have a holistic view of how fast this technology transfer is occurring, the level of Chinese investment in U.S. technology, or what technologies we should be protecting."); *see also* WARD, *supra* note 1, at xii (citing Admiral Scott Swift, U.S. Navy (Retired), on "the necessity of the United States to develop a grand strategy of its own"); JAMES MANYIK ET AL., COUNCIL ON FOREIGN REL., INDEPENDENT TASK FORCE REPORT NO. 77, INNOVATION AND NATIONAL SECURITY: KEEPING OUR EDGE 3 (2019), https://www.cfr.org/report/keeping-our-edge/pdf/TFR_Innovation_Strategy.pdf [https://perma.cc/6X4G-YXSW] (noting that

the aggregation of the many meritorious suggestions contained within these reports still does not yield a coherent grand counterstrategy.

Bradford Lee documented four distinct, but not mutually exclusive, categories of competitive strategies or counterstrategies, useful here for organizing and assessing the myriad of existing proposals for an Innovation Warfare response.[153] The categories have been rephrased slightly and adapted here for the Authors' purposes. The four counter-competitive strategies, as identified by Lee, are summarized as follows:

1) Denial: These strategies neutralize the impact of the competitor's strategy. Thus, even if the competitor executes the elements of their strategy successfully, their desired objective will not be achieved. In the context of Innovation Warfare, strategies that enhance America's innovation capabilities are an example of a denial strategy. Even if China's Innovation Warfare strategy executes as planned, America will simply outrun and outperform it in the innovation race. Other denial strategies thwart execution of the competitor's strategy. Review and approval of foreign investment by the Department of Treasury to prevent foreign ownership of critical American technologies is one example. To distinguish these two different forms of Innovation Warfare denial strategies, they have been renamed as: "Outperform" and "Thwart."
2) Cost Imposition: These strategies seek to impose consequences or ratchet up the costs for pursuing the competitive strategy such that the costs for pursuing the strategy negate the benefits. Trade wars and economic sanctions are the most common forms of cost imposition. In

"the government and the private sector must undertake a comprehensive and urgent response").

[153] *See* TAI MING CHEUNG & THOMAS MAHNKEN, THE GATHERING PACIFIC STORM: EMERGING US-CHINA STRATEGIC COMPETITION IN DEFENSE TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENT 20–23 (2018).

the context of Innovation Warfare, cost imposition strategies can include enforcement of intellectual property rights.

3) Co-opting the Competitor's Strategy: These strategies either leverage elements of the adversary's own strategy against them or induce the adversary to take actions that reduce the effectiveness of their strategy. For example, in the context of Innovation Warfare, the Chinese penchant for devaluing western intellectual property rights by publishing an extensive quantity of prior art documents also serves as a source of competitive intelligence about Chinese research activities.
4) Political Leverage: These strategies exploit or influence factors within an adversary's political system. Persuading the Chinese populace against intellectual property theft may prove difficult. In the context of Innovation Warfare, however, the political ecosystem is much broader and includes other nation states, trading partners, and international institutions.[154]

Table 1[155] summarizes the defensive countermeasures recommended by existing studies and whitepapers, organized by the type of counterstrategy employed

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[154] *Id.*

[155] MANYIKA ET AL., *supra* note 152; BROWN & SINGH, *supra* note 2; ATKINSON & EZELL, *supra* note 16; BRAD SMITH & CAROL ANN BROWNE, TOOLS AND WEAPONS: THE PROMISE AND THE PERIL OF THE DIGITAL AGE (2019); Letter from Kelvin K. Droegemeier, Dir., White House Off. of Sci. and Tech. Pol'y, to the U.S. Rsch. Cmty. (Sept. 16, 2019); *IP Attache Services*, USPTO https://www.uspto.gov/ip-policy/ip-attache-program/ip-attache-services [https://perma.cc/G55H-SYYX]; BEENY, *supra* note 122; *see also* DEP'T OF DEF., INDO-PACIFIC STRATEGY REPORT: PREPAREDNESS, PARTNERSHIP, AND PROMOTING A NETWORKED REGION (2019), https://media.defense.gov/2019/Jul/01/2002152311/-1/-1/1/DEPARTMENT-OF-DEFENSE-INDO-PACIFIC-STRATEGY-REPORT-2019.PDF [https://perma.cc/46ZX-M79F] (incorporating the National Defense Strategy and recommending the strengthening of economic partnerships in the region to counter Chinese influence); WHITE HOUSE, NATIONAL STRATEGY FOR CRITICAL AND EMERGING TECHNOLOGIES (Oct. 2017) [hereinafter WHITE HOUSE NATIONAL STRATEGY], https://www.whitehouse.gov/wp-content/ uploads/2020/10/National-Strategy-for-CET.pdf [https://perma.cc/9HU5-7RG6].

Table 1: Compilation of Existing Recommendations and Their Strategic Alignment

STRATEGY	STRATEGIC OBJECTIVE		TACTIC
	OUTPERFORM	Restore Federal R&D Funding	Increase funding to 1.1 % of GDP consistent with historical average
			Commit $20B to fund university research in critical technologies
			Executive branch initiatives & multi-stakeholder efforts to select & execute R&D on society wide and national security problems
			Office of Science and Technology Policy to use increases in federal R&D funding to sponsor AI research
		Attract and Educate a Science and Technology Workforce	Establish a 21st Century National Defense Education Act and other incentives to boost STEM pipeline
			Private- Public efforts to address under-representation of minorities in STEM fields
			Private-public efforts towards debt forgiveness for students in STEM fields
			Green cards for foreign nationals earning advanced STEM degrees
			Enable immigrants to live and work in US if they start a business
			Targeted efforts to prevent knowledge theft from universities
		Support Technology Adoption in the Defense Sector	Federal Agencies and DOD to devote between 0.5 and 1% of budgets to rapid technology integration
			Hire domain specialist deputy for integration of key technologies from outside government
			Establish new Digital Service Academy and ROTC programs for advanced technologies
			Enable rotations of private sector employees into government temporary assignments
			Drive IT adoption to levels seen in private sector throughout government
		Pro-growth and productivity enhancing policies	Create unified Innovation and Investment Tax credits for: workforce training, equipment and machinery; expand R&D tax credit
			Create a National Innovation Foundation to help establishments become more innovative and competitive
			Promote development and adoption of next generation wireless
			Establish industry consortiums for collaborative research
	THWART	Tighten and Enforce Existing U.S. Regulations	CFIUS reforms
			Continuously update and enforce export control laws
			Increased vigilance and awareness of university and faculty relationships
		Improve Cybersecurity Behaviors	Promote industry adoption of NIST cybersecurity best practices
			Govt. and industry cooperation in supply chain risk management processes and supply chain transparency
	COST IMPOSITION	Consequences for Violating International Agreements	Enforce more at WTO and create tax incentives for companies bringing cases
		Decrease Demand for Chinese Exports	Increased use of tariffs and enforcement of § 232 of the Trade Expansion Act of 1962 and §301
	POLITICAL LEVERAGE	Bolster Technology Alliances and Ecosystems	State and Treasury to create international technology alliance for use and control of emerging technologies
			Dept. of Commerce and major trading partners to develop common technology standards and free flow of data
			Dept. of Commerce to encourage American investment in emerging tech ecosystems overseas
			Executive agencies to form international cooperative research partnerships to apply frontier technologies to global challenges
			Increased utilization of USPTO IP Attaché Program and use of Technological Diplomats

The vast majority of recommended actions documented in Table 1 seek to outperform Chinese innovation accretion by improving the United States' own domestic innovation infrastructure and capabilities. Official White House documents on the topic include *A Strategy for American Innovation*, which has not been itemized in Table 1, but falls squarely in this camp and mirrors many of the recommendations of Table 1.[156] The most recent White House document, *National Strategy for Critical and Emerging Technologies*, articulates the goal of maintaining U.S. world leadership in critical and emerging technologies.[157] Attainment of this goal rests on two major pillars, the first of which clearly seeks to bolster the U.S. innovation ecosystem to outperform the Chinese ecosystem.[158] Data in Table 1 reflects key measures called for in the *National Strategy for Critical and Emerging Technologies*. Other than the Success Act, which aims to diversify the nation's pool of inventors, specific executable steps with measurable outcomes for pursuit initiatives in this category could not be identified.[159]

Some of the other categories of recommendations given in Table 1 have been implemented with varying degrees of success. The government appears to be proactively pursuing measures designed to directly thwart China's technology appropriation tactics. Treasury Department guidelines for review of foreign investments under the Committee on Foreign Investment in the United States ("CFIUS")

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[156] *See* NAT'L ECON. COUNCIL & OFF. OF SCI. & TECH. POL'Y, A STRATEGY FOR AMERICAN INNOVATION (2015), https://obamawhitehouse.archives.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf [https://perma.cc/JVU8-WPKP].

[157] *See generally* WHITE HOUSE NATIONAL STRATEGY, *supra* note 155.

[158] *Id.* at 2, 7.

[159] *See* Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018, Pub. L. No. 115-273, 132 Stat. 4158 (recognizing that "patents and intellectual property are important engines of innovation, invention, and economic growth," and that "there is a significant gap in the number of patents applied for and obtained by women and minorities."). The Act also directed the United States Patent Office and others to work to close this gap.

regulations were tightened in 2018.[160] These revised guidelines brought increased scrutiny of Chinese investments in critical and emerging technologies.[161] As a result, Chinese investment in U.S. firms fell eighty-three percent in 2018, from $29 billion to $5 billion in 2017, and from a previous high of $46 billion in 2016.[162]

The White House issued an open letter to the nation's research institutions in 2019.[163] This letter began a dialogue regarding Chinese efforts to acquire U.S. taxpayer-funded research via a variety of mechanisms, including direct sponsorship of U.S. faculty, placement of Chinese nationals at U.S. research institutions, student exchanges, and outright theft of research.[164] While the letter contained no specific directives, this initial dialogue undoubtedly raised institutional awareness of the matter. Subsequent to issuance of the letter, several institutions took action against researchers who failed to disclose their relationships with Chinese institutions.[165] The

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[160] *See* Foreign Investment Risk Review Modernization Act of 2018, Pub. L. No. 115-232, §§ 1701–28, 132 Stat. 2174, 540 (codified at 50 U.S.C. § 4656) (adding four new categories of review to the previous regulations: (i) purchase or lease of land proximate government facilities; (ii) investments that may provide access to certain nonpublic technical information of U.S. businesses; (iii) changes in foreign investor's rights resulting in control of a U.S. business; and (iv) any other transaction designed to circumvent CFIUS jurisdiction).

[161] *See id.*

[162] Paul Wisman, *China's Investment in US Drops 83% Amid Growing Mistrust*, ASSOCIATED PRESS (May 8, 2019), https://apnews.com/d3009cef73e24479ac53e8ad968effcd [https://perma.cc/DB5W-ECRY].

[163] *See* Droegemeier, *supra* note 155.

[164] *Id.*

[165] *See, e.g.,* Tara Law, *Emory University Fires 2 Neuroscientists Accused of Hiding Chinese Ties*, TIME (May 25, 2019, 3:44 PM), https://time.com/5596066/emory-fires-chinese-researchers/ [https://perma.cc/69UQ-3SXR]; Mike Zaveri, *Wary of Chinese Espionage, Houston Cancers Center Chose to Fire 3 Scientists*, N.Y. TIMES (Apr. 22, 2019), https://www.nytimes.com/2019/04/22/health/md-anderson-chinese-scientists.html [https://perma.cc/2A4X-LQXV]; Jeffrey Mervis, *NIH probe of foreign ties has led to undisclosed firings – and refunds from institutions*, SCI. (June 26, 2019, 5:10 PM), https://www.sciencemag.org/news/2019/06/nih-probe-foreign-ties-has-led-undisclosed-firings-and-refunds-institutions [https://perma.cc/3KE6-A6EL]; Press Release, Dep't. of Just., Harvard University Professor and Two Chinese Nationals Charged in Three Separate China Related Cases (Jan. 28, 2020), https://www.justice.gov/opa/pr/

National Defense Authorization Act for Fiscal Year 2020 also included several provisions designed to protect U.S. researchers from foreign influence and directed the Director of the Office of Science and Technology Policy to establish an interagency working group to further protect federally funded research from foreign interference.[166]

Of the remaining recommendations documented in Table 1, on which significant actions have been taken, the most notable is the current "trade war" resulting from the President's imposition of tariffs for national security reasons under Sections 232 and 301 of the Trade Expansion Act of 1962.[167] These tariffs were met with the imposition by China of tariffs on U.S. imports.[168] As of this writing, the U.S. Trade Representative has concluded "Phase I" of negotiations with China to cease the exchange of punitive tariffs.[169]

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harvard-university-professor-and-two-chinese-nationals-charged-three-separate-china-related [https://perma.cc/N8EF-7X3X].

[166] The National Defense Authorization Act for Fiscal Year 2020, Pub. L No. 116-92 §§ 228, 1746, 116 Stat. 1790-646 (2019), https://www.congress.gov/116/bills/s1790/BILLS-116s1790enr.pdf [https://perma.cc/2WKW-SMXQ] (directing the Secretary of Defense in Section 228 to carry out research on foreign malign influence operations in university research programs). Section 1746 of the Act states:

> The Director of the Office of Science and Technology Policy, acting through the National Science and Technology Council, in consultation with the National Security Advisor, shall establish or designate an interagency working group to coordinate activities to protect federally funded research and development from foreign interference, cyber-attacks, theft, or espionage and to develop common definitions and best practices for Federal science agencies and grantees, while accounting for the importance of the open exchange of ideas and international talent required for scientific progress and American leadership in science and technology.

Id. § 1746.

[167] WAYNE MORRISON, CONG. RSCH. SERV., RL33536, CHINA-U.S. TRADE ISSUES, 51–52 (July 30, 2018), https://fas.org/sgp/crs/row/RL33536.pdf [https://perma.cc/SFC4-RBH9]

[168] *Id.*

[169] *See What's in the U.S.-China 'phase one' Trade Deal*, REUTERS (Dec. 13, 2019), https://www.reuters.com/article/us-usa-trade-china-details-factbox/whats-in-the-u-s-china-phase-one-trade-deal-idUSKBN1YH2IL [https://perma.cc/TP43-69XP].

These negotiations struck an accord on agricultural trade and certain intellectual property matters, but left unresolved many of the necessary negotiations on key intellectual property and innovation issues at the root of China's Innovation Warfare strategy until "Phase II."[170] Specifically, the agreement does not appear to address the theft of intellectual property by Chinese companies.[171]

The *National Strategy for Critical and Emerging Technologies* also contains a smattering of additional political strategy measures.[172] Specifically, the document calls for increased communication with the private sector to raise public awareness and to enlist the cooperation and assistance of industry in guarding against innovation ecosystem vulnerabilities.[173] The document additionally lists initiatives that foster the incorporation of democratic norms and ideals into the innovation process via private sector and international alliances.[174] While a limited subset of the enumerated initiatives is described with specificity, most are simply aspirational.[175]

Not listed in Table 1 are the myriad of legislative initiatives, currently pending in Congress, intended to repulse the Innovation Warfare threat posed by China. The Authors' research reveals at least twenty such bills introduced by members of both parties, but as of yet, none have been taken up for vote or transmitted to the other chamber.[176] The majority of this pending legislation concerns the imposition of sanctions or penalties for intellectual property theft, or otherwise proposes restrictions on trade with certain entities.[177]

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[170] Rachel Layne, *Here's What's in the U.S.-China "Phase One" Trade Deal*, CBS NEWS (Dec. 16, 2019), https://www.cbsnews.com/news/us-china-trade-deal-heres-whats-in-the-us-china-phase-one-trade-deal/ [https://perma.cc/9K5F-9JR7].

[171] *Id.* (citing U.S. Trade Representative Robert Lighthizer).

[172] *See* WHITE HOUSE NATIONAL STRATEGY, *supra* note 155.

[173] *Id.* at 10.

[174] *Id.* at 7.

[175] *See id*.

[176] This research included a search of www.congress.gov for pending legislation and its status as of January 2020.

[177] *See, e.g.,* Preventing SBA Assistance from Going to China Act of 2019, S.75, 116th Cong. (2019); Telecommunications Denial Order Enforcement Act, S. 152, 116th Cong. (2019); Sanction Entities in China for Undermining Rules,

Congress recently heard testimony from the Department of Defense on its efforts to combat the threat from China, but, as of yet, no clear mandates for executable actions have emerged.[178]

Despite an attempt to organize existing recommendations and initiatives using the format suggested by Lee, current recommendations and pending legislative actions consist mostly of a list of meritorious, but loosely related tactics when viewed in totality. Prior white papers and reports nonetheless contain many constructive and worthwhile ideas that should be implemented. The *National Strategy for Critical and Emerging Technologies* is commendable for recognizing the need for a unified government approach.[179] This official policy document also does much to advance the formulation of a national Innovation Warfare counterstrategy by defining those critical technologies in which it is necessary to lead and those for which risks must simply be mitigated.[180] Yet, a significant number of the actions called for in support of those objectives lack particulars and remain ambiguous in scope and execution.[181] The viability of this strategy document past the current national election cycle is also uncertain. Thus, existing recommendations and initiatives, even when taken together, fail to define a comprehensive counterstrategy for three principal reasons:

1) Existing recommendations focus largely on boosting the nation's innovation capacity but infrequently establish broader objectives, measurable outcomes, or endpoints. This omission makes assessing strategic effectiveness difficult both because the desired end state is uncertain as well as because there are no feedback loops to assess progress against goals and make mid-course corrections.

Exploiting Intellectual Property Act of 2019, S.1092, 116th Cong. (2019); Zero Tolerance for Electronics Theft Act, H.R. 2841, 116th Cong. (2019).

[178] *See generally DOD's Role in Competing with China, Hearing before the Armed Servs. Comm.*, 116th Cong. (Jan. 15, 2020), https://armedservices.house.gov/2020/1/full-committee-hearing [https://perma.cc/L7T8-DCMD] (noting the Committee took testimony from three witnesses each of whom identified possible DoD roles).

[179] *See* WHITE HOUSE NATIONAL STRATEGY, *supra* note 155, at 1–2.

[180] *Id.* at 3–4.

[181] *See id.*

2) Existing reports and recommendations rest principally on refortifying the strength of the American innovation ecosystem and fail to recognize the value of choke points or control positions in securing needed innovation resources and in making progress along future innovation roadmaps. In particular, existing efforts underappreciate intellectual property as one form of control position, and underutilize intellectual property as an armament in the Innovation Warfare battlespace.
3) No allocation of roles and responsibilities exists. While some authors and official documents have called for a "whole of government approach," there is no discernable lead to coordinate the effort, no visible assignment of tasking, no sharing of information and resources, and no specified organizational design for executing upon the strategy.[182]

VI. CRAFTING AN INNOVATION WARFARE COUNTERSTRATEGY

The United States must urgently articulate and execute a defensive Innovation Warfare counterstrategy in view of the above findings. While the United States cannot be sure of the metes and bounds of the Chinese Innovation Warfare efforts, construction of the U.S. counterstrategy should be guided by certain core principles.

First, the United States acts as a nation that respects personal liberties and the rights of its people. Formulation and execution of an Innovation Warfare defense strategy do not equate to nationalism or xenophobic behaviors. Assessing the risk presented by individual foreign nationals is a totality of the circumstances evaluation that balances a free and open society against potential harms. In twenty-first century world where big data and analytics provide intelligence and competitive advantages to those in possession of it, the United States must establish and adhere to norms on its use while respecting individual freedoms and rights to privacy.

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[182] *See* BROWN & SINGH, *supra* note 2, at 3, 25*; see also* WARD, *supra* note 1, at xiv.

Second, the post-World War II economic order led to an international rules-based system of laws that are invaluable for avoiding armed conflict. Some may fairly criticize this liberal economic order as imperfect. However, an international system of rules-based trade is a means of peace. The Innovation Warfare competitive strategies run by China seek to undermine confidence in and alter the rules-based systems surrounding trade, innovation, and intellectual property.

These Innovation Warfare strategies are destabilizing. Although Innovation Warfare competitive strategies run by adversaries may have consequences as drastic as war, successful counterstrategies must both remain within the rules paradigm and avoid escalation ladders to armed conflict.

Third, Innovation Warfare counterstrategies should remain consistent with and support the *National Security Strategy* and the National Defense Strategy of the United States.

Fundamentally, at its core, Innovation Warfare is about seizing control of the technological future(s), thereby securing a dominant economic and security position from which to accomplish other geopolitical aims. In view of that central observation, the necessity for a coherent strategic response, and the principles articulated above, a four-step approach to crafting and executing the needed Innovation Warfare counterstrategy is proposed:

1) Future-Oriented Technology Intelligence – Develop machine learning tools to identify the possible technological futures and drive towards the preferred future(s);
2) Strategic Technology Development – Optimize and scope federal R&D spending to seed the innovations necessary to attain the preferred future(s);
3) Secure Technology Control Positions – Identify and secure control positions along the preferred future technology implementation path, including deploying and protecting intellectual property as an armament in the Innovation Warfare battlespace; and
4) Organize to Win – Develop cross-functional capabilities and inter-organizational coordination both within the government and across the public-private interface.

VII. THE ELEMENTS OF AN INNOVATION WARFARE COUNTERSTRATEGY

Seizing control of the technological future presupposes the satisfaction of several preconditions. First, one can identify the set of multiple possible future(s) that could possibly arise from the present state. Second, there exists some framework for assessing which of these alternative future(s) would be preferable over the others. Third, one possesses both the mechanisms and the means to drive towards and achieve the preferred future state(s). Fourth, one can organize to manage the attainment of each of these preconditions.

A. Future-Oriented Technology Intelligence – Identify Possible Technological Future(s) and Drive Towards the Preferred Technological Future(s)

One cannot seize control of the technological future(s) if one cannot see the evolution of potential future(s). Although the *National Strategy for Critical and Emerging Technologies* itemizes critical technologies in which the United States must lead, such lists are merely a grainy, low-resolution snapshot of current times.[183] The entity with the best and earliest intelligence about emerging technological trends and evolutions can most effectively optimize their innovation investments and gain an early lead in critical technology areas. The nation state with the most advanced and robust forecasting tool is the one likely to prevail in the Innovation Warfare competition.

Fortunately, this first precondition is no longer the stuff of fairy dust or expert opinions. Prior to 2005, little scholarship or development of analytic capabilities for technology prediction existed.[184] Companies wishing to lay out future strategic direction

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[183] *See* WHITE HOUSE NATIONAL STRATEGY, *supra* note 155, Annex (identifying a list of twenty technology areas); *see also* Memorandum from Russell T. Vought, Dir., Off. of Mgmt. and Budget, to The Heads of Executive Departments and Agencies 1 (Aug. 14, 2020), https://www.whitehouse.gov/wp-content/uploads/2020/08/M-20-29.pdf [https://perma.cc/7WE3-EPKR] (identifying five R&D budgetary positions).

[184] Katarzyna Halicka, *Main Concepts of Technology Analysis in the Light of the Literature on the Subject*, 182 PROCEDIA ENG'G 291, 292 (2017).

and technology roadmaps were the initial developers of, and still rely heavily on, these first-generation predictive techniques as a source of competitive intelligence.[185] These first-generation techniques depend almost exclusively on the analysis of patent and patent application databases. Two such tools employed during this early time period were backward/forward patent citation analysis and patent landscape, or contour mapping.[186]

Both of these early technology analysis methods remain widely used today.[187] These early methods, however, really only provide snapshots of the status quo from which a patenting entity's areas of technology investment and patenting strength relative to others can be inferred. These earlier methods are raised and explained here only to distinguish them from the advanced big data analytic

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[185] *See* Brian de Haaff, *8 Key Components of Technology Roadmaps*, HUFF POST (Dec. 6, 2017), https://www.huffpost.com/entry/8-key-components- of-techn_b_9413856 [https://perma.cc/7DYP-F7LF]; *see also* Eric P. Raciti, *IP Landscaping – Creating a Conceptual Fabric of Information*, FINNEGAN (June 2014), https://www.finnegan.com/en/insights/articles/ip-landscaping-creating-a-conceptual-fabric-of-information.html [https://perma.cc/GS5Z-QQEB] (advising clients on the strategic advantages of landscaping tools).

[186] Backward patent citation analysis examines the list of previously issued patents referred to by a patent examiner when evaluating whether an invention is patentable. Analysis of backward citations reveals concentrations of other inventors or companies working in similar technology areas. Forward patent citation analysis evaluates the number of times any given patent is cited elsewhere by others. An earlier patent cited by many later patents likely documents an important invention that served as the foundation for subsequent innovation. *See*, *e.g.*, M.M.S. Karki & Dr. K.S. Krishnan Road, *Patent Citation Analysis: A Policy Analysis Tool*, 19 WORLD PAT. INFO. 269, 271 (1997). Patent landscape analysis, provides a visual representation of clusters of patents organized by a common theme, such as assignee or subject matter. In the map, the higher the "terrain," the greater the concentration of patenting activity within that technology, the more similar the technology to others, the closer together their contours are horizontally spaced. *See, e.g.,* WORLD INTELL. PROP. ORG., GUIDELINES FOR PREPARING PATENT LANDSCAPE REPORTS 37–40 (2015), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_946.pdf [https://perma.cc/6ZSW -AF53].

[187] Jeffrey Kuhn, Kenneth Young & Alan Marco, *Patent Citations Reexamined,* 51 RAND J. OF ECON. 109, 109–111 (2020) (noting that although just a few patents generate the majority of subsequent citations, thereby possibly distorting analysis and limiting the usefulness of the tool, the tool remains viable); *see also* Raciti, *supra* note 185.

techniques currently under development, which form the focus of this discussion.

Advanced technology forecasting tools belong to a class of analytics known as Future-Oriented Technology Analysis ("FTA").[188] FTA is an umbrella concept spanning a range of tools used to analyze technology future(s) and their impacts.[189] FTA studies may be normative or exploratory.[190] Normative FTA starts from a preferred future and attempts to discern which actions would result in that future.[191] Explorative FTA focuses on forecasting several possible future(s) and then conducting additional analyses to assess the most probable or preferred future(s).[192] FTA concepts by themselves are not new, and the military and government have used scenario planning, SWOT analysis, the Delphi technique, and other first-generation FTA tools for more than fifty years in various fashions.[193]

What is new is the explosion in quantitative methods for FTA analysis enabled by big data and machine learning that make existing technology forecasting tools far more robust than the citation analysis, patent contour maps, and opinion-based methods of the past.[194] Recent techniques also differ from contemporary big

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[188] TUGRUL DAIM ET AL., ANTICIPATING FUTURE PATHWAYS THROUGH LARGE DATA ANALYSIS x–xi (2016).

[189] Helvio Jeronimo Junior et al., *Approaching Future-Oriented Technology Analysis Strategies in Knowledge Management Processes*, INT'L CONF. ON COMPUT. SUPPORTED COOP. WORK IN DESIGN (May 2019).

[190] *Id.*

[191] *Id.*

[192] *Id.*

[193] Daiane Ferrira, Carlos Eduardo Barbosa, Jonice Oliveira & Jano Moreira De Souza, *Analyzing the Collaborative Aspects of Future-Oriented Technology Analysis*, INT'L CONF. ON COMPUT. SUPPORTED COOP. WORK IN DESIGN (May 2016); *see Delphi Method*, RAND CORP., https://www.rand.org/topics/delphi-method.html [https://perma.cc/JKW6-GBBZ] (explaining the Delphi method, developed by the RAND Corporation in the 1950s was originally used to forecast the impact of technology on warfare using informed intuitive judgment).

[194] DAIM ET AL., *supra* note 188, at ix (noting the advancements in computational tools and the expansion of date sources beyond just patents and

data tools in their ability to extend the forecast interval for technology prediction.[195] State of the art FTA can theoretically analyze the current and immediate next stage of technology evolution while providing insights on successive generations.[196] Whereas earlier generation techniques might reveal one generation ahead, machine learning FTA tools can anticipate next generation "+n" evolutions in technology, wherein "n" represents the number of successive generations.[197]

Modern FTA toolsets encompass a variety of different methodologies, including technology data mining, technology roadmapping, competitive technical intelligence ("CTI") analysis, bibliographic analysis, and webographic analysis that process not only patent data, but also scientometric indicators, blogs, trademarks, corporate security filings, speeches, and other relevant databases.[198] Korean authors Changyong Lee *et al.* describe one example of such methods.[199] The method employed by Lee *et al.* analyzes patent application filings and uses neural networks to

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acknowledging the growing acceptance of these tools for use in future oriented analysis).

[195] Earlier generation patent contour mapping, for example, simply provides a current pictorial view of the existing patent landscape as it exists at a single moment in the present. *See* YI ZHANG ET AL., GENERATING COMPETITIVE TECHNICAL INTELLIGENCE USING TOPICAL ANALYSIS, PATENT CITATION ANALYSIS AND TERM CLUMPING ANALYSIS, ANTICIPATING FUTURE INNOVATION PATHWAYS THROUGH LARGE DATA ANALYSIS 156 ("Citation-based analysis has a fundamental limitation in that it underestimates the importance of contemporary patents and may not work in rapidly evolving industries where technology life cycles ("TFC") are increasingly short and too many new inventions are being patented throughout the world."); FTA by definition is "future oriented" and provides a variety of tools useful for identifying multiple possible technology futures. *Id.* at xi–xvi.

[196] ZHANG ET. AL., *supra* note 195, at 164–165 (identifying technology trajectories for technology and sub-technology over a generational time horizon spanning the years 1991 to 2014).

[197] The Authors each have knowledge of proprietary techniques on which this conclusion is based.

[198] *See* DAIM ET AL., *supra* note 188, at ix–xvi.

[199] *See* Changyong Lee et al., *Early Identification of Emerging Technologies: A Machine Learning Approach Using Multiple Patent Indicators*, 127 TECH. FORECASTING & SOC. CHANGE 291, 291–92 (2018).

identify emerging technologies at a very early stage.[200] Their method can additionally predict which of these emerging technologies is more likely than other similar emerging technologies to materialize as dominant over time.[201] In additional examples, Park *et al.* describe network analysis and time series models for predicting emerging technology.[202]

Numerous other quantitative methodologies exist.[203] Figure 7 diagrams one example of an FTA technique based on graphical network analysis. Figure 7, while heavily simplified, provides a basic explanation of how this method of explorative FTA works. In actual practice, the analysis can employ a wide array of databases beyond the patent databases shown in Figure 7. Extensive training and validation of the machine learning algorithms are necessary to produce valid results.

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[200] *Id*. at 292.

[201] *Id*.

[202] *See* Sang-Sung Park, Seung-Joo Lee, & Sunghae Jun, *A Network Analysis Model for Selecting Sustainable Technology*, 7 SUSTAINABILITY 13126, 13126 (2015) (describing a network analysis model useful for planning R&D and picking sustainable long-term technologies as a focus, with an analysis of Ford Motor Co.); Jong-Chan Kim, Joon-Hyuck Lee, Gab- Jo Kim, Sang-Sung Park, & Dong-Sick Jang, *Time Series Analysis of Patent Keywords for Forecasting Emerging Technology*, 3 KIPS TRANSACTIONS ON SOFTWARE & DATA ENG'G 355 (2014), https://doi.org/10.3745/KTSDE.2014.3.9.355 [https://perma.cc/9BKS-79YC] (describing the use of auto-regressive integrated moving averages ("ARIMA"), which is a statistical analysis technique that uses time series data to predict future trends and to forecast technology) (S. Kor.).

[203] For a relatively recent summary of advanced patent analytic methods, *see* Leonidas Aristodemou & Frank Tietze, *The State-of-the-Art on Intellectual Property Analytics (IPA): A Literature Review of Artificial Intelligence, Machine Learning and Deep Learning Methods for Analysing Intellectual Property (IP)*, 55 WORLD PAT. INFO. 37, 41 (2018); Jenny Sanchez-Torres & Ian Miles, *The Role of Future-Oriented Technology Analysis in e-Government: A Systemic Review*, 5 EUR. J. OF FUTURES RSCH. 1, 3 (2017).

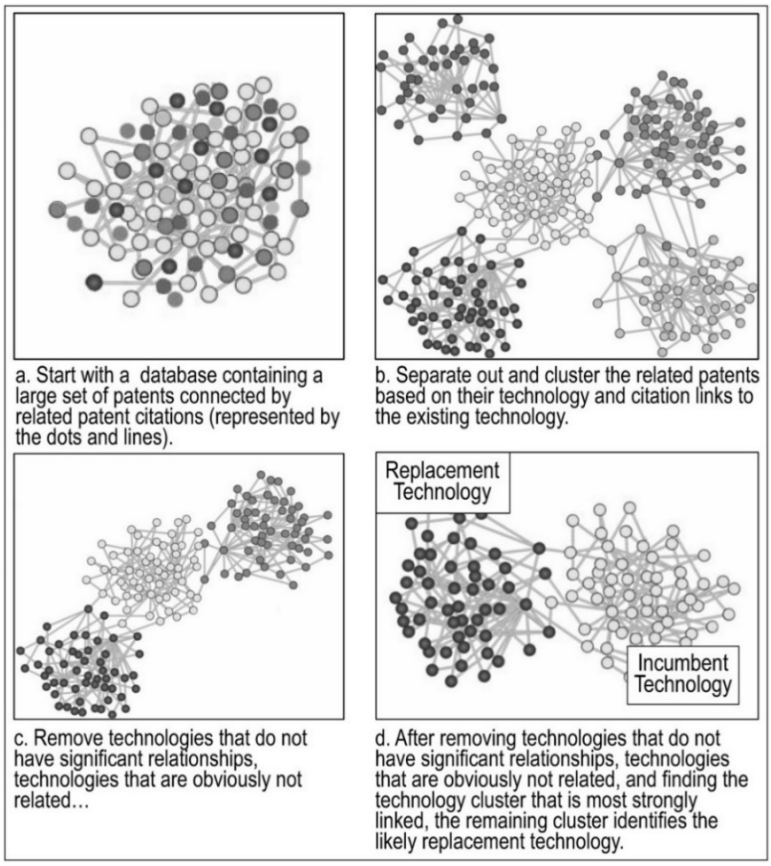

Figure 7. Simplified Example of a Graphical FTA Method[204]

A recent journal article revealed that Asia is leading in the application of machine learning to conduct FTA using patent data.[205] Chinese, Taiwanese, and Korean institutions hold the top ten spots in total number of research articles published on this topic.[206] So, it

[204] *See also* Park, Lee & Jun, *supra* note 202 (describing a graphical network methodology, as diagrammed in Figure 7, which begins with a data set for a specific technology in contrast with Park et al. that begins with a data set from within a company portfolio); Gabjo Kim & Jinwee Bae, *A Novel Approach to Forecast Promising Technology Through Patent Analysis*, 117 TECH. FORECASTING & SOC. CHANGE 228, 229 (2017).

[205] *See* Aristodemou & Tietze, *supra* note 203, at 39.

[206] *Id.* at 39–40.

is no surprise that China already possesses sophisticated FTA capabilities.[207] The newly passed regulation authorizing ubiquitous data mining of internet traffic and the elimination of domestic VPNs gives the Chinese a treasure trove of technology and business information to mine for this purpose.[208] The Chinese National Science Library offers several categories of FTA services for Chinese policymakers, research institutions, and Chinese companies.[209]

In contrast, the United States ranks fourth in FTA research, with U.S. authors comprising only eight percent of the research contributions to the FTA field.[210] A short review of publicly available information reveals that a significant amount of military technology forecasting still relies upon expert opinions, literature reviews, and direct intelligence.[211] While these methods remain valuable, they leave China and those with robust FTA capabilities in a better position to chart the innovation future. Only two Department of Defense organizations could be identified—the Office of Naval Research and the Defense Logistics Agency—with FTA tools under development.[212] These FTA tools utilize graphical

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[207] Xiwen Liu et al., *Combining Scientometrics and Patent-Metrics for CTI Service in R&D Decision-Making: Practices of Nation Science Library of CAS*, *in* ANTICIPATING FUTURE INNOVATION PATHWAYS THROUGH LARGE DATA ANALYSIS 321 (Tugrul U. Daim et al. eds., 2016).

[208] *See* Dickinson, *supra* note 124.

[209] *See* Liu et al., *supra* note 207, at 323.

[210] *See* Aristodemou & Tietze, *supra* note 203, at 40.

[211] *See, e.g.*, MICHAEL O'HANLON, FORECASTING CHANGE IN MILITARY TECHNOLOGY, 2020-2040 1–2 (2018), https://www.brookings.edu/wp-content/uploads/2018/09/FP_20181218_defense_advances_pt2.pdf [https://perma.cc/6Y9B-2X4U].

[212] *See* Dallas Rosson, Predicting Part Lifecycles Utilizing Machine Learning (2016) (Master's Thesis, University of Washington) (on file with author), https://www.researchgate.net/publication/315677947_PREDICTING_PART_LIFECYCLES_UTILIZING_MACHINE_LEARNING [https://perma.cc/29H3-G9TC]; Dennis Summers, *Network Representation and Visualization to Assess Obsolescence Issues*, DEF. MFG. & MATERIAL SHORTAGES CONF. (2015); MICHAEL S. NASH ET AL., INST. FOR DEF. ANALYSIS, A RESEARCH AND DEVELOPMENT INVESTMENT PORTFOLIO FOR DIMINISHING MANUFACTURING SOURCES AND MATERIAL SHORTAGES (June 2018), https://www.ida.org/-/media/feature/

network analyses of patent data and scientometric data to predict future technologies in the context of supply chain logistics and lifecycle management.[213] The Defense Advanced Research Projects Agency ("DARPA") has undertaken efforts to improve the computing infrastructure necessary to perform such analyses.[214] It could not be determined whether DARPA also has an FTA capability. A review of the *National Intelligence Strategy of the United States* did not unearth any discussion of FTA tools or reveal the use of such analyses in intelligence products.[215] A review of National Science Foundation funding reveals research in big data and information data science generally, but did not specifically

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publications/a/ar/a-research-and-development-investment-portfolio-for-diminishing-manufacturing-sources-and-material-shortages/d-9148.ashx [https://perma.cc/2UZ9-5MHY]. The fact that one could not identify machine learning FTA capabilities in other DOD Departments does not mean they do not exist, just that they were not searchable. The U.S. Air Force released an ambitious new science and technology strategy in April 2019. U.S. AIR FORCE, SCIENCE AND TECHNOLOGY STRATEGY: STRENGTHENING USAF SCIENCE AND TECHNOLOGY FOR 2030 AND BEYOND iii (2019), https://www.af.mil/Portals/1/documents/2019%20SAF%20story%20attachments/Air%20Force%20Science%20and%20Technology%20Strategy.pdf [https://perma.cc/C7YV-Y9T4] Within that strategy document, the Air Force states: "Instead of [reacting to others' advances and] looking where potential adversaries are heading, the Air Force scientific and technical enterprise will predict where adversaries cannot easily go and then ensure the Air Force gets there first." *Id*. Although this statement implies use of FTA capabilities, subsequent statements by Air Force officials suggest that no process yet exists to establish which kinds of programs these efforts might consist of, and that research decisions might be made after consultations with industry and stakeholders, indicating that FTA is not used in the decision making process. Jon Harper, *Air Force Unveils Long-Awaited S&T Strategy*, NAT'L DEF. (Apr. 17, 2019), https://www.nationaldefensemagazine.org/articles/2019/4/17/breaking-air-force-unveils-long-awaited-st-strategy [https://perma.cc/ 44S7-LQLD].

[213] NASH ET AL., *supra* note 212, at 2.

[214] *Extracting Insight from the Data Deluge Is a Hard-to-Do Must-Do,* DARPA (June 2, 2017), https://www.darpa.mil/news-events/2017-06-02 [https://perma.cc/JLB3-SWQM].

[215] *See generally* DANIEL R. COATS, U.S. INTEL. CMTY., NATIONAL INTELLIGENCE STRATEGY OF THE UNITED STATES OF AMERICA (2019), https://www.dni.gov/files/ODNI/ documents/National_Intelligence_Strategy_2019.pdf [https://perma.cc/92XM-T2NY].

reveal investment in the development of FTA tools of the type presently under discussion.[216]

The Navy and Defense Logistics Agency's tools are used to manage the lifecycles of existing military technology.[217] The Authors' research revealed no evidence that their FTA capabilities are coupled with R&D efforts in ways other than supply chain management and support of existing and near-term military platforms. Utilization of FTA insights in this manner is not inappropriate but is decoupled from execution of an Innovation Warfare counterstrategy, wherein the prediction of future strategic technologies has a broader national security purpose. Direct coupling of FTA results to other innovation and intellectual property management functions, such as patent acquisition, strategic planning, basic research priorities, or technology transfer goals, was not observed. Of the observed FTA capabilities, all were of the exploratory type, and none were of the normative type. Both types are valuable to Innovation Warfare countermeasures.

The United States, through the Department of Defense and/or the Director of Science and Technology within the Office of the Director of National Intelligence, must urgently fund and further develop both exploratory and normative FTA capabilities based on machine learning and big data mining toolsets.[218] The government

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[216] *Harnessing the Data Revolution,* NAT'L SCI. FOUND., https://www.nsf.gov/news/special_reports/big_ideas/harnessing.jsp [https://perma.cc/2HPJ-J4ZL] (identifying ten areas of primary focus for NSF research where one, "Harnessing the Data Revolution," focuses on improved education, development of necessary cyber and IT infrastructure, and basic research in information science). The Authors additionally reviewed the list of National Science Foundation ("NSF") awards given on the NSF website using a variety of search terms and by inspection of recently granted awards, and they were unable to identify any focused research in FTA tools.

[217] *See also* Rosson, *supra* note 212; Summers, *supra* note 212; *see generally* NASH ET AL., *supra* note 212 (reviewing publicly available research literature for Navy and Defense Logistics Agency tools yields works similar to the above all focused on lifecycle management; the fact the Authors' research did not identify other FTA tools and uses does not mean they do not exist, only that they are not currently published).

[218] 50 U.S.C. §§ 3030, 3191 (authorizing the Director of Science and Technology within the Office of the Director of National Intelligence to lead and fund scientific advances in intelligence gathering as well as the awarding of

must further design a mechanism for sharing and supplying the results of FTA as input to the government's Innovation Warfare strategic planning process. Much like in the aftermath of 9/11, where the government devised a way for agencies to share intelligence data about potential terrorist threats, the government should develop means for sharing the methodologies and the results of FTA intelligence across agencies.[219]

In addition, the United States government must devise a mechanism for making some form of FTA available to the private sector. The Chinese government routinely provides FTA services to its businesses and corporations, creating a significant competitive advantage for Chinese firms.[220] Specifically, the Chinese National Science Library helps Chinese technology-based firms improve their innovation capabilities, identify potential R&D partners, identify innovation pathways, and otherwise conduct "industrial technology and development strategizing."[221] These services are provided in "13 key scientific fields," although the literature fails to list those fields.[222]

As documented below, other precedents exist for government provision of technological competitive intelligence to the private sector, albeit with earlier generation tools. Many patent offices, including the Canadian and Scandinavian Patent Offices, routinely perform such analyses for their fellow government agencies and their constituent companies.[223] The Nordic Patent Institute, a

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educational grants for graduate studies in these areas); *Id.* § 3038 (authorizing the Secretary of Defense to allocate funds to satisfy the intelligence needs of the military as well as other departments and agencies).

[219] Intelligence Reform and Terrorism Prevention Act of 2004, Pub. L. No. 458, 118 Stat. 3638 (2004) (creating the Information Sharing Environment managed by the Office of the Director of National Intelligence upon the recommendations of the 9/11 Commission).

[220] *See* Liu et al., *supra* note 207, at 322–23.

[221] *Id.* at 321.

[222] *Id.* at 323.

[223] *See* Jonathan Calof, *Reflections on the Canadian Government in Competitive Intelligence – Programs and Impacts*, 19 FORESIGHT 1, 31–47 *(*Mar. 13, 2017); *see also* CANADIAN INTEL. PROP. OFFICE, PATENT LANDSCAPE REPORT: SHALE OIL AND GAS 2 (2016), https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/vwapj/Shale

combination of three Scandinavian Patent Offices, routinely offers their patent examiners time and expertise on a consulting basis to assist companies with a variety of issues.[224] The Singapore Patent Office has also started providing such a service to its companies.[225] The World Intellectual Property Organization, a United Nations organization, is mandated to provide patent landscape reports in specific technology fields to developing countries.[226]

Although the U.S. Patent Office makes complete patent datasets available for download, the Office does not make FTA tools or services available to private U.S. citizens and corporations.[227] On information and belief, the U.S. Patent Office does not provide such tools or analysis to the private sector, likely because first-generation tools are readily available for purchase in the marketplace. The Authors believe that unlike earlier generation analytic tools, the computing infrastructure, and data mining competencies required to perform modern FTA analysis make this capability unavailable to all but the most sophisticated and well-capitalized entities. There is little likelihood that sophisticated FTA tools will be available for purchase in the marketplace in a reasonable time period. The United States could consider licensing a less capable version of its FTA tools to a private firm for commercialization.[228] Until such time, significant competitive advantage accrues to Chinese firms with access to these enhanced FTA capabilities. One must be aware of

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-Oil-Gas-report-May-2017.pdf/$file/Shale-Oil-Gas-report-May-2017.pdf [https://perma.cc/CJA5-2RRG] (exemplifying an industry competitive patent analysis performed by a national patent office).

[224] *Nordic Experts in Global Prior Art Searching,* NORDIC PAT. INST., www.npi.int [https://perma.cc/6DJL-X3DY].

[225] *Growing Your Business with IP*, INTELL. PROP. OFF. OF SING., https://www.ipos.gov.sg/growing-your-business-with-ip [https://perma.cc/KWW3-JHFB].

[226] *Patent Landscape Reports*, WORLD INTELL. PROP. ORG., https://www.wipo.int/patentscope/en/programs/patent_landscapes/ [https://perma.cc/C8RR-YD34] (last visited Mar. 12, 2020).

[227] *Bulk Data Products*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/learning-and-resources/bulk-data-products [https://perma.cc/MF2H-N3FK] (last visited Feb. 21, 2020).

[228] 35 U.S.C. §§ 200–12 (encouraging the licensing of inventions arising from federally funded research).

the possible future(s) if one is to take the actions necessary to chart a course towards the preferred future and innovate competitively in both the government and private sector.

B. Strategic Technology Development – Optimize and Scope Federal R&D Spending to Seed the Innovations Necessary to Attain the Preferred Future

Innovation creates the products and services that transition a technological future from possibility to reality. One must invest in, and undertake, the R&D activities necessary to create the associated innovations in order to implement and drive towards a preferred technological future. Research and development are the engines of innovation.

The United States leads the world in R&D expenditures, but China is on pace to catch up.[229] Figure 8 compares the United States' total expenditures on R&D to the expenditures made by China and Europe. China made large and significant investments in R&D after 2001, with its total investment rapidly approaching the total R&D investment in the U.S. economy. In 2016, the magnitude of Chinese R&D investment in PPP dollars exceeded the combined R&D investment of all European Union countries.

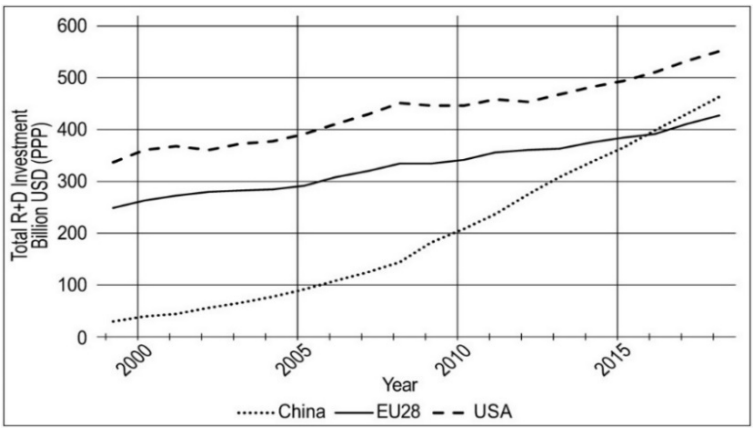

Figure 8. Total R&D Investment in Current PPP Dollars[230]

[229] Irwin, *supra* note 46.
[230] *See* COUNCIL ON COMPETITIVENESS, *supra* note 53.

The allocation of R&D investment dollars has increasingly shifted from the public to the private sector in the U.S. economy over the last several decades.[231]As seen in Figure 9, at its peak in 1966, federal R&D spending made up sixty-seven percent of the total expenditures on R&D in the economy. By 2018, this percentage had dropped to twenty-two percent.

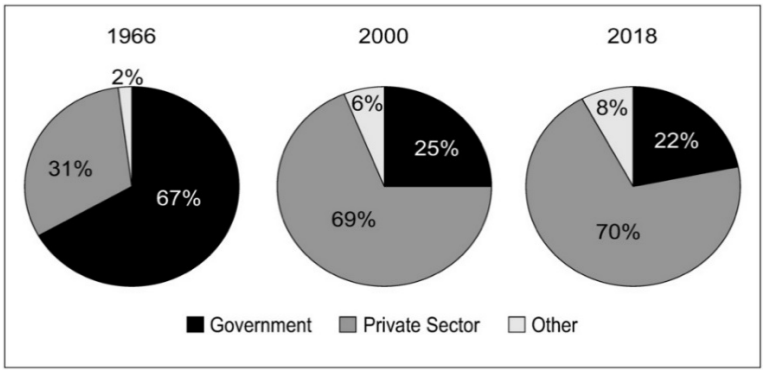

Figure 9. Changes in the Proportion of Federal and Private Sector R&D Expense[232]

The reallocation of R&D spending from the federal government to the private sector has many benefits, but also introduces some risks. These risks include the increased susceptibility of unhardened private sector facilities and information to unsanctioned access in a globally interconnected world.[233] These risks also include market failures which underproduce the type of innovations needed by the military. As with the space program, profit-driven firms may be less

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[231] JOHN F. SARGENT, JR., CONG. RSCH SERV., R44307, U.S. RESEARCH AND DEVELOPMENT FUNDING AND PERFORMANCE: FACT SHEET, 1–2 (2020), https://fas.org/sgp/crs/misc/R44307.pdf [https://perma.cc/HK8G-AXPJ].

[232] *Id.*

[233] Jeanne Suchodolski, *Cybersecurity of Autonomous Systems in the Transportation Sector: An Examination of Regulatory and Private Law Approaches with Recommendations for Needed Reforms*, 20 N.C. J. OF L. & TECH. 121, 130 (2018) (noting that cybersecurity issues must now be managed across a global logistics and supply chain; and additionally noting that shared service models and outsourcing introduces additional business security risks and vulnerabilities).

inclined to undertake fundamental, early-stage, or high-risk research of the type not likely to produce commercial products in a viable time frame.

Although federal R&D spending has increased in real dollars, as shown in Figure 10, federal funding, as a percentage of GDP, has steadily declined with the ending of the Cold War.[234] This "peace dividend" also coincided with the reallocation of the nation's research spending to the private sector.

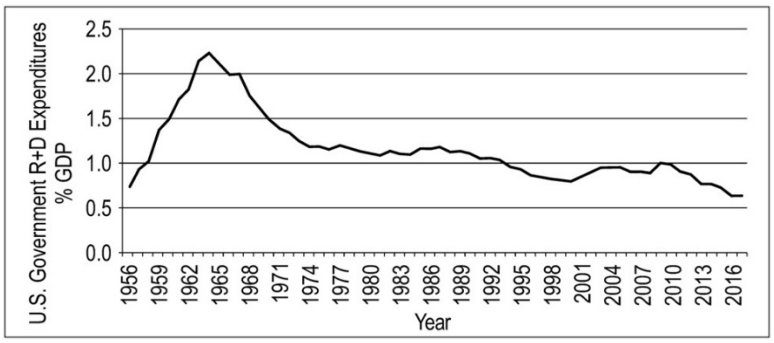

Figure 10. Federal R&D as a Share of GDP[235]

Federal R&D expenditures have had an influential effect on the pace of innovation in the economy.[236] Figure 11 illustrates this correlation. Even though total R&D spending continues to increase as a percentage of GDP, TFP has declined as federal spending has decreased.[237] While correlation does not equal causation, studies have shown that U.S. government research has been critical in the development of many of the technology revolutions of the twentieth

[234] NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS 2018 (2018), https://nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf [https://perma.cc/8W9H-UPRE].

[235] *Id.*

[236] MARIANA MAZZUCATO, THE ENTREPRENEURIAL STATE: DEBUNKING PRIVATE VS. PUBLIC SECTOR MYTHS 68–70 (2013), https://nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf [https://perma.cc/BA57-RCQ3].

[237] Data compiled from National Science Board and Bureau of Labor and Statistics.

century.[238] One study indicated that approximately thirty percent of all granted U.S. patents derive from federally funded research.[239]

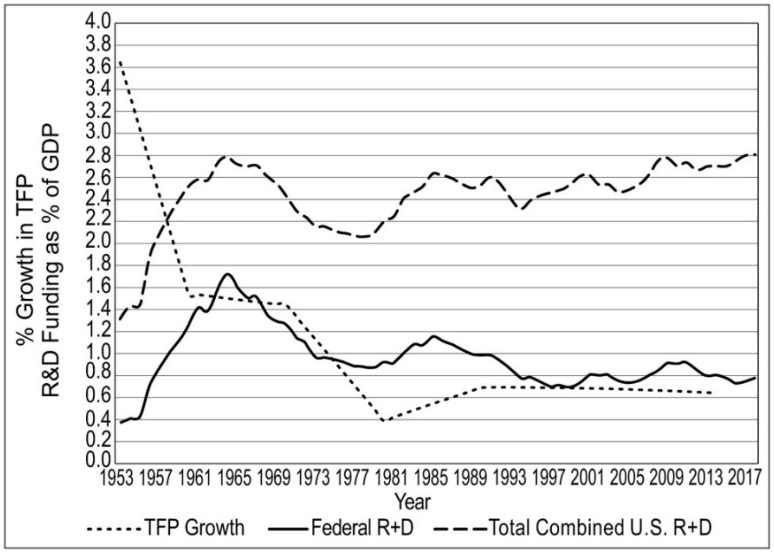

Figure 11. TFP relative to federal R&D and total R&D expenditures[240]

Evidence of the importance of the state's role in innovation goes beyond financing basic research. The state's role additionally includes the financing of applied research and the development of markets in fundamental new areas such as: IT, semiconductors, space, nanotech, alternative energy, and medicine through DARPA, ARPA-E, NIH, SFIR, orphan drugs, etc.[241] The Apollo Program not only put a man on the moon, but it financed an era of U.S. technological superiority.[242] The government has the unique ability

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[238] *See*, *e.g.,* MAZZUCATO, *supra* note 236.

[239] L. Flemming et al., *Government-Funded Research Increasingly Fuels Innovation*, 364 SCI. 1139, 1139–41 (2019).

[240] Data compiled from National Science Board and Bureau of Labor and Statistics.

[241] *See* MAZZUCATO, *supra* note 236, at 79–90.

[242] Robert Gallagher, *How the Apollo Program Produced Economic Wealth*, 14 EIR 24, 24–29 (1987). *But see* Erika K. Carlson, *Apollo Boosted the Economy, Just Not the Way You Think*, ASTRONOMY (May 31, 2019),

to invest in early-stage technology areas that might otherwise constitute too speculative a financial undertaking for a private firm.[243] Preliminary development of early-stage technologies, up to the point where private actors can invest, apportions innovation risk and innovation labor in an economically efficient way.[244]

Additionally, U.S. research grants and investments have been instrumental in building public-private partnerships, and the corresponding formation of geographic concentrations of specialized innovation expertise.[245] Federal Cold War-era spending on research concentrated research dollars at a few major universities, thereby seeding the formation of innovation clusters in Silicon Valley, Boston's Route 128, and Austin, Texas.[246] Examples from Silicon Valley alone abound. The research that led to Google was federally funded.[247] Apple's iPhone relied on key technologies created using federal funding.[248]

Investments in federal R&D spending are, therefore, critical to add capacity to America's overall innovation and R&D efforts and to outperform Chinese spending on R&D innovation along future

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https://astronomy.com/news/2019/05/apollo-boosted-the-economy-just-not-the-way-you-think [https://perma.cc/53XZ-RTZA] (documenting an ongoing research project by academics Alexander Whalley and Shawn Kantor to assess the economic impact of the Apollo Program).

[243] *See* MAZZUCATO, *supra* note 236 at 63–70.

[244] *Id.*

[245] *See also* Mazzucato, *supra* note 236, at 101; *see generally* STATE OF INNOVATION: THE U.S. GOVERNMENT'S ROLE IN TECHNOLOGY DEVELOPMENT (Fred L. Block & Matthew R. Keller eds., Paradigm Publishers 2011) (finding that between 1971-2006, 88% of the most important innovations—as rated by R&D Magazine's annual awards—have been dependent on federal research support).

[246] *See* O'MARA, *supra* note 25, at 93–103.

[247] Nafeez Ahmed, *How the CIA Made Google, part 1*, MEDIUM INSURGE INTELL. (Jan. 22, 2015), https://medium.com/insurge-intelligence/how-the-cia-made-google-e836451a959e [https://perma.cc/VW22-4XRZ] (noting that what eventually became Google's search engine was in part funded by National Science Foundation grants from the Digital Library Initiative).

[248] *See* MAZZUCATO, *supra* note 236, at 93–103.

technology trajectories.[249] Reliance on increased private sector spending is insufficient to ensure investment in early-stage and emerging technologies and to ensure America has a position on the technology roadmaps of the future. A reexamination of the recommendations in Table 1 reveals a strong consensus on this point, with more than half of the total recommendations advocating for an expansion of the country's R&D capacity. Agencies and Departments should allocate between 0.5% and 1% of their budgets to research in those technology areas relevant to securing the preferred technology future(s) whether via direct research or via research grant programs.

R&D investments by the Department of Defense are particularly impactful. Figure 12 diagrams the current allocation of federal R&D funds. The Department of Defense funds nearly half of all federal research, hence its research programs are not only vital to advancing the technological superiority of the military, but also to underwriting research in key technology areas for the economy as a whole.

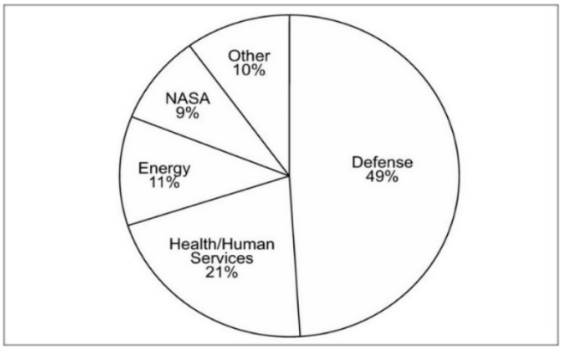

Figure 12. 2019 Federal R&D Expenditures[250]

[249] *DOD's Role in Competing with China: Testimony before the House Armed Servs. Comm.*, 116th Cong. 3–4 (Jan. 15, 2020) (statement of Michele A. Flournoy, Former Undersecretary of Defense for Policy), https://armedservices.house.gov/_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAEDA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf [https://perma.cc/VLP5-D2JU].

[250] OFF. OF MGMT. & BUDGET, EXEC. OFF. OF THE PRESIDENT, FY 2020 BUDGET CHAPTER 21 (2019), https://www.whitehouse.gov/wp-content/uploads/2019/03/

Despite this reality, a recent study showed Department of Defense R&D spending fails to fully align with the emerging technologies prioritized by the National Defense Strategy.[251] The Department of Defense has yet to make serious commitments to investing in those key technologies.[252] Recently, the White House issued guidance to the heads of Executive Departments and Agencies, including the Department of Defense, directing specific actions to remedy this state of affairs.[253] In a Memorandum dated August 2020, the Director of the Office of Management and Budget defined R&D budget priorities for fiscal year 2022.[254] The Memorandum identified five R&D spending priorities and four supporting actions Agencies must fund in the coming budgetary cycle.[255]

Even when the Department of Defense does expend funds on prioritized technology areas, fifty-nine percent of those funds go to just ten contractors.[256] These ten contractors consist of the usual defense industry specialists, as shown in Table 2. While these defense industry partners no doubt have immense capabilities, such spending patterns are not likely to generate new economic clusters of expertise. These spending patterns also limit the military's access to innovations of the type generated by young start-ups and entrepreneurial firms. There exists a need to diversify R&D spending

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ap_21_research-fy2020.pdf [https://perma.cc/DBS8-TX7N] **(**calculating numbers in chart based on tabulated amounts).

[251] GOVINI, AMERICA'S ERODING TECHNICAL ADVANTAGE: NATIONAL DEFENSE STRATEGY RDT&E PRIORITIES IN AN ERA OF GREAT-POWER COMPETITION WITH CHINA 3 (2020) https://www.govini.com/wp-content/uploads/2020/01/Govini_NDS-RDTE-Priorities-1.pdf [https://perma.cc/99TF-EUYR].

[252] *See DOD's Role in Competing with China: Testimony before the House Armed Servs. Comm.*, 116th Cong. 6 (Jan. 15, 2020) (statement of Andrew Hunter, Director, Defense-Industrial Initiatives Group and Senior Fellow, International Security Program, CSIS), https://armedservices.house.gov/_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAEDA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf **[**https://perma.cc/VLP5-D2JU**]**.

[253] *See* VOUGHT, *supra* note 183 (directing agencies to prioritize spending in five key research areas and expanding those areas to include public health).

[254] *Id.* at 2.

[255] *Id.*

[256] GOVINI, *supra* note 251.

to access early-stage technologies at less traditional firms.[257] The White House appears to have recognized this fact since the *National Strategy for Critical and Emerging Technologies* advocates for increased collaboration with the private sector and academia, as well as a stated willingness to leverage private capital and expertise to maintain the national security innovation base.[258]

Table 2: Top Ten Firms Receiving DOD Funding for Research in Key Technology Areas[259]

Contractor									
Lockheed Martin	Raytheon	Northrup Grumman	Boeing	General Dynamics	Bechtel	MIT	Analytic Services	BAE	Mitre

A robust Innovation Warfare strategy consistently aligns government R&D spending, particularly Department of Defense R&D spending, with the preferred technological future(s). Accomplishing this task requires a strong focus on technology governance and means for continuously evaluating the capabilities and effectiveness of the R&D machinery. Application of FTA toolsets can be especially helpful in constructing feedback loops to assess R&D performance and infrastructure needs.[260] Figure 13 diagrams these feedback loops. These feedback loops can assess whether sufficient innovation activity is occurring along the preferred technology roadmaps or whether additional funding or emphasis areas are needed to maintain progress along the desired course. For example, for those critical technologies identified by the

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[257] *Id.; see also* James Serbu, *Navy Picks 5 Sites for 'tech bridges' to Push Fleet Innovation*, FED. NEWS NETWORK (Sept. 5, 2019) https://federalnewsnetwork.com/navy/2019/09/navy-picks-5-sites-for-tech-bridges-to-push-fleet-innovation/ [https://perma.cc/9QFL-P5Y7] (describing Navy initiatives to identify and partner with nontraditional sources of innovation). In the Authors' experience, many firms, including some large tech companies, lack familiarity with federal contracting and view the overhead burdensome, leaving the Department of Defense with limited visibility into and limited access to the innovations created by such firms.

[258] WHITE HOUSE NATIONAL STRATEGY, *supra* note 155, at 7.

[259] GOVINI, *supra* note 251, at 18 (Figure 12).

[260] *See* JEFFREY ALEXANDER ET. AL, BIG DATA AND THE FUTURE OF R&D MANAGEMENT: A PRIMER ON BIG DATA FOR INNOVATION 14–15 (2017).

National Strategy for Critical and Emerging Technologies, as technologies in which the United States must lead, the feedback loops in Figure 13 can assist in tracking relevant innovation activity against the goal. These feedback loops are also useful for evaluating the strength and performance of the innovation infrastructure and R&D ecosystem. In particular, FTA tools can help identify R&D partners, detect concentrations of prolific inventors, assess human capital and education needs, and evaluate overall capabilities in the context of prioritized critical technology fields.

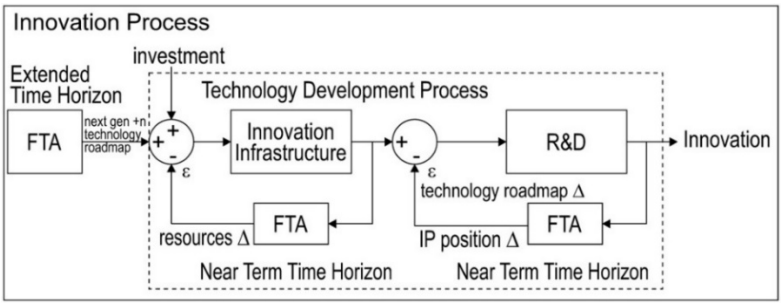

Figure 13. Feedback and Control Loops for Innovation Process Optimization

The United States is a free market economy with a bias towards believing actions taken freely within that economy will naturally produce optimum results. Advocating for proactive management and measurement of federal R&D spending to achieve a preferred future(s) does not equate to advocating for top-down central planning of the economy. Rather, proactive management of federal R&D spending should include mechanisms that couple federal research investment to Innovation Warfare strategy. Tracking the effectiveness of those investments in creating the innovations that implement the preferred technological future(s) provides situational awareness and the insight to adjust course as necessary.

C. Secure Technology Control Position – Intellectual Property as an Armament of Innovation Warfare

Seizing the preferred technological future(s) goes beyond defining and acquiring the innovations needed to implement it. Seizing the preferred technological future(s) also means influencing

others to accept or support the attainment of that future in lieu of a less preferred alternative future(s). In private industry, commercial entities are well versed at utilizing multiple forms of control positions to gain and hold a strategic advantage over competitors, as each competes for future markets.[261] These control positions include first-mover advantages, economies of scale, superior distribution networks, preferential positions in the supply chain, and intellectual property.[262] On a national scale, control positions might include acquiring a monopoly or sole access to a key resource such as helium, sand, or subject matter experts.[263] There are multiple forms and types of control positions useful for safeguarding and securing the ability to influence others in the adoption and attainment of a preferred technological future(s). Each has value and importance in Innovation Warfare, but the following discussion is limited to just a single type: intellectual property.

Intellectual property is a useful concept for the development of technology-based control positions.[264] Intellectual property exists at the intersection of technology and the set of possible control

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[261] *See, e.g.,* MICHAEL PORTER, COMPETITIVE ADVANTAGE 11–15 (1985).

[262] *Id.*

[263] *See* Carmen Chappell & Jordan Smith, *The Worldwide Helium Shortage Affects Everything from MRIs to Rockets— Here's Why*, CNBC (June 21, 2019) https://www.cnbc.com/2019/06/21/helium-shortage-why-the-worlds-supply-is-drying-up.html **[**https://perma.cc/5MXM-HYTQ**]** (stating that the United States controls most of the world's helium supply); *see also* Vince Beiser, *He Who Controls the Sand: The Mining 'Mafias' Killing Each Other to Build Cities*, GUARDIAN (Feb. 28, 2017) https://www.theguardian.com/cities/2017/feb/28/sand-mafias-killing-each-other-build-cities [https://perma.cc/YK8W-WE97] (describing how sand is a critical resource in cement—a necessity in building construction—and spurring a mad race to dominate sand distribution and supply); *see also* Danny Lewis, *Why the U.S. Government Brought Nazi Scientists to America After World War II*, SMITHSONIAN MAG. (Nov. 16, 2016) https://www.smithsonianmag.com/smart-news/why-us-government-brought-nazi-scientists-america-after-world-war-ii-180961110/ [https://perma.cc/9KXM-7RBQ**]** (describing why 88 Nazi scientists were brought to America so that the U.S. could acquire German technology but also to prevent the Soviets from acquiring the scientists).

[264] *See* ULF PETRUSSON, RESEARCH AND UTILIZATION 390 (2016) (describing the mapping of intellectual property-based control positions in the technology context).

positions, as diagrammed in Figure 14. Properly wielded intellectual property can be a powerful mechanism with which to ensure the desired technological future is attained.

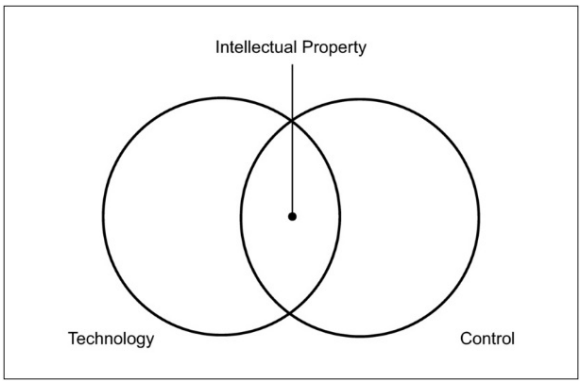

Figure 14. Intellectual Property Exists at the Intersection of Technology and Control Positions

There are multiple forms of intellectual property, and each is useful for protecting different aspects of innovations.[265] All forms of intellectual property possess value as a means to prevent others from using innovation without permission. Patents are the strongest and most familiar of these intellectual property rights and are commonly used to build technology-based control positions.[266] Although the

[265] Copyrights protect written works, software code and databases. *See* 17 U.S.C. §§ 101–1332. Trademarks protect avatars, comic book characters, and business names. Performance rights protect musicians' recorded works. *See* 17 U.S.C. §§ 114. And, patents protect useful and novel inventions. 35 U.S.C. §§ 100–101. The precise scope and legal definition vary by country, but international treaties provide for some minimum commonality and protection standards. *See* Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994). In some jurisdictions, additional forms of intellectual property exist. In the United States, for example, trade secret rights protect company proprietary information, such as the formula for Coca-Cola that derives its value precisely from the fact that the formula remains private. *See* 18 U.S.C. §§ 1836, 1839. Not all countries have trade secret rights.

[266] *See* SUZANNE S. HARRISON & PATRICK H. SULLIVAN, EDISON IN THE BOARDROOM REVISITED 30–33 (2011)

following discussion is further limited to patents, the concepts and principles described apply to all categories of intellectual property.

Patents help innovative entities straddle the dimension of time. Savvy entities protect innovation value streams both in the present and in the future via a portfolio of patents. Many leaders think of intellectual property, and patents in particular, as simply a necessary defensive expenditure.[267] But experienced leaders realize that intellectual property is a type of real option that connects current R&D investments to future benefits inclusive of the ability to control and manage outcomes at a later point in time.[268] The difference between these two points of view is significant.

Under U.S. law, a patent is a right to exclude others from making, using, or selling the patented invention.[269] These rights mean that others must have the patent owner's permission to practice the invention claimed in the patent. Therefore, the patent owner "controls" how the patented technology is to be utilized and holds the option to exercise that right throughout the life of the patent. Patents are, therefore, real options on control positions, or simply for ease of discussion, control positions.[270]

The real option nature of patents, however, nonetheless provides key insights on their optimum use as control positions. Entities file patent applications hopeful that the resulting patent may prove to be of some use or value in the future.[271] Often one or more of these future anticipated uses of a patent, such as licensing, technology transfer, influencing standards-setting or other technology adoption,

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[267] *Id.*

[268] *Id.*

[269] 35 U.S.C. § 271(a).

[270] *See generally* Eduardo Schwartz, *Patents and R&D as Real Options* (Nat'l Bureau of Econ. Rsch., Working Paper No. 10114, 2003), https://www.nber.org/system/files/working_papers/w10114/w10114.pdf [https://perma.cc/P884-888A] (developing a "simulation approach to value patents and patent-protected R&D projects based on the Real Options approach"); PHILIPP N. BAECKER, REAL OPTIONS AND INTELLECTUAL PROPERTY: CAPITAL BUDGETING UNDER IMPERFECT PATENT PROTECTION (2007) (describing the use and management of a portfolio of patents as real options on R&D investments).

[271] *See* HARRISON & SULLIVAN, *supra* note 266.

or stopping infringement, fails to materialize.[272] In such a case, the patent option is null. But, if one of these uses were to come about, the patent option is "called" and the patent often assumes a significant amount of value through that use.[273] That value, or future return, varies depending on the precise use and may not materialize at all.[274] Thus, not all patents are equally valuable. Entities, therefore, try to file as many patents to obtain as many options to assert a control position in the future as possible.[275]

The first and most obvious means of using patents as control positions is to obtain them at all. Every such control position a U.S. entity obtains is one that its adversaries do not obtain. In the context of Innovation Warfare, patents can be used to own and control relevant technology future(s) for U.S. interests. Either a U.S. company can own and control a relevant patent asset, or the U.S. government can own and control the patent asset. In either scenario, a U.S. entity, not an adversary, owns and controls the patent asset.

Patent portfolio size need not, however, be unbounded. Nor, does there exist a magic number to own. In the Authors' experience, different industries and technologies utilize patents differently. For this reason, caution must be exercised when attempting to establish a desired number of patent assets solely by reference to the size of the R&D investment. The right number of patents, or control positions, to own is both a statistical and financial question. In an ideal world, an entity wants to own enough patents so that when they reach into their portfolio in response to a given scenario, they would be statistically likely to find an executable option. Realistically, the size of the portfolio becomes limited by the financial costs of acquiring it and maintaining it.

In Innovation Warfare, the strategic objective for acquiring patents can be more precise, and hence more precision can be obtained in defining, scoping, and evaluating the portfolio, by coupling the patent acquisition efforts to the FTA and R&D

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[272] *Id.*
[273] *Id.*
[274] *Id.*
[275] *Id.*

initiatives previously described. White space is often defined as the emergent technological areas just beginning to be populated by inventions.[276] By patenting in white space areas, one begins to own and control the technological future. From the previous discussion of the FTA analysis, one can see that FTA serves as a sophisticated and systematic means to chart white spaces of strategic interest. From the previous discussion of R&D investments, one can see the federal government, and in particular the Department of Defense, has an outsized role in funding the research likely to generate inventions in these strategic white space areas. Thus, the federal government, and in particular the Department of Defense, plays an important role in securing the patent control positions most relevant to an Innovation Warfare counterstrategy.

Table 3 lists, by Agencies, the approximate number of patents acquired by the U.S. government in 2019. The number of overseas patents applied for and issued to the United States is not given in Table 3. Agencies who originate patent applications do not also always possess the authority to file and prosecute patent applications overseas.[277] These Agencies make recommendations to the Department of Commerce, which then files such cases in appropriate jurisdictions as desired.[278] The totals provided in Table 3 are consistent with yearly totals for the previous five years. The Department of Defense receives more than half of all government patents, and the Navy receives the largest percentage of these. In light of this discussion and the proposals to follow, government agencies, and especially the Department of Defense, may wish to reevaluate and recommit to patenting activity.

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[276] As practitioners in this area the Authors have relayed their understanding of the use of this term from their professional experience.

[277] 3 C.F.R. §§ 1943–1948 Comp. 651–52 (2020) (stating that all government departments and agencies who acquire title to inventions shall inform the Department of Commerce; and the Department of Commerce shall determine whether, and in what foreign jurisdictions the United States shall file foreign patent applications).

[278] *Id.*

Table 3: Approximate Number of Patents Issued to U.S. Government 2019[279]

	DOD			Other			
	Army	Navy	Air Force	DOE	NASA	DHS	Other
Issued Patents	160	351	58	20	45	9	426
Totals	569			500			
Total U.S. Government	1069						

In an Innovation Warfare race with China to secure control positions on the technological future, a numbers game is being played over time. Chinese nationals currently file more patent applications than nationals of any other country.[280] According to a recent study, "[i]f women, minorities, and children from low-income families were to invent at the same rate as white men from high-income (top twenty percent) families, the rate of innovation in America would quadruple."[281] In recognition of this fact, Congress passed the Success Act in 2018 to promote the inclusion of underutilized groups, specifically women, minorities, and veterans, into the invention and patenting process.[282] Veterans comprise approximately forty-seven percent of the civilian workforce at the Department of Defense.[283] For this additional reason, the Department of Defense may have significant opportunities to expand its patenting activities. Acquiring patents and putting control position options into U.S. hands and away from adversaries is, by itself, a win for the United States.

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[279] The numbers provided in Table 3 were generated from an assignee search of the U.S. Patent Office database using online search tools and are believed approximate but representative of the actual numbers.

[280] WORLD INTELL. PROP. ORG., WIPO FACTS AND FIGURES 2019 12 (2019), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_943_2019.pdf [https://perma.cc/KZQ9-2VA3].

[281] Alex Bell et al., *Who Becomes an Inventor in America? The Importance of Exposure to Innovation*, 134 Q. J. ECON. 647, 653 (2018).

[282] Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018, Pub. L. No. 115-273, § 3, 132 Stat. 4158.

[283] U.S. OFF. OF PERS. MGMT., EMPLOYMENT OF VETERANS IN THE FEDERAL EXECUTIVE BRANCH FISCAL YEAR 2014 3 (2015), https://www.fedshirevets.gov/veterans-council/veteran-employment-data/employment-of-veterans-in-the-federal-executive-branch-fy2014.pdf [https://perma.cc/5YA6-KX6A].

Once obtained, a variety of tactics exist to exercise the option on and to extract strategic advantage from patents. Licensing is one such tactic. For a myriad of reasons, this avenue has the greatest promise in an Innovation Warfare context. Specifically, judicious use of licensing activities by the federal government can promote U.S. innovation and foster the growth of emerging industries. For precisely these reasons, Congress directed that federally funded research be patented and licensed.[284]

In compliance with Congress's wishes, the Department of Defense includes Technology Transfer Offices within each agency responsible for the licensing of defense technology.[285] Existing Department of Defense licensing programs have produced noteworthy and measurable outcomes on the U.S. economy.[286] To make licensing a truly effective Innovation Warfare counterstrategy, however, requires augmentation of current licensing practices coupled with direction to align those efforts with the strategic objectives. Current licensing transactions mostly consist of the consummation of ad hoc targets of opportunity, untethered to the types of strategic goals articulated herein, and conceived and implemented in the context of a single deal.

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[284] Bayh-Dole Act, 35 U.S.C. §§ 200–12 (establishing that "[i]t is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development").

[285] *Id.* § 209 (describing the authority and policies for licensing of federally owned inventions); Instructions from Dep't of Defense, DoD Technology Transfer (T2) Program, at Instruction 5535.8 (May 14, 1999), https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/553508p.pdf?ver=2018-10-22-082514-847 [https://perma.cc/E5WM-ZV8U] (implementing the policies and procedures for licensing Department of Defense Technology Transfer programs and allocating responsibility for this function to the Office of the Under Secretary of Defense for Research and Engineering).

[286] *See* TECHLINK & UNIV. OF COLO. SCH. OF BUS., NATIONAL ECONOMIC IMPACTS FROM DOD LICENSE AGREEMENTS WITH U.S. INDUSTRY 5 (2018), https://www.nsa.gov/Portals/70/documents/what-we-do/research/technology-transfer/DoD-Licensing-Study-2017.pdf?ver=2019-08-07-133426-037 [https://perma.cc/3VUA-795B] (finding that as of 2017, existing DoD licensing programs had produced $58 billion in total economic impact nationwide, $27 billion in new product sales, and created 214,791 jobs).

Three more sophisticated licensing practices offer more effective alternatives. Each of these three licensing alternatives utilizes patent-based control positions to build strategic openness.[287] Strategic openness promotes attainment of the preferred technological future(s) by influencing and enabling others to adopt the technologies underlying it.

The first of these alternatives, and with a past history of success, involves revitalization of patent pools. The United States successfully utilized patent pools to ensure the viability of the emerging radio and aviation industries.[288] Patent pools gather those patents required to participate in a given industry into a single lot available for license.[289] Patent pools are thus pro-competition and economically efficient. The patent owner receives royalties for the patents placed into the pool, while industry participants receive a license in exchange for those royalties.[290] Pools have the effect of de-risking entry into new technology areas since the likelihood of being sued for patent infringement is reduced. Patent pools currently exist for DVDs, MPEG, and RFID technologies, to name but a few.[291] In industries without these cross-license pooling arrangements, firms must negotiate for needed licenses on an inefficient, piecemeal basis.[292] In industries without patent pools, and where patents are abundant, firms face an increased risk of expensive patent infringement suits.

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[287] Strategic openness influences or enables the adoption of a preferred technology by granting others the ability to "see" or "use" it. *See* XIAN XU ET AL., STRATEGIC OPENNESS AND OPEN STRATEGY 50–84 (David Seidl, Georg von Krogh & Richard Whittington eds., 2019).

[288] Robert Merges, *Institutions for Intellectual Property Transactions: The Case of Patent Pools* 28 (Aug. 1999) (unpublished manuscript), https://www.law.berkeley.edu/files/pools.pdf [https://perma.cc/PF3J-WACJ]; Kevin Closson, *Patent Pools*, SPIE (Sept. 30, 2009), https://spie.org/news/spie-professional-magazine-archive/2009-october/patent-pools?SSO=1 [https://perma.cc/423A-UV6D].

[289] *Id.*

[290] *Id.*

[291] *Id.*

[292] *Id.*

Patent pools thus encourage United States entrants into emerging technology areas while creating a preference for the particular technologies covered by the pool. Even if Chinese companies were licensed under the pool, those Chinese firms would still be advancing a preferred technological future as embodied by the technologies and license conditions of the pool.

Public-private sector cooperation on the formation of patent pools in next generation technologies should be further investigated as a means to establish control positions and foster industry growth in those technologies. The creation of such pools similar to that used for radio creates a stronger American innovation ecosystem.

The second advanced licensing concept bears even more promise. This relatively new model is known as "License on Transfer" ("LOT").[293] The model operates on a concept similar to vaccines. In the context of an Innovation Warfare counterstrategy, a LOT licensing model works to "inoculate" U.S. industry from patents acquired by a non-U.S. entity. More specifically, for patents derived from U.S. government-funded research, whether held by a private contractor, grantee, or the U.S. government, the patentee would sign an agreement pledging that if the patent asset were ever transferred to a non-U.S. or non-ally entity, any U.S. company would immediately obtain a non-exclusive license under that patent. In this way, the U.S.-funded invention process would protect U.S. innovators from future lawsuits, should that patent subsequently wind up in the portfolio of an adversary or an adversary's firms.[294]

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[293] Ken Seddon, *Invest in Growth: How LOT Network Addresses the PAE Problem*, LOTNETWORK (June 5, 2017), https://lotnet.com/wp-content/uploads/2018/04/Introduction-of-LOT-2.0-For-Startups_NonLegal-v5.1.pdf [https://perma.cc/VT5T-SYMC].

[294] Although 35 U.S.C. § 209 specifies certain preconditions for licensing federally owned inventions, the License on Transfer ("LOT") concepts discussed here go further. For example, 35 U.S.C. § 209(b) states that licenses to federally owned inventions are normally granted only to those who will manufacture substantially in the United States. 35 U.S.C. § 2019(b). The Authors believe that the LOT provisions could be triggered even if the licensee or their successors in interest were not in breach of this provision. Likewise, 35 U.S.C. § 209(d)(1) contains a grant-back license enabling any federal agency to practice the invention or products embodying it on behalf of the United States. The LOT terms could be

The LOT model requires further investigation. The United States could include the necessary licensing terms in its patent licenses without additional legislation. The acquisition process could make such commitments voluntary in exchange for more favorable treatment, but mandating such terms may require additional legislation or modification of existing regulation. In both cases, more thorough legal analysis and implementation plans are required.

The third alternative licensing model is the Library model or patent shield model.[295] This model ensures start-ups are protected from predatory patent lawsuits.[296] In the Library model, a large number of patents are aggregated either by purchasing them or by aggregating the portfolios of many participants.[297] Small businesses or start-ups in emerging technologies of strategic interest enroll in the Library program.[298] Should a Library member be threatened with litigation by another entity, they can search the Library portfolio for any patents that might be asserted in a countersuit or otherwise be useful in defeating the litigation efforts.[299] If any such patents exist within the Library, the relevant patent assets are transferred to the start-up; or optionally, the start-up receives an exclusive license that enables them to assert that patent in a countersuit.[300] The Library concept is an additional means through which the federal government could incubate and protect the indigenous innovation

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drafted to trigger license rights to both the government and U.S. private entities upon the occurrence of certain specified events. In addition, LOT terms could be made a part of federal contracting such that they would apply to any patents owned and developed by private entities in connection with those contracts. Other implementations of the LOT concept are possible.

[295] Suzanne Harrison et al., Licensing 2.0: Corporation's New Approach to IP Monetization, Panel Discussion at Licensing Executive Society Annual Meeting (Oct. 23, 2017).

[296] *Id.*

[297] *Id.*

[298] *Id.*

[299] *Id.*

[300] *Id.*

ecosystem, especially in strategic technology areas along future technological pathways.[301]

Whatever the licensing model, the generation and maintenance of a patent portfolio is key to gaining and leveraging control positions to advantage American industry. Furthermore, the rights embodied in that portfolio must be coupled with existing platforms or products and must also constitute a series of carefully placed strategic bets representative of emerging technological future(s). Coupling a robust patent portfolio with creative licensing is a winning tactic in the Innovation Warfare battlespace.[302]

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[301] Other additional models exist but the three most promising models have been presented in the main text. Chief among these additional models are patent buying funds. These funds protect indigenous companies in emerging industries from coercive foreign technology transfer activities. The purpose of the fund is to buy patents to be asserted against companies who have forced those indigenous companies to license their intellectual property. Korea's Intellectual Discovery is one of the most prolific patent buying funds established for this purpose. *About ID,* INTELL. DISCOVERY, http://www.i-discovery.com/site/en/overview/aboutid.jsp [https://perma.cc/KUX5-JXKG] (last visited Mar. 13, 2020). Significant additional research would be required to evaluate the benefits and legal authorities for federal government agencies to establish or to participate in such funds.

[302] Patent infringement lawsuits are an additional control position tactic. Patent infringement lawsuits can be brought in federal court before the International Trade Commission. 28 U.S.C. § 1338(a); 19 U.S.C. § 1337(a)(1)(B). Patent infringement lawsuits, however, present challenges that make them less attractive than licensing as an Innovation Warfare counterstrategy. Lawsuits are incredibly expensive and resource intensive. In the federal government, the Department of Justice has responsibility for filing and litigating patent infringement cases. Unlike a licensing-based approach, implementing a litigation-based counterstrategy would require significant financial commitment and coordination across government agencies. Relying on private parties to execute litigation tactics in the context of Innovation Warfare is also not likely to achieve significant strategic outcomes. Not only are private parties intimidated by China into forgoing this option, but private entities are driven to maximize profitability. Private entities get graded on maximizing shareholder value not on the strategic goals of an Innovation Warfare defense. Only in rare and highly impactful situations is litigation warranted.

D. Organize to Win

The good news is that within each government agency, the component pieces and the requisite statutory authority exist to execute on the recommendations contained in this Article. On the agency level, such as within the Department of Defense, those pieces need only be organized and managed for strategic and synergistic effect. On a broader level, the Innovation Warfare threat demands, as others have also suggested, an integrated government approach.[303]

Albert Einstein once said, "[i]n the middle of difficulty lies opportunity."[304] The fundamental values that Americans hold dear are under attack and require new and different strategic thinking and organizational mandates to combat this new threat. Innovation Warfare as prosecuted by the Chinese amounts to a malign foreign influence campaign as defined by 50 U.S.C. § 3021.[305] This conclusion rests the overall coordination of the response and counterstrategy within the province of the National Security Council.[306] While the concept of "malign foreign influence campaigns" is currently thought of in the context of social media and election interference, the statutory definition of that phrase is much more encompassing.[307] Per the statute, "malign foreign influence operations and campaigns" means the "coordinated, direct or indirect application of national, diplomatic, informational, military, economic, business, corruption, educational, and other capabilities by hostile foreign powers to affect attitudes, behaviors, decisions, or outcomes within the United States."[308] Innovation Warfare certainly meets this definition, and the National Security Council should be tasked with coordinating the interagency response at the highest levels of government, subject to the

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[303] *See* BROWN & SINGH, *supra* note 2, at 25.

[304] ALICE CALAPRICE, THE EXPANDED QUOTABLE EINSTEIN 321 (2000).

[305] *See* 50 U.S.C. § 3021(h).

[306] *Id.* § 3021(g)(1) ("The President shall designate an employee of the National Security Council to be responsible for the coordination of the interagency process for combating malign foreign influence operations and campaigns.").

[307] *See id.* § 3021(h).

[308] *Id.*

provisions of the National Defense Authorization Act, as described below.

Congress, through the National Defense Authorization Act for Fiscal Year 2020, has also directed action to be taken.[309] Section 1239 of the Act directs the Secretary of Defense and the Secretary of State, in coordination with appropriate government officials, to provide an updated strategy to "counter the threat of malign influence operations by the People's Republic of China."[310] This updated strategy must include actions to counter seven specific elements, including: security measures, information operations, cyber measures, political and diplomatic measures, financial measures, energy security measures, and promotion of values.[311] As defined by the Act, an Innovation Warfare counterstrategy as described herein falls within the bounds of the political measures element.[312] Congress also directed the organizational design, for implementing the resulting strategy, be defined.[313]

Congress further directed the Secretary of Defense, acting through the Office of Net Assessment, to conduct studies on competitive strategies with respect to China.[314] Innovation Warfare

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[309] National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92 §§ 1239, 1253(c), 133 Stat. 1198, 1655, 1671 (2019) (directing the Secretary of Defense, through the Office of Net Assessment, to develop no fewer than three long-term competitive strategies with respect to the Peoples Republic of China to shape strategic competition to the advantage of the United States; and to deliver a report on same to Congress).

[310] *Id.* § 1239(b) (updating and expands to include China tasking to counter malign influence campaigns as previously assigned pursuant to the National Defense Authorization Act for Fiscal Year 2018).

[311] *Id.* § 1239(a); National Defense Authorization Act for Fiscal Year 2018 § 1239A.

[312] National Defense Authorization Act for Fiscal Year 2018 § 1239A (stating "[p]rograms and activities to enhance the resilience of United States democratic institutions and infrastructure at the national and subnational levels.").

[313] National Defense Authorization Act for Fiscal Year 2020 § 1239(b)(2) (stating that "[a] description of the interagency organizational structure and procedures for coordinating the implementation of the comprehensive strategy for countering malign influence . . . be provided").

[314] *Id.* §§ 1239(b)(2), 1253(c)(1). The Office of Net Assessment is the Department of Defense internal "think tank" created in 1973 by Richard Nixon

as a competitive strategy prosecuted by China, and against which counter-competitive strategies are needed, definitely falls within this mandate. Congress directed that no fewer than three counter-competitive strategies be developed and reported to Congress by December 19, 2020.[315]

At the uppermost levels of government, therefore, clear authority and delegation of responsibility exist to counter the Innovation Warfare threat. The Secretaries of Defense and State have the primary responsibility for further defining and developing specific Innovation Warfare threat doctrines and counterstrategies.[316] The National Security Council has the responsibility to coordinate implementation of the strategic response, and to coordinate information sharing between the White House, the Department of Defense, the State Department, and various sister agencies. In the context of an Innovation Warfare response, these sister agencies include, at a minimum: the Department of Commerce, the National Science Foundation, the Department of the Treasury, the Department of Justice, the U.S. Trade Representative, the Small Business Administration, and the Department of Education. The National Security Council, through the Office of Director for National Intelligence and the Director of Science and Technology, should also cooperate with: (1) the Department of Defense in the funding and development of FTA tools, and (2) with the Department of Commerce in making some version of those tools available in the private sector.

Beyond setting and orchestrating Innovation Warfare counterstrategies at a whole of government level, within the

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that looks 20 to 30 years in the future. *See* Humberto Enrique Lopez Arellano*, Net Assessment: Creating an Institutional Capacity and General Process To Perform It*, 17–18 (June 2017) (Thesis, M.A., Naval Postgraduate School), https://apps.dtic.mil/dtic/tr/fulltext/u2/1046458.pdf [https://perma.cc/B6PV-8246] (discussing the historical origins and purpose of the Office).

[315] National Defense Authorization Act for Fiscal Year 2020 § 1253(c)(2).

[316] *Id.* § 1239(b) (updating the National Defense Authorization Act for Fiscal Year 2018, by expanding the Secretary of State and Department of Defense's role to include the development of strategies to counter the malign influence activities of China).

Department of Defense there exist numerous additional opportunities to respond to the Innovation Warfare threat across different time dimensions. Recognition that Department of Defense priorities and organizational design may need modification is growing.[317] Opportunities include mobilization and reorganization of existing functional units and capabilities to better align with the counterstrategy. These opportunities additionally include tasking existing functional units and bases of expertise to facilitate capture of intellectual property control positions.

More specifically, each Department must first articulate an intellectual property strategy logically connected to and supported by the current technology strategy, preferably focusing on the zero to ten-year time frame. The intellectual property strategy should ideally include patenting goals and technology transfer goals. In addition to existing guidance, the technology transfer goals should be coupled with activities that push strategic and early-stage roadmap technologies into the American innovation base. The technology transfer strategy should additionally evaluate and incorporate the novel licensing approaches described above. These activities will make significant progress in the implementation of a fully integrated Intellectual Property Management decision process, as diagrammed in Figure 16, and moves patent acquisition and licensing activities from mostly ad hoc, independently conducted activities, to the realm of the strategic.

Second, a centralized group within the Department of Defense's senior management level should be created. This newly created centralized group would utilize FTA to identify and prioritize the multiple possible technological futures which may emerge beyond a ten-year time horizon, and additionally, identify the set of possible corresponding technology roadmaps. This group would then manage the placement of longer-term strategic U.S. control position bets along those roadmaps.

Establishing control positions via patents forms an important part of a multi-part control position strategy. Predicting in advance

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[317] RONALD O'ROURKE, CONG. RSCH. SERV., R43938, RENEWED GREAT POWER COMPETITION: IMPLICATIONS FOR DEFENSE–ISSUES FOR CONGRESS (Sept. 30, 2020) https://fas.org/sgp/crs/natsec/R43838.pdf [https://perma.cc/A3W4-X6DF].

which specific subset of patent control positions will be the "winners," however, can prove challenging. As noted in the previous paragraph and per the process as drawn in Figure 13, patent bets are being placed on technologies more than ten years in the future. As with most bleeding-edge technologies, there exist multiple competing technology roadmaps; each ostensibly realizable in the future.[318]

A successful Innovation Warfare counterstrategy therefore requires placing patent bets across competing roadmaps, and, over time, determining which is the most favorable to U.S. interests, and then leveraging those control positions to make the preferred roadmap the most likely chosen by both industry and allies. In the business world this is known as the "beforemath." Business professor and author Stan Davis further elaborates:

> "Many people," . . . "wait for events to happen and then they react or respond to them. When this occurs, people must deal with the aftermath of the event. But suppose things were turned around. Suppose you decided what it was that you wanted to occur in the future. If you made such a decision, and could visualize in your mind's eye what that future looked like, then you could manage the events between your present and your desired future . . . you would decide on the future you wanted to take place, and then deal with the beforemath of making it happen."[319]

In the patent world, sophisticated companies are already performing these tasks routinely.[320] One of the benefits of the Department of Defense running such a process is that the process can more easily be executed on a larger scale, for a larger number of technologies, than one single company can do successfully. The

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[318] See Yi Zhang, Hongshu Chen & Donghua Zhu, *Semi-automatic Technology Roadmapping Composing Method for Multiple Science, Technology, and Innovation Data Incorporation*, ANTICIPATING FUTURE INNOVATION PATHWAYS THROUGH LARGE DATA ANALYSIS 13–14 (2016) (surveying existing methodologies for creating technology roadmaps and noting that such roadmaps can be created in any of multiple dimensions for a given technology, e.g. time, policy, market demands; and further noting the previous creation of at least one multi-dimensional model for China's solar cell industry.) The Authors' also collectively individually each have professional experience in the creation of technology roadmaps.

[319] HARRISON & SULLIVAN, *supra* note 266, at 155.

[320] *See id.*

Department of Defense senior leadership process can then be integrated with the technology transfer function to seed these emerging technologies into the private sector via one or more of the licensing methods described above.

Congress has, in fact, requested a subcomponent of this work via the National Defense Authorization Act.[321] Specifically, Section 232 of the Act directs the Department of Defense to establish a process and policies regarding emerging technologies.[322] Emerging technologies is further defined to mean:

> [T]echnology determined to be in an emergent phase of development by the Secretary of Defense, including quantum computing, technology for the analysis of large and diverse sets of data (commonly known as 'big data analytics'), artificial intelligence, autonomous technology, robotics, directed energy, hypersonics, biotechnology and such other technology as may be defined by the Secretary.[323]

This portion of the Act can be read broadly to include innovation policies and technology adoption for Innovation Warfare countermeasures, as well as nonproliferation and classification efforts.

Implementing these organizational changes requires a significant effort and most importantly, significant top-down support. As of this writing, within the Department of Defense, the Under Secretary of Defense for Research and Engineering retains responsibility for R&D and technology licensing; the Under Secretary of Acquisition and Sustainment retains responsibility for intellectual property strategy and management of the congressionally mandated intellectual property cadre of experts; the Office of General Counsel retains responsibility for filing and prosecution of patent applications; while responsibility for the development and utilization of FTA tools remains dispersed.[324]

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[321] National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92 § 232, 133 Stat. 1198 (2019)

[322] *Id.* § 232(a).

[323] *Id.* § 232(d)(2).

[324] 10 U.S.C. §§ 133a, 133b (defining the roles and responsibilities of the Under Secretaries of Research and Engineering and of Acquisition and Sustainment respectively); *Id.* § 2322 (allocating management of intellectual property matters to the Under Secretary of Defense for Acquisition and Sustainment); Instructions from Dep't of Defense, DoD Technology Transfer (T2) Program, at 2 (May 14, 1999),

Relying on licensing functions, patent acquisition functions, and strategic decision-making to coordinate across boundaries in a meaningful and nimble way is challenging.

For this reason, private corporations faced with similar situations have typically created a senior leadership position to oversee and manage strategic intellectual property processes. The Department of Defense should evaluate the creation of a Chief Intellectual Property Officer ("CIPO") to facilitate and coordinate these processes and to ensure that this structure is replicated throughout each constituent Department.[325] The creation of this position is consistent with Congress's prior direction that the Department of Defense maintain a cadre of intellectual property experts.[326] The CIPO position may be either an attorney residing in the organization's law department, or a business/management leader reporting elsewhere. Statutory authority for either architecture exists within the Department of Defense. For example, the Under Secretary of Defense for Acquisition and Sustainment is tasked in part with developing sets of intellectual property and licensing strategies.[327] Yet, most patent prosecution takes place within the Department's various legal offices, which already put significant responsibility on the organization's patent attorneys to develop the requisite intellectual property control position strategies. Optionally, a single department, such as, for example, the Department of the Navy, could be designated as the executive

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https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/553508p.pdf?ver=2018-10-22-082514-847 [https://perma.cc/E5WM-ZV8U] (allocating technology licensing functions to the Under Secretary for Research and Engineering); 10 U.S.C. § 140 (describing the duties of General Counsel as chief legal officer and performs such duties as the Secretary of Defense may prescribe; these duties as assigned currently include patent prosecution).

[325] *See* 10 U.S.C. § 131(b)(9) (permitting the Secretary of Defense to appoint "such other offices and officials as may be established by law or the Secretary of Defense may establish or designate in the Office").

[326] National Defense Authorization Act for Fiscal Year 2018 § 802. In the National Defense Authorization Act for Fiscal Year 2018 § 802(c), Congress requested an update including a list of the intellectual property experts and their reporting and leadership structure. *Id.* § 802(c).

[327] 10 U.S.C. § 2322(a).

agency charged with leading these efforts and effectively serving in the CIPO role.

Figure 16 diagrams the decision architecture and organizational design described in the preceding paragraphs. Figure 16 shows a structure and allocation of responsibilities for implementing a whole of government Innovation Warfare counterstrategy at the highest levels with a subsequent allocation of responsibilities and tactical implementation at the agency level. Figure 16 illustrates the Department of Defense recommendations provided above.

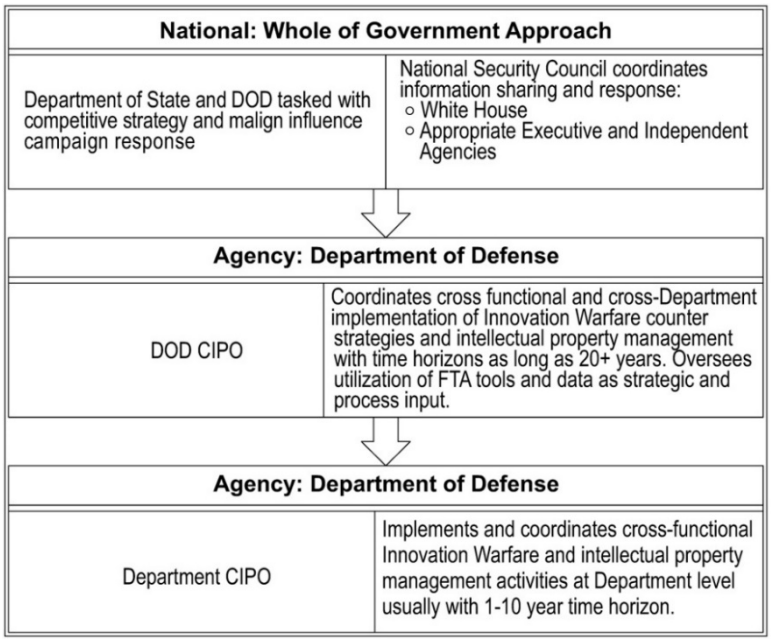

Figure 16. Innovation Warfare Decision and Implementation Structure

Either organizational structure works. The choice frequently comes down to who in the organization has the necessary skills to fill the CIPO role, given that it requires a mix of both highly advanced business and legal skills. When the role is assigned to the law department, that department has to recognize the CIPO must perform non-attorney-client privileged business tasking and has the authority to make management, not just legal, decisions. When the role is assigned to a business or managerial unit, the law department

must recognize that the CIPO must have portfolio oversight and the authority to direct certain portfolio actions. Based on the Authors' collective experience, these reorganization and realignment efforts often require a multi-year implementation window.

Figure 17 diagrams an intellectual property management process for implementing the Innovation Warfare counterstrategies described herein. Figure 17 shows one possible organizational design and process flow wherein the Department of the Navy serves as the example. The exact implementation may vary by Department or Agency, however, the basic functional process flow has been found to constitute a recommended best practice.[328]

The precise organizational boundaries demarcated in Figure 17 may change but the overall process remains fixed. In all cases, however, coordination across the many organizational boundaries requires a designated leader with the appropriate institutional authority, who is specifically tasked with implementing the control position and needed intellectual property strategies. In Figure 17, this leader is shown as the CIPO per the recommendations given above.

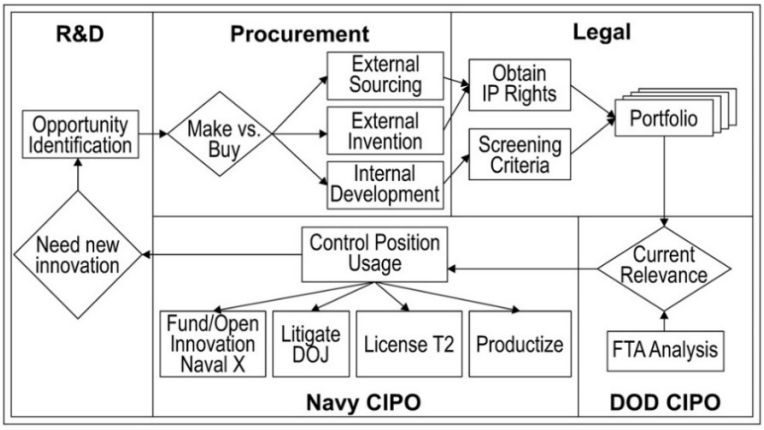

Figure 17. One Example of a Department Organizational Design

VIII. CONCLUSION

Innovation Warfare is a competitive strategy prosecuted by nation states against the innovation infrastructure of the U.S.

[328] *See* HARRISON & SULLIVAN, *supra* note 266, at 15–17.

Innovation Warfare is a means to a geopolitical end and does not constitute economic competition as usual. Countries engaging in Innovation Warfare pose both a national security and economic risk to the United States because those countries threaten the innovation ecosystem at the root of economic power and prosperity, and at the root of military technological superiority.

China is currently prosecuting an Innovation Warfare competitive strategy against the United States. As documented and described herein, there currently exists a comprehensive, coordinated effort by China to acquire U.S. technology and to co-opt the U.S. innovation base for its own purposes. A future in which China prevails in the Innovation Warfare "fight" is one in which the United States cedes the technological future to another, and one in which its geopolitical power and the prosperity of its citizens is at risk. The danger presented by China's Innovation Warfare tactics is also an existential one.

A technological future dictated by Chinese interests is unlikely to incorporate western values of privacy and personal liberties into that technology. Innovation Warfare thus constitutes a threat against which the United States must defend itself. Development and execution of an Innovation Warfare counterstrategy are therefore critical to protecting the national security and economic interests of the United States and negating the type of economic and geopolitical aggression that previously led to two World Wars. Executing a counterstrategy not only preserves the peace but ensures that peace is one in which American welfare and liberties remain intact. There are four things the United States must do to execute an effective counterstrategy. These four things are:

1) Future-Oriented Technology Intelligence – Develop machine learning tools to identify the possible technological futures and drive towards the preferred future(s);
2) Strategic Technology Development – Optimize and scope federal R&D spending to seed the innovations necessary to attain the preferred future(s);
3) Secure Technology Control Positions – Identify and secure control positions along the preferred future technology implementation path, including deploying and protecting

intellectual property as an armament in the Innovation Warfare battlespace; and

4) Organize to Win – Develop the cross-functional capabilities and inter-organizational coordination both within the government and across the public-private interface.

Innovation Warfare distilled down to its most basic truth is a footrace to control the technological future. FTA capabilities are thus vital not just to winning, but also to defining the mileposts along the racecourse. Future investments in FTA capabilities will be critical to overtake the lead others have built in this field. One cannot influence the attainment of a future one cannot see, or which others can see well in advance. In a world where others have advanced FTA capabilities, it will be difficult to optimize research into new technologies with equivalent speed and insightfulness absent those investments.

The capabilities necessary to implement the remaining elements of the Innovation Warfare counterstrategy already exist but must be marshalled and aligned with strategic goals. In particular, the government, and specifically the Department of Defense, should work to expand its intellectual property portfolios and align them with Innovation Warfare objectives. Intellectual property constitutes a crucial armament in the Innovation Warfare battlespace. Intellectual property establishes control positions along the racecourse to the technological future(s). According to the principles of strategic openness, these control positions can be gated open to encourage technology adoption, or gated closed to prevent it. Deft use of advanced licensing techniques employs these principles to manage the established control positions and ensures that the technological future arrived at is the one preferred.

Each of these enumerated counterstrategy elements stands not alone but works in concert with the others. Leadership must organize nationally and at the agency levels to synchronize these efforts. Agencies with strong research portfolios, such as the Department of Defense and Department of Energy, will require a designated leader or function to coordinate the intellectual property and control position aspects of the counterstrategy across various internal stakeholders. This functionality can be achieved by

appointing a CIPO or by expanding the responsibilities of existing personnel. Within the Department of Defense, it may additionally be possible to designate one department, for example, the Navy, as the lead executive agency with overall responsibility for implementing the counterstrategy. Sufficient statutory authority exists to execute the Innovation Warfare counterstrategy and organizational design, without the need for additional legislation or rulemaking.

Innovation Warfare may exist in the gray area between peace and war, but it nonetheless is a conflict the United States must win.