The End of Military-Techno *Pax Americana*? Washington's strategic responses to Chinese AI-enabled military technology

Abstract:

This article uses the international relations (IR) 'polarity' concept as a lens to view the shifting great power dynamics in artificial intelligence (AI) and related enabling technologies. The article describes how and why great power competition is mounting in within several interrelated dual-use technological fields; why these innovations are considered by Washington to be strategically vital, and how (and to what end) the United States is responding to the perceived challenge posed by China to its technological hegemony. The following questions addressed in this paper fill a gap in the existing literature: Will the increasingly competitive U.S.-China relationship dominate world politics creating a new bipolar world order, as opposed to a multipolar one? Why does the U.S. view China's progress in dual-use AI as a threat to its first-mover advantage? How might the U.S. respond to this perceived threat?

Key words: Artificial intelligence; great power competition, U.S.-China; emerging technology; polarity

Introduction:

This article considers the intensity of U.S.-China strategic competition playing out within a broad range of artificial intelligence (AI) and AI-enabling technologies (e.g., machine learning, 5G networks, autonomy and robotics, quantum computing, and big data analytics).[1] It describes how great power competition is mounting in intensity within several dual-use high-tech fields, why these innovations are considered by Washington to be strategically vital, and how (and to what end) the U.S. is responding to the perceived challenge posed by China to its technological hegemony. The article uses the International Relations (IR) concept of 'polarity' (the nature and distribution of power within the international system) as a lens to view the shifting great power dynamics in AI-related strategic technology (e.g., microchips, semiconductors, big-data analytics, and 5G data transmission networks).[2]

The article argues that the strategic competition playing out within a broad range of dual-use AI and AI-enabling technologies, will likely *narrow* the technological gap separating great military powers (notably the U.S. and China), and to a lesser extent,

other technically advanced small-medium powers.[3] The article builds on the growing body of literature that reinforces the perception in the U.S. that China's pursuit of AI technologies will threaten the unassailable first-mover advantage that U.S. has in a range of dual-use - and military-specific - AI applications (Boulanin, 2019; Johnson, 2019; Horowitz, 2018; Moore, 2017; Hoadley and Nathan, 2017; Allen and Chan, 2017). Because of this perceived threat, Washington will likely consider even incremental progress by China through a military lens, and thus treat any progress as a national security threat.

What are the implications of U.S.-China defense innovation for the strategic balance and stability, in particular, efforts by the United States to sustain its first-mover advantages in advanced military technology? (Boulanin, 2019; Geist and Lohn, 2018; Ayoub and Payne, 2016; Technology for Global Security, 2019) Why does the U.S. view China's progress in dual-use AI as a threat to its first-mover advantage? How might the U.S. respond to this perceived threat? Will the increasingly competitive U.S.-China relationship dominate world politics creating a new bipolar world order, as opposed to a multipolar one?[4] (Wohlforth, 2011; Wagner 2009; Schweller, 2010) The article is an attempt to acquire greater insight into these questions, to better understand the shifting power dynamics and strategic competition in the development of AI-related and enabling technology, and the implications of these trends for strategic relations between great powers.

Scholars have long recognized the central role technological innovation plays in power transitions, the balance of power, and international politics and security more broadly (Organski and Jacek Kugler 1980; Gilpin 1981; Drezner, 2001; Kennedy, 2016; Simmons, 2016). IR scholars of various stripes have also begun to reflect on the nuanced relationship between advances in technology, the rise of new powers' political and military, material, social and ideational prominence in the international order, and responses to these trends by dominant powers (Gilpin, 1975 p.67). While scholars have demonstrated the salience of technological innovation, and more recently, illuminated how dominant and rising powers interact in this arena, much less literature exists on the consequences of technological change; in particular,

contextualized with the notion of a return to multipolarity (Drezner 2001 pp.3-25; Taylor 2016; Kennedy, 2016 pp.1-28). This paper contextualizes these broader questions with U.S. responses to recent trends in AI, and the distribution of power in the international world order more broadly. Despite the recent surge of articles in the popular press and trade journals on the potentially transformative impact of AI, there has been little in the way of rigorous scholarship on how AI defense innovations impact the power dynamics between great powers. In particular, the paper unpacks the critical drivers of U.S. national security policy in response to advances in the AI capabilities of great powers (especially China).[5]

There are several ways to frame this discussion within the broader context of the U.S. response - resisting the notion, embracing it, or eschewing it - to the notion of multipolarity, associated with this technological phenomenon (Porter, 2019 p. 8). The most compelling narratives include: First, the U.S. as the dominant power in AI-related technology and the fallacy of the narrative centered on multi-polarity, and the rise of the rest (Posen, 2003 p. 10). Second, and juxtaposed, a sense of alarm building within the defense community in the U.S. spurred by the rapid progress made in the development of AI-enabled technologies by rising powers, and thus, a mounting sense of urgency that the U.S. may be unable to sustain its first-mover advantage in this increasingly diffused and competitive arena (Kennedy and Darren Lim, 2017 pp.553-572). Third, faced with the inexorable shift away from unipolarity, and towards multipolarity more generally, Washington has begun to accept its reduced status within the emerging technological multipolar order.

Connecting these three narratives are the following research puzzles: is Sino-American bilateral competition in AI the key driving force behind the so-called 'AI revolution'? Alternatively, instead, is there a genuine sense that the nature of this defense innovation competition is more widely distributed, to technically advanced small-middle powers (and even non-state entities)?[6] From a U.S. perspective, the former proposition would intimate that we can speak of an emerging bipolar order in AI, and the latter would support the 'new multipolarity' thesis. This article critically unpacks these interconnected trends and themes and presents a nuanced account of the

mounting challenge facing U.S. technological hegemony in AI-related technology.

The article proceeds as follows. First, it summarises the responses by U.S.decision makers and analysts to the debate about U.S. decline and the rise of the narrative of an imminent shift to a multipolar order. This grand strategic overview will be contextualized with particular reference to the relative decline of the United States vis-à-vis China, and the implications of the U.S. being displaced as global hegemon. This includes what might be thought of as 'denialists' (those that argue that unipolarity is, in fact, durable and that serious U.S. decline is a myth), 'accepters' (those advocating for retrenchment or strategies of 'offshore balancing' to navigate the inevitable 'rise of the rest'), and 'resisters' (those concerned about the rise of peer competitors but who believe that Washington can still see down the challenge and maintain its hegemonic position).

It then sets up the debate over rapid advances and proliferation of AI-related technologies capabilities, through an exploration of those that view harnessing these capabilities as a central aspect of efforts to maintain Washington's unipolar dominance. It outlines the range of opinions that exist in the U.S. surrounding the impact of military AI on future warfare, the military balance, and national security more broadly. It also examines the potential threat scenarios that could emerge from the several proven transformative defense innovations in AI (e.g., low-cost swarming technologies, machine learning cyberweapons, and AI-augmented military espionage) in the hands of rising revisionist and dissatisfied great powers such as China, intent on exploiting US military vulnerabilities to these military-technological domains; thereby, threatening U.S. military superiority and the unipolar order that it undergirds.

Next, it examines the perception of the rise of a bipolar order divided between Washington and Beijing. Again using the lens of defense innovation, it analyses the credibility of the popular idea that U.S. has been caught off guard by China's accomplishments in the development of AI-related technologies (or the U.S.'s 'Sputnik Moment'), and that as a result the United States risks losing its first-mover advantages in the adoption of AI on the future battlefield. Next, this section briefly outlines recent AI-related programs to demonstrate the alacrity within the US defense

community challenge caused by the pursuit of AI capabilities by states (especially China) to enhance their military power. Specifically, that China's aggressive development of dual-use strategic technologies (e.g., semiconductors, quantum computing, the internet of things, and 5G networks) could portend a state-sponsored bid to surpass the U.S. in the development and deployment of these strategic capabilities.

Finally, and in response to calls from within the U.S. to take action to maintain U.S. hegemony in the emerging global AI race, the paper examines the nature of this particular 'arms race' in the context of predictions of a shift towards a multipolar order (Rapoport, 1957 pp.249-99; Glaser, 2004 pp.44-84). Unlike the Cold War-era nuclear arms race, this AI arms race will probably involve many more actors; including non-state actors - especially commercial entities, NGO's, and terrorist groups. Above all, the commercial driving forces and dual-use features of this dynamic, which *prima facie* intonates a much more diffused and multipolar reality - as opposed to a bipolar one. That is, cutting edge technology today is in many ways hastening the transition to a multipolar world order. It argues that despite the powerful commercial forces driving the rapid proliferation and diffusion of AI technologies (amongst great and small-medium powers), the emulation and assimilation of military-specific AI technology will be constrained by several salient features of this phenomenon.

The article conceptualizes 'multipolarity' not simply as an objective description of how capabilities are distributed between great powers; but rather as a multifaceted concept that focuses on great power status, strategic narratives, and in particular, perceptions. This framework provides a robust foundation to examine U.S. threat perceptions, and strategic responses to Chinese AI-enabled dual-use technology. In this way, the article contributes to existing scholarship on the role of emerging technology and defense innovation in world politics, and in particular, where civilian investments and initiatives are indistinguishable from military enterprises (Garfinkel and Dafoe, 2019 pp.736-763; Gartzke and Lindsay, 2015 pp.316-348).

The article's methodology also makes a novel contribution to the literature. It

uses a wide range of open-source (official and semi-official) Chinese language reports, in combination with commercial and defense-centric think-tank and research group reports, to benchmark both China's AI approach and U.S. perceptions of these developments; ostensibly through a national security and military lens (iiMedia, 2017; PwC 2017; Mckinsey Global Institute, 2017; China State Council, 2017; Tencent Research Institute et al., 2017; China Academy of Engineering; Chinese Academy of Sciences, 2017; China Institute for Science and Technology Policy at Tsinghua University 2018; China Economic Net; Council on Foreign Relations, 2017; CB Insights Research 2018). Currently, there are no standardized classifications or metrics for either the commercial or military development of AI technology. This study applies six broad categories compiled by the Center for Data Innovation (i.e., talent, research, enterprise development, adoption, data, and hardware) to analyze Chinese AI advances and U.S. responses (Castro et al., 2018 pp.13-15).

Strategic implications of AI and the maintenance of American unipolar edge:

In the post-Cold War era, a preoccupation of U.S. policy-makers and analysts has been the nature and implications of U.S. unipolarity. This discourse has centered on two key questions: How long will unipolarity last? Also, is the pursuit of hegemony a viable or worthwhile strategic objective for the United States to pursue? The preservation of the U.S. liberal hegemonic role as unipole has been the overarching grand strategic goal of every post-Cold War administration from George H. W. Bush to Barack Obama (Layne, 2012 p. 2). Having outlined the prominent strands and voices about how the U.S. should (and are able to) respond to the notion of decline and the rise of a multipolar order, the analysis that follows uses the AI as a lens to explore how the U.S. is positioning itself vis-à-vis China - preparing for bipolarity with China or reluctantly accepting multipolarity?

World leaders have been quick to recognize the transformative potential of AI as a critical component of national security (Work, 2015). In large part driven by the perceived challenges posed by rising revisionist and dissatisfied powers - especially China and Russia (U.S. Department of Defense, 2017). The U.S. Defense of

Department (DoD) released a 'National Artificial Intelligence Research and Development Strategic Plan' - one of a series of studies on AI machine learning - on the potential for AI to reinvigorate U.S. military dominance (U.S. Department of Defense, 2016). In the context of managing the potential flashpoints in the Taiwan Straits, the South China Seas, and Ukraine, then- U.S. Secretary of Defense Ashton Carter stated that Russia and China are the United States' "most stressing competitors" and continue to "advance military systems that seek to threaten our [U.S.] advantages in specific areas" [including AI] and in "ways of war that seek to achieve their objectives rapidly, before, they hope, we [the U.S.] can respond" (U.S. Department of Defense, 2016).

In an effort to capitalize on the U.S.'s comparative advantage in private sector innovation, and to circumvent the burdensome military industrial-acquisition process, the DoD also established the Defense Innovation Unit Experimental (DIUx) to foster (albeit with mixed success) closer collaboration between the Pentagon and Silicon Valley (Kaplan, 2016). In a similar vein, the recent summary of the DoD's debut AI strategy stated that "China and Russia are making significant investments in AI for military purposes" that "*threaten to erode* our [U.S.] technological and operational advantages," and in response, the U.S. must "adopt [military-use] AI to *maintain its strategic position*, prevail on future battlefields, and safeguard this [i.e. U.S.-led] order" (U.S. Department of Defense, 2019).

The potential national security challenges facing the United States from AI-augmented capabilities can be grouped under three broad categories (Center for a New American Security, University of Oxford, University of Cambridge, Future of Humanity Institute, and OpenAI & Future of Humanity Institute, 2018): (1) *digital security* (e.g. spear phishing, speech synthesis, impersonation, automated hacking, and data poisoning); (2) *physical security* (e.g., micro-drones in swarm attacks); and (3) *political security* (e.g., surveillance, deception, and coercion) especially in the context of authoritarian states. While it is too early to predict which AI technologies will enable particular capabilities, or how these dynamics could influence the offensive or defensive balance, the general trajectory of this disruptive, and potentially

destabilizing technological phenomenon is evident (Horowitz, Scharre, and Velez-Green, 2017).

As a new, and potentially more powerful class of technology, AI could redefine and transform the status quo in military-use technology with unpredictable and highly destabilizing strategic implications. Even if AI-augmented weapons and systems are unable to produce better decisions than humans, militaries that use AI will doubtless gain significant advantages on the battlefield (e.g., remote-sensing, situational-awareness, and battlefield-maneuver), compared to those who depend on human judgment alone. In particular, in operating environments that demands endurance and rapid decision-making across multiple combat zones. The U.S. intelligence community, for example, is actively pursuing several publicly documented AI research projects to reduce the 'human-factors burden,' increase actionable military intelligence, enhance military decision-making, and ultimately, to predict future attacks and national security threats (Tucker, 2017). For now, however, it remains unclear when, whether, and under what circumstances greater degrees of autonomy in 'human-machine' collaboration will provide a distinct strategic battlefield advantage.

Recent IR scholarship has posited that rising powers pursuit of innovation is most likely to raise security concerns for the dominant state when the behavior of the rising power is perceived as an attempt to undermine the existing order - rules, norms, and governing institution **(**Goldman and Andres, 1999 pp.79-125)**.** In particular, if the emergent order conflicts with the dominant states' national security interests. Both China and Russia have developed a range of military-use AI technologies as part of a broader strategic effort to asymmetrically exploit perceived U.S. military vulnerabilities. In a quest to become a 'science and technology superpower,' and catalyzed by AlphaGo's victory (or China's 'Sputnik moment'), Beijing launched a national-level AI-innovation agenda for 'civil-military fusion' - or U.S. Defense Advanced Research Projects Agency (DARPA) with Chinese characteristics (State Council Information Office, 2017). Similar to China, the Russian private sector has also benefitted from state-directed support of human capital development and early

investment in advanced technologies, in a broader effort to substitute its continued dependence upon Western technology with indigenous technologies, and despite Russia's weak start-up culture. In short, national-level objectives and initiatives demonstrate recognition by great military powers of the potential military-technological transformative potential of AI for national security and strategic calculus.

U.S. analysts and policy-makers have suggested a range of possible responses to these emerging security threats to preserve U.S. technological leadership, which harnesses U.S. natural advantages to pushback against the rising great military powers in the multipolar order. These national security policy recommendations include (Hadley and Nathan, 2017; Work and Brimley, 2014; Gesit and Lohn, 2018): (1) the DoD should fund and lead AI-simulated war games and red-teaming creative thinking exercises, to investigate existing and new security scenarios involving disruptive AI innovations; (2) the U.S. needs to leverage its world class think-tank community, academics, AI experts, computer scientists, and strategic thinkers to assess the implications of AI for a range of security scenarios (e.g., AI dual-use technologies; AI and nuclear security; AI and the offense-defense balance; AI and economic power; and how the U.S. should prepare for and react to the event of artificial general intelligence) and devise a long-term AI strategic agenda to meet these challenges; (3) prioritize DoD AI-based R&D to leverage the potential low-cost force multiplier advantages of AI technologies (i.e., autonomy & robotics), and to mitigate potential vulnerabilities and risks; (4) the U.S. defense community should actively invest in and establish a commanding position in the nascent development of 'counter-AI' capabilities (both offensive and defensive); (5) the U.S. national security policy-making community (i.e., DARPA, IARPA, Defense Innovation Board; the Office of Naval Research, and the National Science Foundation) should seek increased funding for AI-related research, and to combat the competition for talent and information on cutting-edge AI, the U.S. must actively support and engage university programs to ensure the U.S. retains its relative talent pool advantages (especially vis-à-vis China), and ensure sufficient numbers of AI talent are nurtured to

collaborate with the government; and finally, (6) the DoD should fund R&D in reliable fail-safe and safety technology for AI-systems - especially military AI applications and tools.

AI technologies will likely have a similar (or possibly greater) impact on the augmentation and diffusion of military power, as cyberspace has already had (Singer and Friedman, 2014 p.13). Just as low-cost of cyber capabilities have given the offense the upper-hand in the cyberspace, so the proliferation of cheap, scalable, and easily diffused autonomous weapon systems could mean that future drone attacks (e.g., targeted assassinations or offensive drone swarming missions) carried out by an increasing number of malevolent actors prove even more difficult to attribute, and thus, defend against (Nye, 2017 pp.44-71). Rapid advances in AI technologies - even if these capabilities are unproven - could, like the historical case of missile defense technology, blur the lines between conventional and nuclear capabilities and doctrines, in ways that are liable to stoke tensions, undermine deterrence, trigger arms race instability, and increase the risk of inadvertent escalation (Bracken, 2017).

America's Sputnik moment in AI and China's digital revolution:

As AI military applications have grown in scale, sophistication, and lethality, many in the U.S. defense community have become increasingly alarmed about the implications of this trend for international competition and national security (Hadley and Nathan, 2017 p.17). In his opening comments at 'The Dawn of AI' hearing Senator Ted Cruz stated, "ceding leadership in developing artificial intelligence to China, Russia, and other foreign governments will not only place the United States at a technological disadvantage, but it could have *grave implications for national security*" (Hadley and Nathan, 2017 p.17). Similarly, Director of U.S. National Intelligence Daniel Coates recently opined, "the implications of our adversaries' abilities to use AI are *potentially profound and broad*" (Ibid. p.17).

Given the anticipated national security value U.S. strategic near-peer competitors (notably China and Russia) attach to military AI systems, several defense analysts have characterized the exorable pace and magnitude of AI technology as a 'Sputnik

moment,' which could be a harbinger for a military revolution (or perceived as such); triggering a global AI arms race, changing the character (and even nature) of warfare (Robert, 1993; Asif, 2000). AI is, however, only one facet of a broader trend towards increasing the speed of modern (conventional and nuclear) war, and the shortening the decision-making timeframe, associated with advances in weapon systems such as, cyber-attacks, anti-satellite weapons, and hypersonic missile technology - especially hypersonic boost-glide vehicles and hypersonic cruise missiles (Wilkening, 2019; Acton, 2013). These trends could lead to arms race instability between great military powers (especially China, Russia, and the U.S.), as rivals states modernize their capabilities to reduce their perceived vulnerabilities (Schelling and Halperin, 1975).

While evidence of exponentially accelerated military-technological competition - in research, adoption, and deployment - of AI-related subset technologies (i.e., 5G networks, IoTs, robotics and autonomy, additive manufacturing, and quantum computing), doesn't *necessarily* mean an 'arms race' is taking place. Rather, framing great power competition (especially U.S.-China) in this way risks the adoption of operational concepts and doctrine that increases the likelihood of arms racing spirals and warfare (Roff, 2019 pp. 1-5). According to the DoD's newly established Joint Artificial Intelligence Center (JAIC) head Lt. General Jack Shanahan, "its strategic competition, *not an arms race*. They're [China] going to keep doing what we're doing; we [the U.S.] acknowledge that." Shanahan added: "what I don't want to see is a future where our potential adversaries [China] have a fully AI-enabled force and we [the U.S.] do not" (Shanahan, 2019).

In response to a growing sense of alacrity within the U.S. defense community, the Pentagon has authored several AI-related programs and initiatives designed to protect U.S. superiority on the future digitized battlefield (e.g., the Third Offset, Project Maven, DARFA's 'AI Next Campaign,' the establishment of the JAIC, the Joint Common Foundation JCF, and the DoD's 'AI Strategy'). Taken together, these initiatives demonstrate the perceived gravity of the perceived threat posed to U.S. national security from near peer states' (especially China and Russia) pursuit of AI-related capabilities to enhance their military power. For example, in

response to Chinese strategic interest in AI DIUx proposed greater scrutiny and restrictions on Chinese investment in Silicon Valley companies (Simonite, 2017). This behavior typifies a broader concern that synergies created by China's civil-military fusion strategy could allow the technology, expertise, and intellectual property shared between American and Chinese commercial entities to be transferred to the PLA (Bartholomew and Shea, 2017 p.507).

Moreover, broader U.S. national security concerns relating to Chinese efforts to catch up (and even surpass) the U.S. in several critical AI-related enabling technologies, has prompted Washington to take increasingly wide-ranging and draconian steps to counter this *perceived* national security threat. Against the backdrop of deteriorating U.S.-China relations, responses such as these could accelerate the decoupling of cooperative bilateral ties between these two poles; increasing the likelihood of strategic competition, mutual mistrust, and negative action-reaction dynamics known as a security dilemma (Jervis, 1976, chap. 3; Johnson, 2017 pp.271-288).

By 2018, on the advice from the Committee on Foreign Investment in the United States (CFIUS), Washington blocked four attempts by Chinese companies to invest in advanced semiconductor technology. In one notable case, China's Fujian Grand Chip Investment Fund's effort to acquire Aixtron (a German company with a subsidiary in the United States) was derailed by the U.S. Treasury. Officials warned that the risks related to "the military applications of the overall technical body of knowledge and experience of Aixtron" had significant implications for U.S. national security (US Department of the Treasury, 2016). In another example, and on the advice from the CFIUS, the Trump administration used an executive order to block the acquisition of U.S. Lattice Semiconductor by Canyon Bridge Capital Partners. The order cited the "national-security risk posed by the transaction" and highlighted Beijing's support for the transaction (White House, 2017). Because of CFIUS's increased scrutiny of foreign investment in U.S. technology, Chinese transactions in the semiconductor sector were circa 95 percent lower in the first half of 2018, compared to the previous year (Bob, 2018). Moreover, in response to intelligence reports of Chinese attempts to

obtain U.S. technology through acquisitions, licensing, and espionage, Congress proposed legislation to tighten further CFIUS's scrutiny of the review process.

What the U.S. alarmist tone, and stringent policy responses, to the perceived threat posed by China's bid for technological leadership reveals is this: when we compare the public narratives surrounding the 'new multipolarity' thesis with what is happening two things emerge (Zala, 2017 pp. 2-17). First, the nature of the emerging great power competition in AI suggests that a shift to Sino-American bipolarity (rather than multipolarity) is more likely in the short-medium term. Second, even in the event, China surpasses the U.S. in AI (that many experts consider a strong possibility), It still trails the U.S. in several qualitative measures that coalesce to preserve its technological leadership (Lee, 2018). The United States has the world's largest intelligence budget, most popular hardware, software, and technology companies, and the most advanced (offense and defensive) cyber capabilities.

China is by some margin Washington's closest peer-competitor in AI-related technology. Beijing's 2017 'Next Generation AI Development Plan' identified AI as a core "strategic technology" and "international competition." China's official goal is to "seize the strategic initiative" (especially vis-à-vis the U.S.) and achieve "world-leading levels" of AI investment by 2030 - targeting more than US$150 billion in government investment (The State Council Information Office, 2017). Beijing has leveraged lower barriers of entry to collect, process, and disseminate data within China to assemble a vast database to train AI systems.

According to a recent industry report, China is on track to possess twenty percent of the world's share of data by 2020, and the potential to have over thirty percent by 2030 (Knight, 2017). These efforts could be enhanced by the synergy and diffusion of a range of disruptive technologies such as machine learning, quantum technology, 5G networks, and electromagnetics. In addition to the availability of vast datasets, comparing the AI-capabilities of U.S. and China also incorporates wider qualitative and quantitative measures such as hardware, high-quality machine learning algorithms, private-public sector collaboration, and broader technological and scientific initiatives and policies (Ding, 2018).

State-directed Chinese investment in the U.S. AI market has also become increasingly active, and in several instances, Chinese investment has competed in the direct competition with the DoD (Kania, 2017). In 2017, for example, a Chinese state-run company Haiyin Capital outmaneuvered the U.S. Air Force's efforts to acquire AI software developed by Neurala in 2017 (Mozur and Perlez, 2017). Incidences such as these are indicative of broader US concerns relating to China's proclivity for industrial espionage in its race to catch up (and overtake) the U.S. in several strategically significant AI-related dual-use fields (e.g., semiconductors, robotics, 5G networks, cyberspace, the internet of things, big data analytics, and quantum communications). Among these critical enabling technologies that could fundamentally change the future warfare are next-generation data transmission networks. The strategic importance of 5G networks as a critical future military technological enabler was demonstrated during the protracted tensions between China's Huawei and Washington. Experts view 5G as a cornerstone technology to increase the speed, stability data-loads, reduce the latency (i.e., accelerate network response times), and enhance mobile digital communications.

From a military perspective, these attributes will fuse multiple sensors with unmanned air, sea, and subsurface and ground systems, facilitating a significant incremental step towards full autonomy. Also, 5G's data transmission speed will also greatly enhance the connectivity of the Internet of Things (IoT). In combination, 5G and IoT could enable close-range military communication devices, platforms (i.e., C3I and ISR), and drone swarming machine-to-machine communication, to function without the need for vulnerable and expensive satellites or early-warning aircraft. Data retrieved from these networks could then be analyzed in real-time by command and control centers, infused with AI-machine learning systems, to locate and track an adversary, and then, issue AI-assisted orders - autonomously or human-directed - to swarms of offensive drones for precision strike missions.

Because of the extremely high data rate and the need for rapid analyzes and commands, AI is a critical component in all of these scenarios. According to an AI and telecommunications researcher at the University of Electronic Science and

Technology of China, "the 5G network and the internet of things (IoT) enlarge and deepen the cognition of situations in the battlefield by several orders of magnitude and *produce gigantic amounts of data, requiring AI to analyze and even issue commands*" (Zhen, 2019). Against the backdrop of rising tensions in the Sino-American relationship on a plethora of interconnected policy arenas (i.e., trade, and geopolitical influence in the Asia-Pacific), the technological race for the access and control of critical enablers that will connect sensors, robotics, autonomous weapons systems, and the exchange of vast volumes of data in real-time through AI-machine learning techniques on the digitized battlefield, will become increasingly intense and strategically motivated (Kania and Costello, 2018 p.5).

In 2017, Chinese President Xi Jinping explicitly called for the acceleration of the military 'intelligentization' agenda, to better prepare China for future warfare against a near-peer adversary, namely the United States (Xinhua, 2017). Although Chinese think-tanks and academic discourse are generally poor at disseminating their debates and content, open-source evidence suggests a strong link between China's political agenda related to the 'digital revolution,' Chinese sovereignty and national security, and the current public debate surrounding the rejuvenation of the Chinese nation as a great power (Xinhua, 2015). In short, national security is ultimately interpreted by China (and the U.S.) as encompassing economic performance.

President Xi's Belt-and-Road-Initiative (BRI), and the virtual dimension the 'Digital Silk Road,' are high-level efforts designed to ensure that the mechanisms, coordination, and state-level support for this agenda will become increasingly normalized (Yuan, 2017).[7] Chinese President Xi Jinping recently stated that AI, 'big data,' cloud storage, cyberspace, and quantum communications, were amongst the "liveliest and most promising areas for civil-military fusion."[8] Towards this end, Xi has pledged additional state support and resources to enhance China's economic and military dimensions of its national power (Li, 2015; Lee and Sheehan, 2018).[9] While BRI investment is predominantly in emerging markets with comparably low-levels of technology maturity, human capital, and military power the BRI framework supports a broader agenda to expand China's geopolitical sphere of influence and improve its

position in the future distribution of power - especially vis-à-vis the United States.

In the case of quantum technology, the potential convergence between AI and quantum computing could create promising synergies that Beijing intends to leverage to ensure it is at the forefront of the so-called 'quantum AI revolution.' Chinese analysts and strategist anticipate that quantum technologies will radically transform future warfare, with a strategic significance equal to nuclear weapons (PLA Daily, 2016). In 2015, for example, Chinese researchers reportedly achieved a breakthrough in the development of a quantum machine learning algorithms, which could relieve several military-technological bottle-necks (e.g., quantum radar, sensing, imaging, metrology, and navigation), allowing greater independence from space-based systems - where currently China lags the U.S. - enhance ISR capabilities; potentially creating new vulnerabilities in U.S. space-based GPS and stealth technology in future conflict scenarios - especially in the undersea domain (Kania and Costello, 2018 p. 18).

In sum, the evidence suggests a strong link between Beijing's pursuit of AI leadership and its broader geopolitical objectives. This link has, in turn, reinforced the narrative within the U.S. defense community that China believes this technological transformation is an opportunity to strengthen its claim on the leadership - and eventual dominance - of the emerging technological revolution, having missed out on previous waves (Godement, 2018 pp.1-5). In sum, despite the clear economic issues at stake (i.e., the rents to be captured in the data-driven economy), the threat to U.S. technological hegemony is generally interpreted through a military and geopolitical lens.

By contrast, the increasingly strained relationship between the Trump administration and Silicon Valley will likely pose additional challenges to this critical partnership in the development of AI technologies for the U.S. military. Following a recent high-profile backlash from employees at Google, for example, the company recently announced that it would discontinue its work with the Pentagon on Project Maven (White, 2018). Several defense analysts and U.S. government reports have noted the growing gap between the rhetoric and the research momentum (especially in AI and robotics), and the paucity of resources available, to make the U.S. military

more networked and integrated (Harris, 2018).

Specifically, these reports highlight various shortcomings in the U.S. defense innovation ecosystem such as inadequate funding to sustain long-term R&D, institutional stove piping inhibiting multi-disciplinary collaboration, and an insufficient talent pool to attract and retain top scientists in AI-related fields (U.S. Department of Defense, 2017). In its debut AI strategic report, the DoD committed to "consult with leaders from across academia, private industry, and the international community" and "invest in the research and development of AI systems" (U.S. Department of Defense, 2019 p. 5). Details of the implementation and funding arrangements for these broad principles remain mostly absent, however. Moreover, the apparent mismatch (even dissonance) between the rapid pace of commercial innovation in AI technologies, and the lagging timescales and assumptions that underpin the U.S. DoD's existing procurement processes and practices could exacerbate these bilateral competitive pressures (Kennedy and Lim 2016 pp. 553-572).

China's pursuit of AI-related (especially dual-use) technologies will fuel the perception (accurate or otherwise) in Washington that Beijing is *intent* on exploiting this strategically critical technology to fulfill its broader revisionist goals (Wohlforth, 2011, p.37).[10] That is, once the 'digital silk road' initiative reaches fruition, BRI could enable China's 5G, AI and precision navigation systems to monitor and dominate the IoT, digital communications and intelligence of every nation within the BRI sphere of influence, as part of Beijing's strategic objective, to ensure the leadership of a new international order; China's version of the Greater East Asia Co-Prosperity sphere, or Halford Mackinder and Mahan's theories of world control (Beasley, 1991).

Towards this end, in 2017, Beijing established the 'Military-Civil Fusion Development Commission,' designed to expedite the transfer of AI technology from the commercial research centers to the military. Recent Chinese achievements in AI demonstrate Beijing's potential to realize this goal. For example, in 2015 Baidu reportedly designed AI software capable of surpassing human-levels of language recognition, a year before Microsoft achieved a similar feat (Hempel, 2018). In the defense realm, China is actively researching a range of air, land, and sea-based

autonomous vehicles (Gertz, 2018). In 2017, following reports of a computer-simulated swarming destroying a missile launcher; a Chinese university with ties to the People's Liberation Army (PLA) demonstrated an AI-enabled swarming of 1,000 unmanned aerial vehicles at an airshow (Global Times, 2017). In addition, open-sources indicate that China is also pursuing a range of AI-enabled applications to augments its existing cyber (offensive and defensive) capabilities (Li, 2016).

In addition to this unique scaling advantage, China's defense AI innovation has also benefited from its approach to AI acquisition: a centralized management system where few barriers exist between commercial, academic, and national security decision making. While most external analysts consider China's centralized approach to the development of AI affords it with unique advantages over the U.S., others posit that Beijing's AI strategy is far from perfect. Some analysts, for example, have characterized Beijing's funding management as inherently inefficient. These analysts note that China's state apparatus is inherently corrupt and that this approach tends to encourage overinvestment in particular projects favored by Beijing, which may exceed market demand (He, 2017). Moreover, though China has already surpassed the U.S. in the quantity of AI-related research papers produced between 2017 and 2018, the quality of these papers rank far below U.S. academic institutions (Castro et al., 2019).

Furthermore, China is currently experiencing a shortage of experienced engineers and researchers to develop AI algorithms, and as few as thirty Chinese universities produce indigenous experts and research products. As a corollary, industry experts have cautioned that Beijing's aggressive and centralized pursuit of AI, could result in poorly conceptualized AI applications that adversely affect the safety of AI-enabled military applications, which increase the potential systemic risks associated with these innovations (Barton and Woetzel, 2017). The comparatively measured pace of U.S. military AI innovation might, therefore, in the longer-term result in more capable tools, but without sacrificing safety for speed - even at the cost of falling behind China's AI quantitative lead in the short-term.

Two-horse military AI arms race?

As the most powerful nation-states and leaders in the development of AI, the competitive tensions between China and the United States have often evoked comparisons with the Cold War-era U.S.-Soviet space race. In response to the global AI arms race, and to sustain U.S. superiority and first-mover advantages in AI, U.S. General John Allen and Spark Cognition CEO Amir Husain have argued that the U.S. must push further and faster to avoid losing the lead to China (and to a lesser degree Russia) in the development of AI (Allen and Husain, 2017). While these depictions accurately reflect the *nature* of the increasingly intense competition in the development of AI-related technologies, the *character* of this particular arms race intimates a more multipolar reality - compared to the Cold war-era bipolar space race. Over time, this trend will likely elevate technically advanced small and middle-powers (e.g., South Korea, Singapore, Israel, France, and Australia) to become pioneers in cutting-edge dual-use AI-related technology, and key influencers shaping future security, economics, and global norms these innovations.

Specifically, the commercial driving forces underlying AI technology (i.e., hardware, software, and R&D), together with the inherently dual-use nature of AI-related innovations, reduce the usefulness of the space race analogy (Organski and Kugler, 1980; Gilpin, 1981). In short, the particular problem-set associated with the Cold War-era bipolar structure of power (i.e., a pernicious obsession with the other sides' military capabilities) is, to date at least, far less intense in the context of contemporary competition in AI. Where primarily commercial forces drive military innovation, and in particular, when imitation is quicker and cheaper than innovation, technology tends to mature and diffuse at a faster pace compared to military-specific applications, such as stealth technology (Horowitz, 2011; Gilli and Gilli, 2019 pp.141-189). Second-mover catch-up possibilities in military-use AI through imitation are, therefore, unlikely to be feasible or cheap for states to develop.

As the literature on the diffusion of military technology demonstrates: how states react to and assimilate innovations can have profound implications for strategic stability, and in turn, the likelihood of war (Koblentz, 2014). Specifically, the pace

military actors diffuse technology can influence the relative advantages derived by states from being the first-mover, which tends to be reversely correlated to the speed innovations are adopted (Singer, 2009). As the costs and availability of computing power (an essential ingredient for AI machine learning systems) decrease, therefore, so technically advanced military powers will likely pull away from those actors who are more (or entirely) reliant on mimicry and espionage (Gilli and Gilli, 2019 pp.141-189). Moreover, this trend will likely be compounded if either the cost or complexity of AI algorithms increases; allowing AI first-movers to maximize their competitive advantages (Hof, 2013).

Despite the growing sense the proliferation AI technologies driven by powerful commercial forces, will inevitably accompany (and even accelerate) the shift towards multipolarity, important caveats need to accompany prognostications about the pace and nature of this transformation: the risks associated with the proliferation and diffusion of dual-use AI technologies across multiple sectors and expanding knowledge-bases is a very different prospect compared to arms-racing between great power military rivals. Thus, the development of military AI applications based on military-centric R&D would make it much more difficult and costly for smaller (and especially less technically advanced) states to successfully emulate and assimilate (Brooks, 2006; Cavarely, 2007 pp. 598-614).

Moreover, military organization, norms, and strategic cultural interests and traditions will also effect how AI systems are integrated into militaries, potentially altering the balance of military power (Johnstone, 1995 pp.65-93). In short, military technologies in isolation will unlikely alter how militaries prepare for warfare, deter and coerce their adversaries, and fight wars. Instead, the interplay of technology and military power will continue to be a complex outcome of human cognition, institutions, strategic cultures, judgment, and politics (Biddle, 2006).

Exponential advances in the complexity of weapon systems have raised the technical know-how (or so-called ‘tacit knowledge’) barriers for militaries to imitate and diffuse these capabilities (Hamburger, Miskimens, and Truver, 2011 pp.41–50). In particular, the development of autonomous weapons systems where the platform is

required to both operate in cluttered and multi-domain contested environments (i.e., anti-access/area-denial zones), and interact with humans ergonomically, physiologically, and cognitively (U.S. Department of Defense, 2012 pp.46–49). Consequently, special-purpose AI applications that do not have clear commercial drivers or utility, or that require military-grade software development and assimilation (i.e., for classified use), the first-mover advantages of these capabilities will likely be substantial, and potentially unassailable. Moreover, the successful development and deployment of advanced weapon systems requires in-depth knowledge of an adversary's military doctrine, counter capabilities, tactical options, intentions, and combat environments these capabilities will likely be exposed to. Recent studies suggest AI machine learning techniques cannot compensate for human knowledge, innovation, and intuition; only complement them (Daugherty and Wilson, 2018 p. 76).

Despite the substantial benefits China has derived from a combination of globalization, acquisition of foreign high-tech companies and technology, massive foreign direct investments inflows, and active cyber espionage, it has struggled to close the military-technological gap with the U.S. (and Russia) and achieve new forms of conventional deterrence, in several fields including (Zhang, 2015 pp.210-212): stealth and submarine technology, fifth-generation jet fighters, precision targeting, and missile defense, GPS, satellite imagery (for data-collection and surveillance), and AI machine-learning. Thus, computer-assisted design, engineering, and manufacturing have not compensated for the difficulties of mastering new technologies, necessary to design modern weapon systems.

The pace of military-use AI diffusion to smaller-medium powers (and non-state actors) could also be constrained by three pivotal features of this emerging phenomenon: (1) hardware constraints (e.g., physical processors), and integrating increasingly complex software and hardware with internal correctness; (2) the algorithmic complexity inherent to AI machine learning approaches; and (3) the resources and know-how to effectively deploy AI code (Ayoub and Payne, 2016 p. 809). These features mean that military organizations will need to invest vast amounts of capital and resources in a broad range of disciplines (i.e., psychology, cognitive

science, communication, human-computer interaction, computer-supporter workgroups, and sociology) gaining experience through trial and error; to fuse AI with advanced weapon systems such as, autonomous vehicles, hypersonic weapons, and missile defense systems (U.S. Department of Defense, 2012 pp. 46–49). In sum, states will find it very difficult to develop and deploy military-use AI applications from technology derived from general ancillary dual-use applications alone.

As a corollary, the advantages China derives from its commercial lead in the adoption of AI and dataset ecosystem will not necessarily be easily directly translated into special-purpose military AI applications (Castro et al., 2019). China's strengths in commercial-use AI (e.g., 5G networks, e-commerce, e-finance, facial recognition, and various consumer and mobile payment applications) will, therefore, need to be combined with specialized R&D and dedicated hardware; to unlock their potential dual-use military applications and augment advanced weapon systems.

Absent the requisite level of resources, know-how, datasets, and technological infrastructure, therefore, these constraints could make it very difficult for a new entrant to develop and deploy modular AI with the same speed, power, and force as the U.S. or China (Gray, 2015 pp.1-6). For example, China and the United States are in close competition to develop the supercomputers needed to collect, process, and disseminate the vast amounts of data that traditional computers can handle. While the United States possesses more powerful systems, China trumps the U.S. in terms of the number of supercomputers. Thus, military-led innovations could potentially concentrate and consolidate leadership in this nascent field amongst current military superpowers (i.e., China, the U.S., and to a lesser extent Russia), and revive the prospect of bipolar competition (Bostrom, 2014). For now, it remains unclear how specific AI applications might influence military power, or whether, and in what form these innovations will translate into operational concepts and doctrine (Cummings, 2017).

In sum, the degree to which AI alters the military balance of power, and in turn, how its effects nuclear stability, will depend on large part the speed of the diffusion this technology; as a functions of human innovation, political agendas, and strategic

calculation and judgment, against the backdrop of a multipolar world (and nuclear) order, and heuristic decision making (or the propensity for compensatory cognitive short-cuts) associated with decisions taken under compressed timeframes in uncertain and complex environments (Beverchen, 2007 pp.45-56).

Conclusion:

This article has made the following central arguments. First, while disagreement exists on the likely pace, trajectory, and scope of AI defense innovations, a consensus is building within the U.S. defense community intimating that the potential impact of AI-related technology on the future distribution of power and the military balance will likely be transformational, if not revolutionary. These assessments have in large part been framed in the context of the perceived challenges posed by revisionist and dissatisfied great military powers (i.e., China and Russia) to the current U.S.-led international order - rules, norms, governing institutions - and military-technological hegemony. Today, the United States has an unassailable first-mover advantage in a range of AI applications with direct (and in some cases singular) relevance in a military context.

Second, the rapid proliferation of AI-related military-technology exists concomitant with a growing sense that the United States has dropped the ball in the development of these disruptive technologies. Even the perception that America's first-mover advantage in a range of dual-use enabling strategic technologies (i.e., semiconductors, 5G networks, and IoT's) was at risk from rising (especially nuclear-armed) military powers such as China, the implications for international security and strategic stability could be severe. In response to a growing sense of alacrity within the U.S. defense community cognizant of this prospect, the Pentagon has authored several AI-related programs and initiatives designed to protect U.S. dominance on the future digitized battlefield (e.g., the Third Offset, Project Maven, the JAIC, and the DoD's debut AI strategy). Further, broader U.S. national security concerns relating to Chinese efforts to catch up (and even surpass) the U.S. in several critical AI-related enabling technologies, has prompted Washington to take

increasingly wide-ranging and draconian steps to counter this perceived national security threat.

Third, and related, in the development of AI evocations of the Cold War-era space race does not accurately capture the nature of the evolving global AI phenomena. Instead, compared to the bipolar features of the U.S.-Soviet struggle, this innovation arms race intimates more multipolar characteristics. Above all, the dual-use and commercial drivers of the advances in AI-related technology will likely narrow the technological gap separating great military powers (chiefly the U.S. and China) and other technically advanced small-medium powers. These rising powers will become critical influencers in shaping future security, economics, and global norms in dual-use AI.

In the case of military-use AI applications, however, several coalescing features of this emerging phenomena (i.e., hardware constraints, machine-learning algorithmic complexity, and the resources and know-how to deploy military-centric AI code), will likely constrain the proliferation and diffusion of AI with militaries' advanced weapon systems for the foreseeable future. In turn, these constraints could further concentrate and consolidate the leadership in the development of these critical technological enablers amongst the current AI military superpowers (i.e., China and the United States), which could cement a bipolar balance of power and the prospect of resurgent bi-polar strategic competition.

Today, the United States has an unassailable first mover advantage in a range of AI applications with direct (and in some cases singular) relevance in a military context. However, as China approaches parity, and possibly surpasses the U.S. in several AI-related (and dual-use) domains, so the U.S. will increasingly view future technological incremental progress in emerging technologies - and especially unexpected technological breakthroughs or surprises - through a national security lens. Thus, responses to these perceived threats will be shaped and informed by broader U.S.-China geopolitical tensions (Waltz, 1979). These concerns resonated in the 2018 U.S. Nuclear Posture Review (NPR). The NPR emphasized that the coalescence of geopolitical tensions and emerging technology in the nuclear domain, in particular, how

unanticipated technological breakthroughs in "new and existing innovations," might change the nature of the threats faced by the United States and the "capabilities needed to counter them." (NPR, 2018, p.14). In sum, against the backdrop of U.S.-China geopolitical tensions, and irrespective of whether China's dual-use applications can be imminently converted into deployable military-use AI, U.S. *perceptions* of this possibility will be enough to justify draconian countermeasures.

Several future research questions outside the scope of this study would benefit from further study: How might rising powers and non-state actors leverage AI technologies in ways that threaten the strategic environment of nuclear-armed great powers? How might the diffusion of dual-use AI to medium-small and non-state actors affect great power strategic stability? As the distribution of military AI capabilities begins to diffuse to small and medium rising powers, independent of poles how might these states behave in the new multipolar order? Related, under what conditions can mastery of a particular technology such AI affect the global balance of power? Less dependent on the U.S. for their security, might rising power be more (or less) inclined to cooperate and form new regional bonds, or instead, grow to fear one another? And, how might the pace of this transition influence this outcome.

Notes:

[1] Recent progress in AI falls within two distinct fields: (1) 'narrow' AI, and particularly, machine learning; (2) 'general' AI, which refers to AI with the scale and fluidity akin to the human brain. Most AI researchers anticipate that 'general' AI to be at least several decades away. Narrow AI is already utilized in the private sector, in particular, in data-rich research fields and applied sciences. Most experts generally agree that the development of 'general' AI is at least several decades away, if at all.

[2] The line between core AI and 'AI-related' technology is a blurred one. For the purposes of this study, core AI technology includes: machine-learning (and deep-learning and deep networks sub-set), modelling, automated language and image recognition, voice assistants, and analysis support systems; whereas 'AI-related' (and AI-enabling) technology includes: autonomous vehicles, big data analytics, 5G networks, supercomputers, smart vehicles, smart wearable devices, robotics, and the internet of things, to name a few.

[3] There is an important difference, however, between narrowing the gap in certain fields, and gaining an overall lead across all the categories (i.e., talent, research, development, hardware, data, and adoption) in the emerging AI race. In a recent report published by the Center for Data Innovation: "Overall, the United States currently leads in AI, with China rapidly catching up, and the European

Union behind both. The United States leads in four of the six categories of metrics this report examines (talent, research, development, and hardware),…[while] … China leads in two (adoption and data)," (Castro et al., 2019, p.2.). Chinese open-source data also confirms the trend that the U.S. is ahead of China in these categories (China Institute for Science and Technology
Policy at Tsinghua University, July 2018).

[4] Polarity analysis focuses on whether the inter-state order is dominated by one (a unipolar order), two (a bipolar order) or three or more (a multipolar order) centers of power. 'Multipolarity' in this context implies that no single state is unambiguously in the lead (or polar) in the international order. In contrast, to 'bipolarity' that implies much less ambiguity in the stratification of power surrounding two poles. In addition to military power, economic capacity, demographics, 'soft power,' and the broader social dimensions of state influence have been associated with the shift towards a multipolar order. See, William C. Wohlforth, "Unipolarity, status competition, and great power war," in *International relations theory and the consequences of unipolarity* ed. John Ikenberry, pp. 33-65 (Cambridge University Press, 2011). For critiques on this contested concept see, Harrison R. Wagner, *War and the State: The Theory of International Politics* (The University of Michigan Press, 2009); and Randall L. Schweller, "Entropy and the Trajectory of World Politics: Why Polarity has become Less Meaningful," *Cambridge Review of International Affairs*, 23:1, 2010, pp. 145–63.

[5] The principal forces driving this evolution include: (1) the exponential growth in computing performance; (2) expanded datasets; (3) advances in the implementation of machine learning techniques and algorithms (especially in the field of deep neural networks); and above all, (4) the rapid expansion of commercial interest and investment in AI.

[6] Examples for technically advanced small-medium powers who have actively invested in AI-related technologies include: South Korea, Singapore, France, and the U.K. Today, however, the U.S. and China lead in most metrics (i.e., talent, research, development, adoption, data, and hardware) used to rank states in the emerging race for AI innovation leadership (Castro, et al., 2019).

[7] China's recent five-year plan reportedly committed over USD$100 billion to AI. Moreover, as China moves forward with its One Belt One Road-related projects that extend to potentially more than eighty countries, AI would become an integral part of these international infrastructure projects.

[8] In quantum computing, for example, China has made significant efforts to integrate its quantum computing and AI research for boosting computer AI power and achieve 'quantum supremacy' - or the point at which a quantum computer is capable of outperforming a traditional computer. Chinese researchers have claimed to be on track to achieve 'quantum supremacy' as soon as 2019.

[9] The economic gains that China may make through commercial applications such as BRI are not dependent upon dual-use technology or geopolitics alone; gains are also based on geoeconomics.

[10] A distinction exists between the erosion of U.S. advantages in ancillary applications based on dual-use AI technologies, and in military-specific AI applications. Where the U.S. retains an unassailable edge in military capacity and innovation, the actual 'threat' posed to U.S. in the military-technological sphere is less immediate than in general-use AI. This implies the 'threat' narrative is more centered on perceptions of Beijing's future intentions as its military-use AI matures.

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