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Algorithmic Warfare, a concept ideally suited for the American military apparatus and way of war, gives the United States a competitive advantage. The Marine Corps is aptly suited for the development of an expeditionary fusion warfare operating concept which can serve as a springboard for force design. Without these concepts to align strategies, all efforts to main, train, and equip the force with emerging technologies in the field of artificial intelligence will endanger our warfighters and national interests.

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MASTER OF MILITARY STUDIES

Warfare in the Third Offset: An Appeal for Joint and Service Concepts

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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EXECUTIVE SUMMARY

Title: Warfare in the Third Offset: An Appeal for Joint and Service Concepts

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Thesis: The Joint Force must establish an effective framework consisting of concept driven strategies for AW while the Marine Corps must pioneer the development of an Expeditionary Fusion Warfare Functional Concept. By evolving the Maneuver Warfare philosophy with the character of the third offset to craft a new operating concept, the Joint Force can gain and maintain a competitive advantage.

Discussion: The initial and interim reports from the National Security Commission on Artificial Intelligence, along with the 2019 Commandants Planning Guidance, are empathic overtures for the development of intrepid new concepts, which leverage the transformative potential of Robotic Autonomous Systems (RAS) and Artificial Intelligence (AI). When former Secretary of Defense Chuck Hagel announced Defense Innovation Initiative in 2015, it was supposed to have begun an era of profound innovation, experimentation, and development of new ways of operating. Instead, the entire US National Security apparatus has floundered in its pursuit of meaningful transformation into the age of AI. That failure means the decisive, asymmetric advantage promised by the third military offset is slipping further and further away.

Meanwhile adversaries such as the China and Russia have already embraced the exceptional potential of AI. In 2017, China published an ambitious and comprehensive AI strategy, while a year later Russia announced its AI policies with their AI: Problems and Solutions Conference. If these AI strategies are realized they would generate asymmetric advantages that threaten American interests and national security. Both Russia and China have developed these strategies around concepts that apply lethal autonomous weapons systems (LAWS) at the tactical level of war, while using AI at the operational and strategic levels. Once realized these concepts will change the character of conflict and present the DoD with problems and risk it is not prepared to face.

Conclusion: Despite trailing in the development and implementation of both artificial intelligence strategy due to the absence of unified joint operating concepts there is still an opportunity for the DoD to gain a competitive advantage. Algorithmic warfare (AW) is a concept ideally suited for to the American military apparatus and way of war and gives the United States (US) a way to achieve a decisive, asymmetric advantage. Meanwhile, the Marine Corps (due to the character and state of the service) has the unique opportunity to develop an expeditionary fusion warfare concept which will serve as a springboard for its ongoing force design efforts. However, without these concepts to align strategies, all efforts to man, train, and equip the force with emerging technologies in the field of AI and RAS waste precious resources and have the potential to endanger our warfighters and our national interests while ceding greater advantage to adversaries.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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INTRODUCTION

"Drastic changes in war are the result of developments that dramatically upset the equilibrium of war"[1] *– MCDP-1*

In May 1997, world champion chess master Garry Kasparov became the first human to lose to a computer. The computer, named "Deep Blue", was engineered by International Business Machine (IBM) and defeated Kasparov with a simple form of reactive artificial intelligence (AI) using supervised machine leaning. This watershed moment in the information age was eclipsed two decades later when world champion Go master Lee Sedol suffered an emotional defeat to a computer engineered by Google's DeepMind Laboratory. However, this time the computer (named "AlphaGo"), used a more advanced limited memory artificial intelligence which employed unsupervised machine learning.[2]

Hardly clashes between great military powers, these seminal moments in the information age ushered in a new era of technological innovation. These pivotal cultural events introduced the world to the AI Revolution (a component of the information or digital age) which is fundamentally changing "the way we live, work, and relate to one another".[3] Characterized by "unprecedented and simultaneous advances in AI, robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, energy storage, [and] quantum computing [this revolution is] redefining industries, blurring traditional boundaries, and creating new opportunities."[4] How states perceive the possibilities and implications of the information age vary dramatically, but one thing is unanimous: the combination of AI with other elements of the information age has the potential to dramatically affect the character of war and thus alter the balance of power. Culture, national interests, and a myriad of other factors have profoundly influenced how states have pursued AI and envisioned its role in national security, military affairs, and all other instruments of national power. These wildly different perceptions

have significantly influenced how states conceptualize the future character of war in the information age and the relationship humans will play in future military operations.

Meanwhile, the security environment continue to evolve into an ever more complex system characterized by "rapid technological change, challenges from adversaries in every operating domain, and the impact on current readiness from the longest continuous stretch of armed conflict in our Nation's history."[5] America's technological superiority is in a state of decline, due to "over a decade focused on grinding stability operations, countries like Russia and China have been heavily investing in military modernization programs to blunt our military's technological edge."[6] From a single service perspective, in the 2019 *Commandant's Planning Guidance* General David Berger, concluded that: "the Marine Corps is not organized, trained, equipped, or postured to meet the demands of the rapidly evolving future operating environment."[7]

The AI revolution has inspired a new way of war, which former deputy Secretary of Defense Robert Work dubbed Algorithmic Warfare (AW).[8] AW is the evolution of the "hyperwar"[9] concept, in which everything on the battlefield is connected near instantaneously via digital means, capable of highly lethal and precise effects, all making decisions autonomously and coordinated via intelligent algorithms.[10] These algorithms are sophisticated computer codes which have the appearance of representative human reasoning and logical inference and provide a means to anticipate or predict the future.[11] AW therefore offers unprecedented potential for military operations in the wider context of the AI revolution. However, Misgivings about the human-machine command and control relationship combined with uninformed misperceptions about the state and form of AI have produced a narrative that is unnecessarily restrictive on the national security apparatus.[12] National security professionals

have been absent in shaping this narrative, while the problem is exacerbated by the divide between military institutions and commercial and academic sectors. Further, much of the military's doctrine, organization, training, manpower, leadership and education, personnel, and facilities (DOTMLPF) remains trapped in the third industrial revolution.[13]

The current state of the Marine Corps is emblematic of the larger Joint Force and even the national security apparatus writ large. While America is failing to fully embrace advances in technology and warfighting, the rest of the world is not. Several years ahead of the US, both China and Russia have prioritized the coordinated development of AI (establishing it as a "high strategic priority")[14], and woven it into all instruments of national power. Those tow powers have placed special emphasis on the role of AI in military affairs to establish a new form of warfare, known as "algorithmic warfare."[15] Both countries have made it clear they are in the midst of an AI arms race, where the winner (as Russian President Vladimir Putin has stated): "will become the ruler of the world".[16]

With the development of increasingly capable and lethal AI concepts, competitors are pursuing strategies that will give them a decisive asymmetric advantage. Warfighting, the foundation of Marine Corps doctrine and philosophy, states that "if we are ignorant of the changing face of war, we will find ourselves unequal to its challenges."[17] The Joint Force must establish an effective framework consisting of concept driven strategies for AW while the Marine Corps must pioneer the development of an Expeditionary Fusion Warfare Functional Concept. By evolving the Maneuver Warfare philosophy with the character of the third offset to craft a new operating concept, the Joint Force can gain and maintain a competitive advantage.

DISSCUSSION

National Security Commission on Artificial Intelligence

Despite seven decades of research and innovation only recently have technological advancements created the foundation necessary for AI to flourish: big data, powerful processing, and training.[18] The Association for the advancement of AI, the largest Society of scientists and engineers in the field, defines AI as the pursuit of the "scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines."[19] AI is extremely broad encompassing anything whereby a computer system has the ability to perform tasks that otherwise would require human intelligence or other forms of intelligence observed in nature.[20] The Congressional Security Commission on AI adds that AI is an artificial System developed in computer software, physical hardware, or other contexts that solves tasks requiring human like perception, cognition, planning, learning, communication, or physical action.[21] Despite the copious number of organizations involved with AI there is not one authoritative, official governing body, resulting in a lack of laws and norms. Consequently, countries are exploiting this lack of governance as they zealously race to implement their own concepts of AW for military operations.

The metaphorical AI arms race is being galvanized by China's strategic AI vision coupled with Russia's aggressive willingness to weaponize AI. Urgency, if not panic, instilled a sense that any further hesitation to enter, and lead, the AI arms race would be crippling for US Security and defense. America's response came in 2019 with Executive Order 13859: The American AI Initiative. Shortly thereafter, Congress authorized a commission of leading experts in industry, science and technology, and security to report on AI's impact to National Security. In November 2019, the commission released a highly anticipated interim report. It confirmed

what experts had long-suspected: strategic competitors and non-state actor's investment in RAS/AI has usurped America's role as a leading innovator while simultaneously threatening critical [US] infrastructure, amplifying disinformation operations, and even the conduct of war.[22] The commission bluntly asserted that China had deployed AI to advance an autocratic agenda and to commit human rights violations.[23] The commission also made it clear that China and Russia want to use AI-enabled autonomous weapons in their military strategies, operations, and capabilities to undermine US military superiority and conventional deterrence.[24] The commission concluded that the US is in nothing less than a high-stakes strategic competition, with AI at the center, and the very future of our national security at stake.[25]

Despite their ominous interim report and even considering the head-start enjoyed by China and Russia the commission was confident that by leveraging advantages in AI research and AI talent pool the US decentralized, entrepreneurial free market system is primed to assert the US at the top of the AI arms race.[26] Even without any national AI strategy the US has still given rise to 75% of the world's top 100 AI start-ups (home to more than 2000 in total), while leading the world every year in both AI patents and overall investment (a gap being narrowed by the Chinese).[27] In order to reassert itself as the world leader in AI innovation, the commission introduced five lines of effort for the US Government:[28]

Line of Effort 1	Invest in AI R&D
Line of Effort 2	Apply AI to national security missions
Line of Effort 3	Train and recruit AI talent
Line of Effort 4	Protect and build upon technological advantages

Line of Effort 5	Marshal Global AI Cooperation

Source: US Commission on AI: Interim Report to Congress

Artificial Intelligence and the Department of Defense

In 2019 the DOD finally released its own AI Strategy outlining a strategic vision for AI adoption, thus setting the stage for the services to craft their own respective strategies. The scope of the strategy is immense given its affirmative conclusion that "AI is poised to transform every industry, and is expected to impact every corner of the Department, spanning operations, training, sustainment, force protection, recruiting, healthcare, and many others."[29] The strategy also addressed significant investments made by Russia and China in AI which threaten to erode the US military advantage. Despite failing to offer a unifying joint AI operating concept, the strategy does explicitly state one of the purposes behind "the rapid and iterative incorporation of AI to address key missions"[30] is to "experiment with new operating concepts and to create repeatable processes and systems that allow all elements of the Department to do the same."[31]

The multiple visions for AI operating concepts stems from differing perceptions of the types of AI and their potential. There are two types, or classifications, of AI: weak AI or strong AI. Weak AI, or artificial narrow intelligence (ANI) is used for a particular use case. Conversely, strong AI, or artificial general intelligence (AGI), can engage in human-like abilities.[32] ANI encompasses all existing AI, including even the most complicated and capable that has been created and is further broken down into reactive machines or limited memory machines. ANI has been making decisions in combat for decades in systems such as the Aegis system and the Terminal High-Altitude Area Defense system.[33]

Similarly, AGI is also divided into two types: theory of mind AI and self-aware AI.[34] AI possessing theory of mind will be able to better understand the entities it is interacting with by

discerning their needs, emotions, beliefs, and thought processes.[35] Self-Aware AI will not only understand humans (like theory of mind) but possesses its own emotions, needs, and beliefs. AGI will theoretically replicate human's multi-functional capabilities with the ability to learn, perceive, understand, and function exactly like a human being. AGI remains an abstract concept, with some experts predicting it could be decades or more away from realization and scalability for mass availability.[36] AGI remains theoretical only despite tremendous research and development (R&D). However, that has done little to temper the excitement over its possibilities and the hysteria AGI has generated when thought about in relation to the conduct of war.

While pursuit of AGI remains elusive, developments in digitized data and rapidly advancing computational processing power[37] have resulted in tremendous proliferation of ANI systems. There has been a flurry of R&D recently, as more than half of all AI patents occurred in the last six years alone.[38] Neil Sahota, the AI Advisor to the United Nations, has credited current breakthroughs in AI innovation to a massive explosion in the quantity, quality, and availability of information (the sum of which is known as big data). The current surge in big data is accelerating at an astonishing rate, in which "we are now producing data so fast that every year, 90 percent of all the data ever produced in the history of the world has been generated in the previous 12 months."[39] Even more remarkably, that percentage is actually increasing with every passing year.[40] The potential of existing ANI in military operations is a phenomenon coined "tactical AI" by Dr. Kenneth Payne (AI expert and ethicist). Payne proposes that "tactical AI in combat hints at radical changes in prospect [force design], including to weapons design, organizational structures, and the ability of humans to direct the action once under way."[41] AI therefore deserves the label of being revolutionary, bordering on evolutionary, because (unlike even

nuclear weapons) it will entail "decision-making of a distinct, nonhuman variety" which fundamentally affects the relationship between strategy and psychology.[42]

Established in 2018, The Joint Artificial Intelligence Center (JAIC) was designated to serve as the focal point for all military AI efforts and given the mission of closing the gap between the US military and its competitors.[43] The 2019 DoD AI Strategy further tasked the JAIC with three essential tasks: accelerating the delivery of AI-enabled capabilities, scaling the Department-wide impact of AI, and synchronizing DoD AI activities to expand Joint Force advantages.[44] The JAIC has five key focal points designed to accelerate RAS/AI adoption across the joint force to address these essential tasks:[45]

Focal Point 1	Launch a set of rapidly, iteratively, and responsibly in order to deliver AI-enabled capabilities that address key missions
Focal Point 2	Achieve scale, and impact across the DoD through a common foundation (of shared data, reusable tools, frameworks and standards, and cloud and edge services) that enables decentralized development and experimentation.
Focal Point 3	Cultivate a leading AI workforce.
Focal Point 4	Engage with commercial, academic, and international allies and partners forging strong partnerships at every stage, from research to deployment, and sustainment.
Focal Point 5	Establish itself as a leader in military ethics and AI safety.

Source: US Joint Artificial Intelligence Center Homepage

The JAIC has focused its efforts on addressing two of the three essential ingredients for AI: big data and training (the third ingredient being processing power).[46] The task has been anything but easy, as the Director the JAIC LTGEN Jack Shanahan puts it, "What has stymied most of the services when they dive into AI is data, they realize how hard it is to get the right data to the right place, get it cleaned up, and train algorithms on it."[47] Despite having vast amounts of data as a by-product of the second offset, Shanahan dishearteningly "can't think of

anything that is really truly AI-ready (because with) legacy systems we're essentially playing the data as it lies, which gets complicated, because it's messy, it's dirty…you have certain challenges of data quality, data provenance, and data fidelity, and every one of those throws a curve ball."[48]

The explosion in big data, processing power, and training has led to an explosion in the proliferation of robotic systems.[49] Combining AI with robotic systems creates unique powered machines, composed minimally of a platform, software, and a power source; capable of executing a set of actions by direct human control, computer control, or both with autonomy while possessing the quality of being self-governing to achieve an assigned task based on the system's own situational awareness, planning, and decision-making.[50] The combination of robotic autonomous systems (RAS) with AI (RAS/AI) is a the new frontier in what DARPA calls the second wave of AI.[51] Demonstrative of this growth are systems (namely unmanned aerial and ground systems) which have already logged thousands of hours supporting combat operations in Iraq, Syria, Afghanistan, and all other combatant commands, plus burgeoning growth in automated unmanned weapons systems. While these systems are not specifically fitted with weapons systems their combination (with exponentially more) RAS/AI possessing kinetic and non-kinetic systems has led to the exploration of lethal autonomous weapons systems (LAWS).[52] As noted in a 2018 Congressional report LAWS and "The nexus of RAS/AI has the potential to change the nature of warfare".[53] Its adoption "improves performance and reduces risk to soldiers and Marines; offers new force designs; better institutional support to combat forces; new operational concepts; and possible new models for recruiting and retaining soldiers and Marines."[54]

How the character of war changes in the age of AI has been largely framed by a cacophony of noise from outside the national security apparatus. Attempting to wrest that narrative back to national security professionals, Secretary of Defense (SECDEF) Chuck Hagel introduced the "Defense Innovation Initiative" in 2014.[55] Similar to previous offset strategies, the challenge confronting the US military today is a "period of fiscal austerity of uncertain duration [coupled with] an array of mounting security challenges [against which] the US cannot afford to simply scale up the current mix of joint power projection capabilities".[56] Therefore, "game-changing advances in AI, robotics, and other technologies" will be the defining feature of the third offset strategy according to former Deputy SECDEF Robert Work.[57] Military offset strategies deliberately change the equation of an unfavorable military competition by applying a country's strengths to develop a radically innovative approach that addresses their disadvantage, thus fundamentally changing the national security equation.[58] The AI revolution creates the conditions for such an advantage by achieving "unparalleled speed, enabled by automating decision-making and the concurrency of action that will become possible by leveraging AI and machine cognition."[59] Known as "hyperwar", this type of warfare will be conflict "where human decision-making is almost entirely absent from the observe-orient-decide-act (OODA) loop…consequently the time associated with an OODA cycle will be reduced to near instantaneous responses."[60]

Once exclusively the domain of humans, decision-making is now shared with or delegated to AI. The introduction of RAS allows for not only the sharing or delegation of the decision but its execution as well. Thus RAS/AI of the future is not only it a far more than a decision facilitating tool, but an all-encompassing decision-making and execution system.[61] For militaries the combination of LAWS autonomously executing lethal action combined with AI

systems making decisions at all three levels of war (thus determining where and when to apply the instruments of national power and more specifically kinetic activities) makes the AW "radically different from earlier military-technological innovations".[62] In light of this, former SECDEF James Mattis remarked, "I'm certainly questioning my original premise that the fundamental nature of war will not change, you've got to question that now".[63]

Adversaries and AI

The success of US forces in the Persian Gulf war served as validation for the second offset and an opening salvo for military operations in the information age. America's competitors, partners, and military industrial complexes alike are moving forward aggressively to advance their concepts of hyperwar in the information age inclusive in their respective AI national strategies. Both Russia and China have developed concepts shaped by culture, economic and geo-political realities, and military manpower issues stemming from populations that are declining in number (while increasing in age). To offset these realities (and in concert with cultural values and norms) both Russia and China have developed concepts of AW which are driving heavy investment and dependence in RAS/AI technologies. Out of necessity or choice Russia and China see the human-machine command and control relationship far differently than the US. In the global AI arms race how states conceptualize the human-machine command and control relationship (as well as the form of AI, AI/RAS, and LAWS) will determine who achieves a true offset.

Chinese and Russian military leadership have long ago recognized how the AI revolution provides the framework for the evolution of "hyperwar". For years Russia has designated development in AI a "high priority" while China established it as a "core priority" (the highest stratum within their respective systems.)[64] Both states have established ambitious objectives,

backed by unity of effort, particularly in the sphere of defense and military application. Chiefly, China has also bolstered its lofty objectives with exorbitant budgets in hopes that such audacity may tilt the balance of power in their favor in little more than a decade.[65]

The People's Republic of China

China has been unequivocal in their belief that "the rapid development of AI will profoundly change human society, life, and the world."[66] In 2017 China unveiled their "New Generation Artificial Intelligence Development Plan" (NGAIDP), boldly aspiring to be the world leader in AI by 2030.[67] AI dominance has become a core priority for China and has manifested into the most comprehensive, integrated, and ambitious national AI strategy of any country as of 2020. In AI China sees a unique opportunity to develop it's own offset strategy and gain an asymmetric advantage over the US and other competitors as well as progress beyond their current place as a manufacturing powerhouse. China is not simply developing AI for military application but is ambitiously weaving their AI strategy across all instruments of national power. Through a carefully crafted and managed national AI strategy, China has woven their vision for AI dominance into larger grand national strategy with the confidence that AI will be the catalyst that shifts the balance of power. China envisages AI will become the new focus of international competition through which major developed countries will "enhance national competitiveness and protect national security".[68] Further, China has aggressively stated they intend for a "new generation of AI [to serve] as the main direction of attack".[69] Utilizing a decidedly human-out of the loop model at both the tactical level of war (with the use of LAWS) and at the operational level (with AI making decisions of where and when to apply forces) China is a provocative competitor, especially in light of its authoritarian regime and deep it is integration of all instruments of national power.[70]

The NGAIDP is segmented into five-year stages, culminating with their ultimate objective: dominance of all aspects of AI by 2030.[71] China's first milestone: by 2020 align with global advanced levels of AI. By 2025 China's objective is to have achieved major breakthroughs in AI and achieved world leading levels in some (but not all) areas. China set 2030 to reach world leading levels across all sectors of AI as their ultimate strategic objective. Those world leading levels translate to an AI powered state apparatus, wherein China's military is integrated with all other instruments of national power and a military with enough RAS/AI and LAWS to gain offset.

China is hedging its bet that it's ascension will be buoyed by an unbidding commitment to invest and build a powerful technological base commensurate of the fourth industrial age. China's New Generation Artificial Intelligence Development Plan is a part of an ambitious grand national strategy to transition it's impressive industrial economy into a more profitable technologically grounded economy. This vision has been backed by a 30-fold increase in overall technology R&D funding from 1991 to 2015, and is projected to surpass the US in absolute R&D spending by 2028.[72] China directs that investment at its "national team" of leading tech firms (Baidu, Alibaba, Tencent, iFlytek, and Sensetime.)[73] Thanks to China's "military-civil fusion"[74] the "national team" of tech firms synthesized and coordinated their development and deployment of new AI technologies. Additionally, AI startups in China have actually been a source of incredible growth: receiving nearly half of total global investment of all AI startups in 2017.[75] Even more alarmingly, the Chinese filed for nearly five times as many AI patents as did the US during that same period.[76] China's road map aims to create a $150 billion AI industry by 2030.[77] Comparatively, in 2018 the US government's investment in AI came in at $1.1 billion while even conservative estimates had China exceeding $7 billion that year.[78] With China's

trajectory headed towards $150 billion by 2028, the US investment will only reach $11 billion.[79] All of this intimates a finely tuned system wherein China's advancement and assimilation of cutting-edge, emerging RAS/AI technology is occurring at blistering speed and scale.

Underappreciated by most in the West, Lee Sedol's loss to AlphaGO had a deeply jarring cultural and psychological impact on the Chinese and has since significantly shaped Chinese perception of AI. Within months of the event, China's Central Military Commission Joint Operations Center argued that AlphaGo's victory demonstrated the enormous potential of AI in combat command, program deduction, and decision-making.[80] China's aggressive spending and R&D on AI technology is equaled by its furious transition from their "informationization warfare" doctrine of the 1990's to their new "intelligentized warfare" doctrine. Informationization warfare doctrine is a near-clone of the second US offset strategy, espousing the integration of an "array of command, control, surveillance, and reconnaissance (C4ISR) systems and concentrated on advancing capabilities for information operations, including cyber warfare, electronic warfare, and psychological warfare."[81] Curiously, in a rare break from their modus operandi China did not wait and copy US strategy for the impending third offset but achieved a head start with the development of their own intelligentized warfare doctrine. The backbone of intelligentized warfare is Chinese confidence that "AI will accelerate the process of military transformation, ultimately leading to a profound Revolution in Military Affairs".[82] The psychological significance of AlphaGo explains China's rare break from a traditional copy-cat role and their deep confidence in the potential AI offers their national security apparatus.

The NGAIDP Plan states that China will "promote all kinds of AI technology to become quickly embedded in the field of national defense innovation". Zeng Yi (a senior executive at China North Industries Group Corporation Limited, China's third largest defense company)

described that in battlegrounds of the future "there will be no people fighting" and that "AI may completely change the current command structure, which is dominated by humans to one that is dominated by an AI cluster".[83] The PLA have codified this vision of future battlefields dominated by RAS/AI and LAWS (absent of humans) into their concept "battlefield singularity" (a supporting concept to intelligentized warfare doctrine).[84] Far from science fiction, "battlefield singularity is the prevailing thought in Chinese defense circles, which expects "the pace of combat to eclipse the speed of human decision-making, leaving militaries no choice but to automate in order to survive."[85] PLA leadership postulate that "AI will transcend firepower, machine power, and information power, becoming the most critical factor in determining the outcome of warfare."[86]

Battlefield singularity is a distinctively "human out of the loop" command relationship in which fully autonomous RAS/AI systems execute warfighting functions without human intervention. Battlefield singularity aligns with Kenneth Payne's prediction that the speed of decision-making and the application of force performed by RAS/AI will grossly out cycle those of the "human in or on the loop" variety. PLA leadership hyperwar of this sped will require significant "upgrading of human cognitive performance to keep pace with the complexity of warfare".[87] Most audaciously the PLA state that "future intelligentized [concepts] are expected to involve prominent employment of intelligent autonomy in weapons systems under conditions of multi-domain integration with command exercised through brain-machine integration, enabled by cloud infrastructure."[88] Forecasting the impending change to the character of war "Chinese military scientists and strategists expect that this revolution in warfare will demand transformation of the human element of warfare, which may require seeking command of the brain and biological sciences".[89] In Battlefield singularity the PLA believe they have found their

asymmetric advantage and have hastened the replacement of informationization warfare doctrine with the manic adoption of intelligentized warfare doctrine.

The Russian Federation

Like China, Russia's audacious rhetoric has been unmistakable regarding the impact of RAS/AI in great power competition and thus their desire to harness it. In 2012 Russia established the Foundation for Advanced Studies, a clone of America's Defense Advanced Research Projects Agency (DARPA). Despite a decade's worth of investment in RAS/AI R&D Russia's Defense Ministry only released its official AI Strategy in 2018 in the form of a 10-point roadmap. The roadmap calls for the formation of an "AI and big data consortium, a fund for analytical algorithms and programs, a state-backed AI training and education program, a dedicated AI lab, and a National Center for AI, among other initiatives."[90] A year later President Vladimir Putin released the "Decree of the President of the Russian Federation on the Development of Artificial Intelligence in the Russian Federation."[91]

Russian strategy is less ambitious than China's (although perhaps not less cohesive), reflecting the realities of Russia's economic situation in relation to China's. Russia's more shrewd approach has also been shaped by several failed ostentatious ventures into AI over the last decade. Epitomizing these failures is the now defunct Skolkovo Center, which opened in 2010 with the hopes it would be Russia's answer to Silicon Valley. Russia came back in 2018 with a rebooted "Technopolis Center" called "Era" designed to be the hub of Russian AI the Skolkovo Center was intended to be. This time Russian applied a valuable lesson: AI innovation requires significant investment. While the Skolkovo Center was backed by a paltry $12.5 million budget, Russia has backed "Era" with a $500 million investment, which will double to $1 billion by 2024.[92]

In contrast to China's integrated grand national strategy the Russia's defense complex is taking the lead with a more focused approach aimed at powering Russian Hybrid Warfare Doctrine. Russia has been unambiguous about its intentions to incorporate AI, especially neural network technologies that power deep learning, to enable autonomous decision-making by weapons systems in everything from direct and indirect fire weapons, to tanks, to hypersonic missiles. Further, Russia and China have been stalwart roadblocks on the world stage preventing any efforts to establish standards and norms limiting the weaponization of RAS/AI. Striking a very similar tone as China, General Valery Gerasimov, Chief of the General Staff of the Russian Forces, has stated that "robots will be one of the main features of future wars… [Russia] is seeking to completely automate the battlefield."[93] Not only does Russian leadership share China's vision of "battlefield singularity" but it is also contending with how that changes the character of war: "In the near future it is possible a fully robotized unit will be created, capable of independently conducting military operations. How shall we fight under such conditions? What forms and means should be used against a robotized enemy? What sort of robots do we need and how can they be developed?"[94]

Gerasimov's vision of a completely automated battlefield is being brought to fruition by the furious pace of RAS/AI R&D by the Russian Defense Industry. A sampling of Gerasimov's automated battlefield have already been observed in Crimea and Syria.[95] In those conflicts Russia has fertile testing ground for its systems where they have already deployed the Uran-6 mine clearing system and the Scarab and decision-making Sphere situational awareness systems.[96] Meanwhile, the Russian defense titan Kalashnikov "is developing and launching an entire range of autonomous weapons, each with a 'neural network' enabling the machines to pick out targets and decide autonomously whether to engage."[97] Another defense industry giant

Degtyarev has built a drone named Nerekhta, which can "stealthily traverse close to a target, and then explode with the force to destroy fortifications or enemy tanks".[98] Several other projects such as autonomous nuclear submarines, smart swarm robot missiles, and the Armata T-14 Super Tank indubitably point to a human out of the loop concept, regardless of ambiguous statements coming out of the Kremlin.[99]

Algorithmic Warfare Operating Concept

In some respects, the American AI Initiative and the Congressional Commission was meant to reanimate SECDEF Hagel's stagnant Defense Innovation Initiative and address the problems confronting American AI for national security: lack of oversight, confusing direction, and non-existent governance. Suffocated by paranoid apprehensions over the ethics of AI for military purposes, there has been a void in operating concepts for AW and doctrine development. Without the requisite framework that concepts of operation provide the AI strategies the DoD and respective services do have were crafted in isolation and thus compartmentalized. The absence of strategic direction or formal concepts founded in Joint and service doctrine has exacerbated the compartmentalization of these strategies leading to a lack of inter (and even intra) service and DoD cohesion as well as integration. Inefficiencies run rampant and the core ingredients to successful AI (especially big data and training) continue to go unaddressed.

Joint Force 2030, the DODs Capstone Concept for Joint Operations, states that "as current capabilities are enhanced and new ones introduced, the Joint Force must develop innovative concepts of operation".[100] In 2016, Two years after the announcement of the Defense Innovation Initiative, the DOD released the Joint Concept for Robotic and Autonomous Systems (JCRAS). The JCRAS implores services to "change from incremental RAS development to a more comprehensive process and replaces approaches that merely add new technology to

existing systems and formations."[101] The JCRAS envisions that the DOD and services "will evolve as new capabilities are integrated [thus] requiring continuous evaluation of organizational structures and DOTMLPFP implications to optimize efficiency and effectiveness."[102] The imperative is to "aggressively pursue and integrate future technologies in a holistic manner, engaging in rigorous experimentation producing innovative operational approaches."[103] The JCRAS states that Commanders, planners, and the entire force must understand the unique capabilities, limitations, and advantages of RAS to develop innovative concepts of operations."[104]

The roots of the JCRAS can be found in a memorandum by the Department of the Navy released in 2015 titled "Treat Unmanned as Manned". The memorandum states that the DoN "will field and sustain diverse unmanned/autonomous forces capable of independent and integrated missions in all physical and operational environments."[105] The JCRAS presents a vision of "future RAS in use by 2035 which enhances the Joint Force's ability to adapt, fight, and win conflicts that are increasingly transregional, multi-domain, and multi-functional in order to guide comprehensive development".[106] The JCRAS describes a Joint Force that employs "highly-capable and interconnected RAS, teamed with humans across all joint functions, embedded into every echelon and formation, from tools for basic tasks into team members capable of coordinating and collaborating across domains and Services."[107] Bolstering this vision are three precepts: 1. Employ Human-RAS teams, 2. Leverage autonomy as a key enabler and match autonomy to the mission, and 3. Integrate RAS capabilities to develop innovative concepts of operation.[108]

The primary focus of the JCRAS is on Human-RAS teams (a concept the Marine Corps calls "manned-unmanned teaming" or MUM-T). Human-RAS teams enable mutual support and

seamless interaction through advances in human-machine collaboration, interoperability, and survivability.[109] Human-RAS teams "range from RAS performing tasks in support of humans, to RAS teaming with humans, to humans launching autonomous RAS capable of cooperative behavior."[110] Teaming humans with RAS in this manner leverages their strengths and reduces their respective weaknesses; thereby purposefully developing optimal combinations that balance RAS attributes such as endurance, precision, speed of action, data processing, efficiency, and possibly expendability with human judgment, intuition, empathy, morality, or understanding in military operations.[111] Governing the human-RAS team is the second precept of flexible autonomy, which is "the ability to adjust the level of human control over RAS, by considering capabilities and limitations, mission risk and complexity, and characteristics of the operating environment."[112]

The human-RAS concept is also known as "Centaur Warfighting"[113] and was shaped significantly by Kasparov's own model of "Centaur Chess"[114] Following his loss to Deep Blue Kasparov wrestled with "Moravec's Paradox" (which contrasts the ease of training computers to perform highly skilled tasks with the difficulty of having them act with the theory of mind and social acumen of even a toddler).[115] To better explain RAS/AI Kasparov developed his own model for categorizing types of AI: [116]

Type A	RAS/AI completes tasks by relying on brute force and trying to examine every single possibility to find the best move.
Type B	RAS/AI are more "human-like" and selectively examine the most promising options based on applied human knowledge.
Type C	RAS/AI with an augmented intelligence, where machines and humans work together to create smarter tools.

Source: Deep Thinking: Where Machine Intelligence Ends and Human Thinking Begins (Garry Kasparov)

Kasparov evolved Type C into “Centaur Chess” where humans and AI cooperate on the same team leveraging the advantages of human and machine, resulting in a more perfect game, better than humans or AI alone.[117] Two decades later the Deputy Secretary of Defense Mr. Robert Work along with military theorist Paul Scharre evolved Kasparov’s “Centaur Chess” into “Centaur Warfighters”, which are “hybrid human-machine cognitive systems, which leverage the precision and reliability of automation without sacrificing the robustness and flexibility of human intelligence.”[118] The concept of centaur warfare recognizes that factors such as speed, degraded communications, the availability of quality big data, and rules of engagement (ROE) should govern the human-machine command and control relationship.

There are three forms of human-machine command and control relationships: human in the loop, human on the loop, and human out of the loop. Human in the loop systems are characterized by (semiautonomous) machines “that perform a function for some period of time, then stop and wait for human input before continuing”.[119] Human on the loop systems consist of human-supervised machines “that can perform a function entirely on their own but have a human in a monitoring role, with the ability to intervene if the machine fails or malfunctions”.[120] Lastly, human out of the loop systems or fully autonomous systems apply when machines “perform a function entirely on their own with humans unable to intervene”.[121]

Russian and Chinese RAS/AI concepts employ an inflexible human-out of the loop model at the tactical and even operational levels of war based on their confidence in AI’s ability to out cycle human capacity. In contrast AI theorist George Gilder, asserts it’s premature (even preposterous) to conclude “that artificial intelligence will make human minds obsolete and that we’ll soon produce machine-learning tools and robotics that excel the capabilities of human brains...no matter how much our technology evolves it will never replace human

consciousness."[122] Gilder offers an decisively different human-machine command and control relationship in which AI acts as consigliere to humans enabling humans to realize unparalleled potential.[123] To realize the full human potential AI theorist Michael DeLanda asserts that "our future depends on establishing a partnership with computers and on allowing the evolutionary paths of both humans and machines to enter into a symbiotic relationship."[124] A 2017 study conducted at the US Army Research Laboratory concluded that "future manned-unmanned forces must be able to work increasingly as agile synchronous teams in complex, ambiguous, and dynamically changing environments."[125] The study found that there must be symbiosis between human and machine which "can be realized via a robust framework that provides user-tunable accessibility into this autonomy, enabling user comfort, trust, and confidence with autonomous components."[126]

Expeditionary Fusion Warfare Operating Concept for the Marine Corps

Warfighting states that, "The challenge is to develop a concept of warfighting consistent with our understanding of the nature and theory of war and the realities of the modern battlefield."[127] In 2019, the Commandant of the Marine Corps acknowledged the realities of the modern battlefield and the direction plus speed of the third offset and declared that AI was radically changing the very character of war and pledged that war in the future will be vastly dissimilar than that of even the recent past.[128] The Commandant was unambiguous: the naval force must exploit the technological revolution AI presents in order to define the future character of conflict on our terms so that "naval forces will deter or fight from a position of enduring advantage."[129] The future operating environment is likely to consist of operation inside an adversary's weapons engagement zone along with a peer-competitor leveraging RAS/AI to achieve their own battlefield singularity. These reasons lead Lieutenant General Eric Smith

(Marine Corps Combat Development Command) to conclude, "absent significant change, the Marne Corps will not be in a position to be relevant".[130] To address these challenges the Marine Corps has been conducting an aggressive Force Design exploring concepts like Expeditionary Advanced Base Operations (EABO) and subsequently driving concept requirement capabilities (CRC). General Berger astutely notes that "some of the capabilities we assume might pan out, will not pan out, and other technological things will come along that we have not even considered."[131] Future operating concepts are driving Force Design like "an aim point [that is monitored] and adjusted based on the threat"[132] by embracing new technologies, relinquishing previous capabilities, and jettisoning those which don't deliver.

Despite the JCRAS directing services to abandon incremental RAS development and adopt a holistic, comprehensive process driven by operating concepts the Marine Corps Robotic and Autonomy Strategy (MCRAS) comes up well short."[133] The MCRAS was published in 2018 and has three stated objectives to: increase situational awareness, lighten the Marines' cognitive and physical burden, improve sustainment, facilitate movement and maneuver, and protect the force.[134] The Marine Corps Combat Development and Integration Command (MCCDIC) is responsible for developing concepts of operation and employment but has never developed or published an AW concept and relegated the majority of AW activities to the Marine Corps Warfighting Laboratory (MCWL).[135] While the MCRAS lacks an operating concept it has a rather unambitious strategy broken into three phases:[136]

Near-Term (2018-2022)	Increase situational awareness, lighten the Marine burden, improve sustainment, to facilitate movement and to protect the force.
Mid-Term (2023-2027)	Increase situational awareness with advanced, smaller and swarming RAS to lighten the load with exoskeleton capabilities, to improve sustainment with fully automated convoy operations, and to improve maneuver with unmanned combat vehicles and advanced payloads.

Long-Term (2028-2032)	Enable manned and unmanned teaming (MUM-T) to achieve scalable sensors with scalable teaming to support MUM-T and advancements in machine learning.

Source: 2017 Marine Corps Robotic Autonomous Systems Strategy

The Expeditionary Fusion Warfare (EFW) concept uniquely suits the service character of the Marine Corps by melding Kasparov's type C Centaur Warfighter with manuever warfare philosophy. EFW is a framework for MUM-T built on trust, cohesion, and fluidity, seeking unlimited partnerships between algorithm, RAS, LAWS and the Marine in every domain. EFW stresses that Marine and Machine are elements of an inseparable team, forged through training and constant interaction, enabling natural human interaction with flexible and adaptable automation. EFW moves fluidly through the human-machine command and control relationship. Applying "Flexible Autonomy" achieves unmatched tempo, by adapting to the environment, the spectrum of conflict, the strengths and weaknesses of the Marine, the MAGTF, and the machine in any given moment.

Pivotal to EFW is a fluid continuum between Marine and machine which is founded in the principle that humans have the instinctual, innate capacity for command. This uniquely human condition has always set humans apart from the world around them.[137] Command therefore is centralized with the Marine while the system of Marine and RS/AI tilt both decisions and execution between one another depending on the circumstances of the environment and opportunities present. Further, the EFW continuum recognizes the culminating point applies not only to humans but RAS/AI as well and with thoughtful application of the continuum delays or avoids it altogether. By applying the philosophy of mission command to the human-machine command and control relationship all pieces of the MAGTF exercise initiative backed by trust. Tough, realistic training with both human and machine building warfare algorithms influenced by experienced warfighters themselves that inspire trust and cohesion.

MCDP-1, *Warfighting* defines war as a "a violent struggle between two hostile, independent, and irreconcilable wills….fundamentally an interactive social process…of continuous mutual adaptation, of give and take, move and countermove."[138] EFW weds the skill of the Marine and the MAGTF with the current (and future) power of algorithmic warfare in a fundamentally interactive social process of mutual adaptation. War has always been characterized by friction, uncertainty, fluidity, disorder, and danger[139] and no technological revolution can change that. EFW maximizes the use of, and trust in, RAS/AI to reduce these elements when conditions allow and embraces wars enduring nature by shifting balance back to the Marine when these factors mitigate the effectiveness of algorithmic warfare. Opponents whose doctrine denies the fundamental nature of war and places faith that technological revolution makes its nature obsolete will be paralyzed when friction, uncertainty, and disorder arrives. Marines, welcome (and even orchestrate) the onset of the fog of war, seizing the opportunity by scaling back RAS/AI, taking the initiative, and avoiding culmination. The Marine and the MAGTF will impose incredible friction on the enemy by exploiting their dependence on algorithmic warfare along with their inability to fluidly team with RAS/AI.

EFW appreciates the human dimension, namely that will, passion, and chance are incalculable because they are affected by the complexity, violence and danger of war. EFW employs RAS/AI to complement the strengths and weaknesses of every Marine and MAGTF. By empowering it to "grasp complex battlefield situations; to make effective estimates, calculations, and decisions; to devise tactics and strategies; and to develop plans"[140] the Marine can see through the fog of war, where an adversary (human or machine not working in harmony) cannot, and thus impose his will. The EFW continuum can tilt in favor of the RAS/AI to rapidly compress decision cycles into fractions of seconds thus making "speed a weapon".[141]

Conversely, the continuum can tilt in favor of the Marine when the fog of war inhibits the flow of AI's essential ingredients or friction and disorder create environments which favor the Marines experience and coup d'oeil.[142]

EFW not only applies to MUM-T but to the MAGTF and AI team, even up and through all levels of war.[143] The character of the "tactical" RAS/AI (composite of specialized subsystems making local decisions) teamed with the Marine might consist of a high-low mix of ANI RAS/AI. At the operational level the MAGTF or the joint task force (JTF) will maintain more robust ANI (postured for rapid adoption of AGI). In either case, the MAGTF or JTF serves as a "connectionist AI"[144] hub for operational decision-making and planning. While not only connecting levels of war, EFW achieves mass and precision by maximizing combat power through the full integration of combined arms in and through all domains and warfighting functions. EFW enhances maneuver in all dimensions so that an inferior force can achieve decisive superiority at the necessary time and place in order to thrive in hyperwar.[145]

Concept Required Capabilities for AW and EFW

Turning AW and EFW concepts into realities faces daunting hurdles such as: fiscally constrained budgets (weighed down further by legacy programs), compartmentalized, antiquated IT networks, deteriorating infrastructure, and Force Design. Successful AI strategy implementation requires a focused vision, commitment of resources, and the "three ingredients" (big data, processing power, and training).[146] AW and EFW will require explainable AI, AI ranges, and AI talent as core capabilities in order to mature into a powerful offset:

CRC 1: Explainable AI

In 2018, the DoN released its unmanned systems roadmap and stated that Unmanned Systems (UxS) and manned/unmanned teams will "transform modern warfare" by operating in

every domain and would be at their best when teamed with Sailors and Marines.[147] The roadmap identified the single most critical component to manned/unmanned teams was the "promotion of operator trust in UxS to achieve manned-unmanned teaming."[148] The 2020 DoN Information Superiority Vision stated, "As we increasingly trust our algorithms, we move from humans identifying and classifying every target to approving target classifications (human in the loop), and finally to verifying automated classifications (human on the loop)."[149]

The US Air Force Research Laboratory published an exhaustive study that tested adaptive hybrid control of RAS/AI by humans. The study tested "shared decision-making in the context of military applications including outcomes from research on intelligent agents, control of multiple unmanned systems, trust and transparency, cognitive architectures, natural language processing, and bi-directional interfaces."[150] The study produced three conclusions:[151]

1. The human-machine team is a personal relationship, a partnership, ideally requiring bi-directional communications and a common worldview.
2. There is an imperative that RAS/AI and humans understand each other's reasoning and uncertainties while making joint decisions (which requires a transparent interface), thus creating mutual understanding.
3. The human-machine relationship requires calibrating the trust of the human operator and providing the RAS/AI with an ability to infer human intent.

Leveraging this trust is essential to navigating rapidly changing environments in which human concurrence with every decision may not be practical. Command authority always resides with the human, but situations may require the human to empower the RAS/AI to take the initiative (in essence "Flexible Autonomy".)[152] The study explicitly concluded that "mixed-initiative systems" entailing shared decision-making between humans and intelligent software

outperformed other models.[153] To establish trust, the RAS/AI must not only perform its duties reliably, but have an interface between that the human operator can interact with naturally. The commitment of resources by the DOD and the services to the research and development of naturalistic human-computer interfaces (HCI) is vital for acceptance of RAS/AI and trust with the human operator.

CRC 2: AI Ranges

AW and EFW cannot be built by engineers and operated by warfighters in vacuums. Warfighters must be influential in the design and future algorithm improvement. Services should seek to build and resource AI ranges using US Special Operations Command (USSOCOM) SOFWERX as an initial model. At service AI ranges, operators would continually train and influence the services algorithms while also developing the tactics, techniques, and procedures needed to bring that algorithm to the battlefield. This training of both AI and operator results in the development of the flexible autonomy continuum models needed to establish trust once deployed for use in operations. Further these models allow for the operators and services themselves to ensure the algorithm is coded with the standards and ethics needed to apply lethal actions in accordance with modern jus in bellum principles.[154]

AI ranges will also create a sorely needed hub for the continuous development and refinement of the algorithms each service needs for its service specific needs. Service AI ranges are needed to provide manage, collate, and cultivate huge datasets. Service AI ranges are vital because each service has its own DOTMLPF and thus its own unique demands on data type and quality. LTGEN Jack Shanahan, Director of the JAIC remarked, "civilian sources [are] too clean to teach an algorithm how to understand a war zone…If you train against a very clean, gold-standard data set, it will not work in real world conditions."[155] Therefore, it

must become a core mission of service AI ranges to train their algorithms on what their service specific data looks like.

CRC 3: AI Talent Management and Integration

The battle to recruit and train AI talent is pervasive across all services and industries. The 2019 National AI R&D Strategic Plan identifies thoughtful steps to move forward in building a talent management system woven in with the right mix of AI talent. Firstly, studies are needed to explore the supply and demand forces in each services AI sectors, to help predict future workforce needs.[156] DOD and services must develop their own models and understanding for projected AI R&D workforce pipeline and determine the right mix of warfighter and engineer. DOD and the services must develop and expand educational pathways and potential training opportunities for specific AI development skills. Managing AI talent in the DOD also means expanding integration opportunities with leading AI firms in all sectors and academia. Conversely, doors must be opened for talented professionals from all sectors to work with and imbed in military AI institutes.

Conclusion

The DOD and services have produced a litany of AI strategy documents in discordance with one another and despite the absence of direction an operating concept provides. The conclusions and recommendations from the national security commission on artificial intelligence provide a guide for the DOD and services to develop synchronized strategies. All strategies should (at minimum) include the imperatives identified by the commissions interim report and the JAIC's focal points.[157] The DOD must take a leadership role in the discussion and foster the appropriate dialogue for the public, in academic circles, and especially within defense and legislative circles. Formalization of AW and EFW as concepts is critical first step. With the

U.S. Policy on Lethal Autonomous Weapons Systems[158] and the JAIC's "Ethical Principles for Artificial Intelligence" the DOD has a framework for prudent advancement of these concepts. [159]

China and Russia have established concepts and nested strategies to create military advantage using AI/RAS and LAWS while the DOD sluggishly trudges into the information age without direction and a reticence to explore the potential presented by the AI revolution. The DOD's trepidations for LAWS is juxtaposed by Russia and China's emphasis on armed robots, in which unmanned ground systems largely support ISR and augment warfighters' capabilities, while the Russian military contemplates small to large [RAS/AI systems] doing the actual fighting in the near future alongside or ahead of the human fighting force."[160] The JCRAS reframes the narrative over LAWS from the perspective of great power competition in that the DOD will inevitably have to field LAWS "in response to enemy systems that make any sort of "man in the loop" role impractical."[161] General Allen (retired) frames the narrative in comparison to the "abandonment of international treaties which banned the use of weaponized aircraft at the outbreak of the first world war" concluding the limitation of AI's use for military purposes is "likely impossible". [162]

Formalizing AW and EFW gives the DOD and the Marine Corps an opportunity to swing the pendulum back in their favor. Adoption of sound operating concepts, while building intelligent and complimentary capabilities, will set the foundation for the DOD's maturation into the third military offset. Apprehension and lack of direction can no longer define the DOD's embrace of war in the age of AI. One thing is clear, the nature and character of conflict and war is changing, and the DoD and the Marine Corps can no longer afford to sit on the sidelines in the AI Arms Race.

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