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Chinese thinking on AI integration and interaction with nuclear command and control, force structure, and decision-making

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1. Introduction

This paper seeks to collect, annotate, and provide a preliminary analysis of the growing Chinese-language literature on AI-related open-source platforms and databases, as well as of key official documents and statements on the topic, in order to systematically present Chinese perspectives on AI and its military applications, including nuclear command and control (C2) and decision-making.

In the field of emerging and disruptive technologies (EDTs), China is considered a serious competitor in artificial intelligence (AI). It is, in fact, becoming a world leader in commercial applications of AI, such as facial recognition, speech technology, financial technology (fintech), research publications and patents, and deep learning. The development of AI in the civilian sphere, which can be adapted for military purposes due to its dual-use nature, plays a key role in advancing AI innovation in China. In order to apply AI in military domain, China has long practiced what it calls 'military-civil fusion (军民融合, MCF)'. It is therefore important to focus on the development plan and policy documents surrounding AI in both the civilian and military domains. Chinese interests in military applications of AI include C2, decision making, and autonomous nuclear weapons systems. These developments reflect the Chinese Government's recognition of the likely economic and security impact of AI in the coming decades, as the strategic rivalry between the great powers intensifies.

The paper begins with a brief overview of the existing Western discussion of AI-enabled nuclear C2, decision-making, and their benefits and risks. This sets the scene against which the collected Chinese literature will be divided into several areas for analysis.[1] Specifically, the paper will:

1. Provide a general overview of Chinese perspectives on AI and its military applications in C2 and decision-making, as well as the associated benefits and risks.

2. Identify, annotate, and analyse Chinese publications that focus specifically on AI's integration into nuclear C2, decision-making, and autonomous use.

3. Explore Chinese discussions on major developments and trends in major nuclear powers' AI research and military application on both C2 and decision-making, with a particular focus on nuclear weapon systems.

4. Review Chinese perspectives on its own role in mitigating the risks involved in military applications of AI technology, including interest in developing a common understanding of what responsible, reliable and transparent AI-enabled C2 platform means through consultation and arms control negotiations with other P-5 members.

5. Summarise Chinese perspectives on the roles of other major actors in mitigating risks from military applications of AI technology.

6. Examine, where possible, the convergent and divergent perspectives from the officials and expert community in China on military application of AI technologies.

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2. A brief overview of the Western debates

AI research and development, and in particular its military applications including in nuclear-weapon systems, have drawn growing attention from governments and policy analysts. The focus has largely been on whether AI enhances strategic stability (and if so, to what extent) or poses significant risks to the management of nuclear weapons. Advances in AI are increasingly being integrated into the military doctrines, force development, personnel and training, and procurement in many major powers. From intelligence gathering and assessment, AI-enabled systems designed to facilitate decision-making, to automated - if not yet autonomous - weapon, serious differences exist.

This is especially true where applications of AI in nuclear-weapon systems are concerned: command and control (C2) systems, and autonomous nuclear weapon systems.Some argue that AI could enhance reliable communication in early warning, providing more accurate and faster analysis of intelligence and data, and AI application in decision-making in general can be beneficial to strategic stability. On the other hand, AI poses risks and can be destabilising, especially where autonomous nuclear-weapon systems are concerned. At the same time, given the asymmetrical nature of AI development, strategic stability can be undermined should certain powers achieve significant advantages in intelligence gathering. Meanwhile, data insufficiency, corruption, and bias, and cyber manipulation and attack, can mislead and seriously undermine decision-making, encourage pre-emptive nuclear use, and arms races due to concerns over the loss of reliable second-strike capabilities.[2]

The Chinese discussions, as presented below, are clearly aware of these debates, as they both seek to grasp the implications of AI applications and determine which paths China should take in the ongoing race.

3. Official stance on developing military AI in China

Despite the focus of this paper on AI's integration in nuclear forces, this chapter briefly presents the official doctrines and stance on military AI in general, with a focus on MCF, military modernisation, and arms control. While not comprehensive, the authors seek to establish a starting point for understanding China's official perspectives on military AI in nuclear forces.

2017 was a milestone year that accelerated AI development in China. In March 2017, the term AI was included in the Government Work Report for the first time by then Premier Li Keqiang at the Fifth Session of the Twelfth National People's Congress.[3] In July the same year, the State Council released the New Generation Artificial Intelligence Development Plan (《新一代人工智能发展规划》, hereafter the '2017 Plan'), which made it clear that China is determined to become a leading power in AI. The 2017 Plan explicitly set out its strategic objectives[4]:

> "…by 2030, China's AI theories, technologies, and applications should achieve world-leading levels, making China the world's primary AI innovation center, achieving visible results in intelligent economy and intelligent society applications, and laying an important foundation for becoming a leading innovation-style nation and an economic power…"

Again in October 2017, AI was explicitly mentioned in the opening speech of the 19th Party Congress of the Chinese Communist Party (CCP) made by Xi Jinping. His speech stressed the importance of working "faster to build China into a manufacturer of quality and develop advanced manufacturing, promote further integration of AI with the real economy."[5] It is clear that China is determined to become a global leader in AI development, and that a wide range of initiatives have been launched for this purpose with the political support of the Chinese leadership.

Military-Civil Fusion and AI

AI development in China began long before the articulated national strategy stated in the 2017 Plan.[6] For instance, released in May 2015, the well-known 'Made in China 2025' policy (中国制造2025) included "intelligent manufacturing as the main priority, and meeting the demands of economic and social development and national defence as the goal."[7] This initiative also stressed the importance of MCF as a key source for the People's Liberation Army (PLA) to enhance its military capability with the application of AI.

In January 2017, the Military-Civil Fusion Development Committee was established, chaired by Xi Jinping.[8] This reflected a continued effort from China in deepening the integration between civil and military technologies and increasing synergies between economic development and military modernisation. The 2017 Plan highlighted command and decision-making, military deduction and defence equipment as the focus when developing next generation of AI technology in national defence through MCF.[9]

Moreover, the '14th five-year plan for national economic and social development and long-range objectives for 2035', released in March 2021 set up a "2027 centennial military building goal [2027年实现建军百年奋斗目标]" with an emphasis on the importance of MCF in maritime, aerospace, cyberspace, biotech, new energy, AI and quantum technology. The direct quote is as below:

> "Deepen military-civilian science and technology collaboration and innovation, strengthen military-civilian overall development planning for maritime, aerospace, cyberspace, biotech, new energy, AI, quantum technology, and other fields, promote resource sharing between military and civilian science and technology facilities, and promote the two-way transformation and application of military and civilian scientific research results and the development of key industries. [深化军民科技协同创新，加强海洋、空天、网络空间、生物、新能源、人工智能、量子科技等领域军民统筹发展，推动军地科研设施资源共享，推进军地科研成果双向转化应用和重点产业发展。]"[10]

Military modernisation and AI

China's military modernisation started long before Xi became China's top leader in late 2012. As described in China's '2010 Defence White Paper', the goal of the PLA is to "accomplish mechanisation and attaining major progress in informationisation by 2020".[11] In his speech at the 19th Party Congress of CCP in October 2017, Xi reiterated this goal but also stressed that the goal is to "speed up development of intelligent military, and improve combat capabilities for joint operations based on the network information system and the ability to fight under multi-dimensional conditions".[12] While the Chinese term "intelligentised (智能化)" already appeared in China's 2015 Defence White paper, the English translation referred to "'smart".[13] The term "intelligentised warfare (智能化战争)" appeared in the 2019 Defence White paper.[14] Intelligentisation and the importance of integrating technologies like AI is identified as a key pillar of military modernisation in China. According to Ministry of National Defence spokesperson Ren Guoqiang, one of the key benchmarks for achieving the 2027 centennial military building goal is to "accelerate the integrated development of mechanisation, informatisation and intelligentisation, and seize the opportunity of world military reform [加快机械化信息化智能化融合发展，抢占世界军事变革先机主动]".[15]

Indeed, like other major powers, such as the United States and Russia, China is determined to become a global leader in AI development and to apply AI in the military domain for winning the future intelligentised warfare. As Lieutenant General Liu Guozhi, director of the Central Military Commission (CMC)'s Science and Technology Commission, pointed out, "AI will accelerate the process of military transformation, causing fundamental changes to military units. This will include programming, operational styles, equipment systems, and power generation of combat models etc., ultimately leading to a profound military revolution."[16] Liu also stressed the need for accelerating "military intelligentisation (军事智能化)" and for seizing the opportunity to "change paradigms (弯道超车)".

> "From the perspective of international political games, the most important value of AI lies in the potential changes in the distribution of strategic capabilities among countries. In fact, in the past few decades, all countries have been committed to improving the autonomy and intelligence of weapon systems, so as to overcome the limitations of human information processing capacity, improve decision-making speed and strike accuracy. Related technologies have been widely used in various air defence and anti-missile early warning, precision guidance and other systems. With the continuous development of big data and machine deep learning, the intelligence level

of technology has taken a fundamental leap, and the ability of weapon systems to complete complex tasks independently has been significantly enhanced. The military application of AI seems to have entered the fast lane. [从国际政治博弈来看，人工智能最首要的价值在于对国家间战略能力分配的潜在改变。事实上，在过去几十年里各国均致力于提高武器系统自主能力和智能化程度，以此克服人类处理信息能力的局限性，提升决策速度和提高打击精度。相关技术已经在各类防空反导预警、精确制导等系统中得到广泛应用。随着大数据和机器深度学习的不断发展，技术的智能化水平出现了根本性飞跃，武器系统独立完成复杂任务的能力得到显著增强，人工智能的军事化应用似乎已经驶入快车道。]'[17]

Arms control and AI

China has released two key position papers in relation to AI and its associated risks in the past two years: the 2021 Position Paper on Regulating Military Applications of Artificial Intelligence (hereafter the '2021 Position Paper') and the 2022 Position Paper on Strengthening Ethical Governance of Artificial Intelligence (hereafter the '2022 Position Paper').[18] The key takeaways of these two papers are described below:

1. China emphasises what it considers a responsible way of developing and applying AI in the military domain. Considering the accelerating pace of China's integration of AI into military systems, it is unlikely that China will propose any regulation to restrict the development of military AI. The lack of a definition on the 'responsible way' to develop this tech also leaves room for interpretation.

2. China's 2021 Position Paper does outline opposition to AI being used to undermine its sovereignty and territorial security. This may be seen as a red line in China's stance on the use of AI.

3. Both papers emphasise the importance of human intervention in weapon systems – AI should always be under the control of humans. This position also aligns with China's position on lethal autonomous weapon systems (LAWS). China's July 2022 Working Paper on LAWS states that "acceptable Autonomous Weapons Systems could have a high degree of autonomy, but are always under human control."[19]

4. While there are no detailed measures in its 2021 Position Paper, China follows other countries, including the United States, by calling for an accountability mechanism. In the 2022 Position Paper, a few approaches to self-regulation are suggested, although still on a general level. This includes formulation of guidelines on AI ethics. In fact, many technology companies in China have been part of the domestic rule-making process by providing their insights based on their own experience.[20]

5. On international cooperation, the 2021 Position Paper mentions terms such as "ideological lines", "overstretching the notion of national security" and "man-made barriers".[21] The 2022 Position Paper expresses opposition to the "building of exclusive groups and malicious obstruction of other countries' technological development". This seems to imply a growing concern over technological and strategic decoupling, which makes China stress the importance of continued exchanges in the field of science and technology.

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4. Chinese perspective on AI's application in C2 and decision-making system

This chapter focuses on demonstrating the views from the Chinese expert community, including PLA associated institutes, on AI's application in C2 and decision-making in the general military field and, when applicable, in nuclear weapon systems. It also presents the associated risk, benefits, and challenges of AI application in military use. For each proposition below, one or more quotes are given for illustration.

Application

The application of AI C2 and decision-making systems is already being discussed when it comes to military fire command and control, air defence systems, missile weapons, etc.

> "In the past few decades of our country's development, military fire C2 system has always attached great attention to AI... An intelligentised military fire C2 system is required to realise the intelligence and automation of combat aircraft, improve the hit rate and combat effectiveness, and adapt to any changes in the battlefield at any time, in an all-round, multi-angle form and various distances, while capable to defend against such as electronic interference. [在我国发展的过去几十年中，军事火力指挥与控制系统中一直相当重视人工智能技术的应用…智能在军事火力指挥与控制系统的技术是要求实现作战飞机的智能化和自动化，以提高命中率和作战效能为目的，并适应战争的随时变化，以全方位、多角度的形式和各种距离相结合，同时满足电子干扰等作战条件。]"[22]

> "The main purpose of applying AI in military fire C2 system is to realise the intelligence and automation of combat aircraft, so as to improve the combat effectiveness and hit rate of combat aircraft. [在军事火力指挥及控制系统中使用人工智能的主要目的，就是实现作战飞机智能化及自动化，以此提高作战飞机的作战效能及命中率。]"[23]

> "In air and space defence, situational awareness has always been the basis and core of operations. It is also an important prerequisite for subsequent intelligent decision-making or autonomous control, and it is a key link leading to intelligent warfare in the true sense... Space-based anti-missile weapons must have certain intelligent and autonomous control capabilities, and be able to autonomously control and adjust with the support of intelligence based on the battlefield situation, or form a communication link with other space-based assets and form a network on their own to shape certain combat conditions. [在空天防御中，态势认知一直是作战的基础和核心，也是后续智能决策或自主控制的重要前提，是通向真正意义上的智能化战争的关键环节…天基反导武器必须具备一定的智能自主控制能力，能够在临战态势情报的支持下自主控制调整为作战状态，或与其他天基资产形成通信链接并自行组网，形成一定的作战条件。]"[24]

> "For missile weapons, intelligentised precision guidance is the core of intelligent missile weapons. The application of AI in the field of traditional missile guidance is considered an excellent direction for optimising missile capability... Applying the latest and most advanced AI in missiles, such as missile-borne radar, can further improve the target recognition and anti-interference performance, and provide effective solutions for independent

decision-making and intelligent coordination of missile weapons. [对导弹武器而言，精确制导智能化是导弹武器智能化的核心，将人工智能技术引入传统制导领域，被认为是优化该技术的绝佳方向…将人工智能技术最新进展应用于弹载雷达等制导设备，可进一步提升导弹武器的目标识别抗干扰性能，并为导弹武器自主决策、智能协同等提供有效解决方案。]"[25]

When it relates to nuclear weapons systems, in particular, the Chinese literature shows a wide range of research on the potentials of an AI-enabled nuclear C2 system, from support to decision-making, improvement of early warning system and targeting, to the enhancement of autonomous strike capability of nuclear weapons. This seems in line with the priorities outlined in China's 2015 Defence White Paper, where the importance about improving strategic early warning, command and control, missile penetration and rapid response of its nuclear forces is stressed.[26]

"Preliminary analysis and judgment show that the integration of AI and nuclear weapons basically includes the following three methods. 1) Use AI to improve the capabilities in nuclear intelligence analysis and auxiliary decision-making. AI can conduct cross-analysis of intelligence data to identify nuclear attacks faster and more accurately and predict where the enemy may deploy nuclear weapons. 2) Use AI technology to improve nuclear command and control systems. 3) Develop [nuclear missile] launcher with a higher degree of autonomy and enhance the autonomous strike capability of nuclear weapons through AI technology. [初步分析研判表明，人工智能与核武器的结合基本上包括以下3 种方式。1) 利用人工智能技术提高核情报分析和辅助决策能力: 人工智能可以对情报数据进行交叉分析，更快、更准确地识别核攻击; 预测敌方可能部署核武器的位置。2) 利用人工智能技术改进核指控系统。3) 依托人工智能技术，开发自主化程度更高的发射装置，增强核武的自主打击能力。]"[27]

Following James Johnson's 2019 article in *Journal of Cyber Policy,*[28] two PLA analysts observe the following:

"As far as the application of AI in the nuclear field is concerned, it mainly includes: improving the quality of the NC3 architecture; strengthening the target acquisition, tracking, guidance and identification capabilities of missile and air defence systems; optimising the delivery system of nuclear missiles, helping the nuclear delivery system to operate more autonomously and accurately, and having stronger anti-jamming and anti-spoofing capabilities. [就人工智能在核领域的应用来说，主要包括 : 对核武器的指挥、控制、通信和情报 (C3I) 架构的质量改进 ; 加强导弹和防空系统的目标捕获、跟踪、制导以及识别能力 ; 从质量上优化核导弹的运载系统，帮助核运载系统更自主、更精确地运行，并且具备更强大的抗干扰和抗欺骗能力。][29]

"At present, major nuclear armed states have not yet explicitly promoted AI applications in nuclear warfare systems. However, from a technical point of view, AI technologies such as machine learning and autonomous systems, which are currently booming, may be applied to various aspects of the nuclear combat system in the future, ranging from early warning and command and control systems to nuclear weapon delivery and missile defence systems etc. [目前，主要有核国家尚未在核作战系统中推动明确的人工智能应用。但是，从技术角度分析，当前蓬勃发展的机器学习和自主系统等人工智能技术未来有可能被应用

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于核作战体系的各个方面，涉及范围从早期预警和指挥控制系统到核武器投送和导弹防御系统等。]"[30]

"AI has important implications for early warning and intelligence, surveillance, and reconnaissance (ISR), and its main potential applications involve two aspects: (1) unmanned autonomous ISR system; and (2) analysis and process massive intelligence data. The possible application of AI in command and control includes two aspects: (1) Auxiliary operational decision-making. AI may provide better situational analysis and assistance to military commands to predict developments related to nuclear weapons, including the possible nuclear force production, commissioning, deployment and use of nuclear weapons from opponents. Cross-analysis of intelligence data using machine learning algorithms could help the military identify nuclear attacks that are or may be in progress more quickly and reliably. (2) Strengthening the reliability of the C2 structure. On the one hand, AI can be used to enhance the protection of nuclear C2 architecture against cyber-attacks and jamming attacks, and realise autonomous self-healing networks in physical or cyberspace, thereby improving the reliability of nuclear combat systems. On the other hand, autonomous systems can enhance the resilience of communication architectures. [人工智能对早期预警与情报、监视和侦察具有重要意义，其主要潜在应用涉及两个方面。(1) 无人自主情监侦系统。(2) 海量情报数据的分析处理。在指挥控制可能应用人工智能技术的方向包括两大方面。(1) 辅助作战决策。人工智能可能提供更好的态势分析，人工智能可提供更好的帮助军事指挥部门预测与核武器有关的发展动态，包括对手可能的核力量生产、调试、部署和使用。使用机器学习算法对情报数据进行交叉分析可能有助于军方更快、更可靠地识别正在或可能正在进行中的核攻击。(2) 加强指挥控制架构的可靠性。一方面，人工智能可用于增强核指挥与控制架构对网络攻击和干扰攻击的防护，在物理或网络空间实现自主自愈网络，从而提升核作战体系可靠性。另一方面，自主系统可增强通信架构的弹性。]"[31]

Moreover, there is also a focus on the linkages between AI and cyberspace and the impacts of these technologies on nuclear weapon systems and broader strategic stability. The discussion revolves around the integration of autonomous weapons systems with offensive cyber capabilities aimed at securing a first-strike advantage by targeting an adversary's nuclear warheads, their delivery mechanisms, command and control systems, as well as critical infrastructures.

The discussion revolves around the integration of autonomous weapons systems with offensive cyber capabilities aimed at securing a first-strike advantage by targeting an adversary's nuclear warheads, their delivery mechanisms, command and control systems, as well as critical infrastructures.

"Future Nuclear command and control system will present the combination of 'AI-Cyber-Nuclear'. The combined 'new trinity' character, to the inter-state strategic stability has multiple complex effects: On the one hand, autonomous weapon systems can help strengthen nuclear command and control systems respond to cyberattacks and cyber interference protection from interference and resilience to attacks force. On the other hand, autonomous weapon systems combined with cyber offensive weapons can be used to attack enemies' nuclear warheads and their means of delivery, command control system or infrastructure, etc. Autonomous software can hide loopholes and weaknesses during cyber attacks, and at the same time search for, and research, loopholes in opponent systems. Avoiding the opponent's retaliation when carrying out

active attacks has won a huge first-round attack advantage for countries with more advanced technologies, and it has also weakened the strategic stability among countries. [未来核指挥控制系统将呈现“人工智能—网络—核”相结合的“新三位一体”特征，对国家间战略稳定造成多方面的复杂影响：一方面，自主武器系统有助于加强核指挥控制系统应对网络攻击和网络干扰的防护力，以及遭受攻击后的复原力。… 另一方面，自主武器系统结合网络进攻武器，可被用来攻击敌对国家的核弹头及其运载工具、指挥控制系统或者基础设施等。自主软件能隐藏网络攻击时的漏洞与弱点，同时搜寻和研究对手系统中的漏洞。在实施主动攻击时避免对手的打击报复，为技术较先进的国家赢得了极大的首轮攻击优势，也就削弱了国家间的战略稳定。]”[32]

“Empowered by AI, some non-nuclear combat capabilities pose new threats to the nuclear combat system. In terms of conventional precision strike weapons, data collection and analysis based on AI systems can enable precision strike weapons to have higher mobility and precision, and strengthen the ability to destroy key command, control and communication nodes of the nuclear combat system. For missile defence, target recognition technology embedded with deep learning methods can detect, track, prioritise and select incoming missiles faster and more accurately. In terms of unmanned systems, AI-enabled unmanned systems can launch pre-emptive attacks on enemy hidden nuclear weapon platforms and auxiliary facilities while discovering them. In terms of cyber weapons, autonomous weapon systems combined with cyber offensive weapons can be used to attack nuclear warheads and their delivery vehicles, command and control systems, or infrastructure of hostile forces. [在人工智能的赋能下，一些非核的作战能力对核作战体系构成了新的威胁。常规精确打击武器方面，基于人工智能系统的数据收集与分析可使精确打击武器具备更高的机动性和精度，加强对核作战体系的关键指挥、控制与通信节点的摧毁能力。导弹防御方面，嵌入深度学习方法的目标识别技术可更快、更准确地对来袭导弹进行探测、跟踪、确认优先级和选择目标。无人系统方面，基于人工智能的无人系统在发现敌方隐蔽核武器平台和辅助设施的同时，可对它们发起先发制人攻击。网络武器方面，自主武器系统结合网络进攻武器，可用于攻击敌对势力的核弹头及其运载工具、指挥控制系统或者基础设施等。]”[33]

“From a technical point of view, it is achievable to develop launchers with a higher degree of autonomy to enhance the autonomous strike capability of nuclear weapons. The obstacles are mainly the reliability of the system, the constraints of legal and moral public opinion, and the trust from the military. [开发自主化程度更高的发射装置，增强核武的自主打击能力。从技术角度上来看是可以实现的，其障碍主要是系统的可靠性、法律道德舆论约束，以及军方的信任度问题。]”[34]

China recognises the important role AI will play in its military modernisation, especially as the PLA aims to fight and win intelligentised warfare.

Benefits and opportunities

AI-enabled C2 and decision-making systems will be the key to gaining advantage in future warfare. China recognises the important role AI will play in its military modernisation, especially as the PLA aims to fight and win intelligentised warfare. The application of AI will benefit the PLA by:

a. Increasing efficiency in data processing and perhaps even accuracy,

b. Providing better situational awareness (态势感知) and judgement on the battlefield,

c. Shortening decision-making time for faster reaction times,

d. Providing military rehearsal (军事推演) including war-game simulation.

> 'The development of an intelligent command system with autonomous functions is the top priority of future system building... 1) The unified and standard structured representation of data through machine intelligence technology can objectively, accurately, and dynamically reflect the threats from the battlefield, target situations, and actions effects...2) Help commanders break through the fixed logical thinking that only relies on limited experience, and improve the efficiency and accuracy of decision-making...3) Solve the problem of obtaining information and knowledge from a small number or even a single event, finding information from seemingly random behaviours, and predicting the future behaviour process, managing, and controlling the uncertainty of war. [开发具有自主功能的智能指挥系统是未来系统建设的重中之重...1) 通过机器智能技术对数据进行统一、标准的结构化表示，能客观、准确、动态地反映战场威胁、目标态势和行动效果...2) 帮助指挥员突破仅仅依靠有限经验的固定逻辑思维，提高决策的时效性和准确性...3) 解决从少量甚至单一的事件中获取信息和知识，从看似随机的行为过程中寻找蛛丝马迹的规律，预测以后的行为过程，管理和控制战争不确定性。]"[35]

> "AI can improve strategic decision-making capability. In terms of military command, an intelligentised command system with functions such as deduction, analysis, prediction and decision-making can provide more comprehensive information of the battlefield, simulate the deployment and combat capabilities of both sides, deduce a relatively accurate battlefield situation, and quantify all possible outcomes. [人工智能可以提高战略决策能力。在军事指挥方面，具有推理、分析、预测和决策等功能的智能化指挥系统，可以提供更为全面的战场信息，模拟双方的部署和作战能力，演绎相对精确的战场态势，并以概率形式量化所有可能结果。]"[36]

> "Distributed multi-domain C2 will become the main form of future war command information systems...Under current AI development, key technologies such as target recognition, battlefield situation, information intelligence processing, task planning, and auxiliary decision-making will be promoted. [分布式多域C2将成为未来战争指挥信息系统的主要形式…当前AI条件下将重点推进目标识别、战场态势、情报处理、任务规划与辅助决策等关键技术的进步。]"[37]

> "By constructing a variety of war scenarios under strong confrontation conditions, using AI's autonomous learning ability to deeply analyse the impact of various battlefield environments on combat effects, and strengthen the ability to identify confrontation and multi-target joint tracking and processing capabilities. Especially in complex electromagnetic environments, understanding how to accurately recognise the characteristics of the targets at different distances, attitudes, and backgrounds is the core of interception and striking. [通过构建多种强对抗条件下的作战场景，利用人工智能的自主学习能力深度分析各种战场环境对作战效果的影响，加强识别对抗能力和

多目标联合跟踪处理能力，特别是复杂电磁环境下如何准确稳定识别目标在不同距离、姿态和背景下的特征，是实现拦截打击的核心。]”[38]

Risks and trust in AI

The associated risks from AI application in C2 and decision-making system mainly include:

a. Unpredictable and unexplainable errors due to the nature of AI algorithms;

b. Risk of strategic miscalculation due to compressed decision-making time within the fog of war;

c. Risk of unintended escalation due to the dependence on AI data analysis that could be compromised;

d. General lack of agreed-upon norms;

e. The security risks caused by technology abuse and proliferation, especially by non-state actors.

> “AI technology itself lacks certainty and explainability... National security, especially nuclear security, operates on the basis of reliability and trust. The unpredictable uncertainty of AI will increase the probability of accidents and mistakes. The explainability of AI has not been well solved so far. For a system, what is important is not only reliability, but also explanations that can be trusted by others. If an AI system issues a particular instruction without being able to explain why it made that choice, humans are unlikely to believe it. [人工智能技术本身具有不确定性，并缺乏可解释性…国家安全，尤其是核安全的运作建立在可靠和信任的基础上，人工智能这种难以预测的不确定性，会增加事故和失误的可能性。人工智能的可解释性到目前为止也没有得到很好解决，对于一个系统而言，重要的不仅仅是可靠性，同时也必须具有能使他人信任的可解释性。如果一个人工智能系统发布了某一特定指令，但不能说明为什么会做出这样的选择，那么人类不太可能相信它。]”[39]
>
> “Many countries have partially realised nuclear early warning, C2, and missile targeting automation, but intelligent early warning also means that it is difficult to effectively intervene and prevent false alarms, which will greatly increase the risk of false alarms and misjudgements. … The collection and processing of AI-enabled nuclear strategic intelligence is already the only way for major nuclear-armed countries to innovate in their nuclear strategic intelligence work and shape their nuclear advantages. But it has the risk of eroding the stability of nuclear deterrence by changing the tactical offensive and defensive balance. [许多国家已经部分实现了核预警、指挥和控制以及导弹瞄准自动化，但智能预警也同时意味着错误警报很难得到有效干预和阻止，这将大大提升虚警和误判的风险。… 人工智能赋能核战略情报收集与处理已经是主要拥核国实现核战略情报工作创新、塑造核优势的必由之路。但其存在通过改变战术攻防平衡，侵蚀核威慑稳定性的风险。]”[40]
>
> “If the data signals which AI relies on are altered or attacked, it may cause the risk of conflict and misjudgement. In addition,

in the event of a crisis, the use or provision of AI ISR may also compress decision-making time and increase tension and the potential for unintended escalation. This will negatively impact strategic stability. This risk of conflict and misjudgement comes from three aspects: first, the intention of AI to perform tasks may be misinterpreted. Second, the increased likelihood of accidents and malicious human intervention in AI-enabled military system such as autonomous weapons could generate false signals that could lead to risk miscalculation and poor decision-making. Third, new technologies such as intelligent algorithms and political robots may be used for 'calculated political propaganda' with false information, or even 'hostile manipulation of society', which may give wrong decision-making signals and trigger the risk of conflict. [人工智能决策所依赖的数据信号如果被人为篡改或攻击可能会引发冲突误判风险，而且在发生危机的情况下，使用或提供人工智能情报、监视和侦察也可能压缩决策时间，增加紧张局势和冲突意外升级的可能性，并从负面影响战略稳定。这种冲突误判风险源自三个方面：第一，人工智能执行任务的意图可能被误读。第二，意外事故和人为恶意干预自主武器等人工智能应用的可能性增加，从而可能产生错误信号，引发风险误判和错误决策。第三，智能算法和政治机器人等新技术可能被用于虚假信息的“计算政治宣传”，甚至用于“对社会的敌意操纵”，从而可能给出错误决策信号诱导，引发冲突风险。]”[41]

“AI can speed up decision-making processes. However, due to AI-enabled rapid responses, it can also fail to adapt to the complexity of warfare and can lead to potential risks of decision-making mistakes. AI may not be able to distinguish as accurately and precisely as humans between civilians and combatants, as well as threats and system anomalies. [人工智能可以加速决策速度，但这同时也正因为人工智能助力军事系统可能导致决策速度太快或系统无法适应战争的复杂性，致使人工智能犯下危险错误。人工智能系统可能无法准确区分作战人员与非战人员以及威胁和系统异常，最终不能像人类作战人员那样准确和精确。]”[42]

“The nuclear C2 systems of nuclear powers increasingly rely on expert systems and deep learning algorithms to enhance situational awareness and cybersecurity. However, malicious actors can also use new technologies to deceive or disrupt C2 systems, posing a dilemma for decision makers. Adversaries will also try to hide or alter the design of their mobile missile launchers to deceive the ISR capabilities of intelligent systems. In particular, it should be noted that opponents or third parties will try to 'contaminate' the training data of AI to induce misclassification by the intelligent intelligence system, and errors will occur in the recognition process, and the early warning results of the intelligent intelligence system are often difficult to verify and apply in the real world. [核大国的核指挥和控制系统越来越依赖专家系统和深度学习算法来增强态势感知和网络安全。然而，恶意的行为者也可以使用新技术来欺骗或破坏指挥和控制系统，使决策者陷入两难境地。对手也会试图隐藏他们的移动导弹发射器或改变其设计，以欺骗智能情报手段的ISR能力。尤其需要注意的是，对手或第三方会试图“污染”人工智能的训练数据，以诱导智能情报系统错误分类，在识别过程中出现错误，而智能情报系统的预警结果往往很难在现实世界中得到验证。]”[43]

“When an autonomous weapon is endowed with the ability to independently track, lock, and attack a target, it is no longer a simple weapon, but a fusion of a combatant and a weapon

with a fairly high degree of autonomous judgment. How to make autonomous weapons, which lack the ability to judge human ethical values effectively, abide by the principles of distinction, proportionality, and precautions in combat is the cause of greatest concern for the international community. In other words, when a weapon that lacks human moral sense and legal personality is endowed with full autonomy, who will bear the responsibility once it causes a violation of international humanitarian law? [当自主性武器被赋予了独立地寻找、锁定并袭击目标的能力时，它不再是单纯的武器，而是具备了相当高程度的自主判断能力的交战者与武器的融合体。如何使得缺乏人类伦理价值观判断能力的自主性武器在作战时切实遵守区分原则、比例原则和预防原则，是国际社会最为担忧的原因所在。也就是说，当缺乏人类道德感又不具备法律人格的武器被赋予了完全的自主性后，一旦造成了违反国际人道法的后果，将由谁来承担责任呢？]"[44]

"Autonomous weapon systems may profoundly change the cost-benefit of war, greatly reduce the threshold of war, trigger an arms race among countries, impact traditional strategic stability, and provide various non-state actors with more convenient, but also more dangerous, tools. [自主武器系统可能深刻改变战争的成本收益，极大降低战争门槛，引发国家间的军备竞赛，对传统的战略稳定性带来冲击，并为各类非国家行为体提供更为便捷但也更加危险的工具。]"[45]

There is a lot of discussion on exploring the extent of human-machine interaction in military domain. In China's 2021 Position Paper, it mentioned that "Relevant weapon systems must be under human control, and efforts must be made to ensure human suspension at any time".[46] However, this does not explicitly refer to the application of AI to nuclear weapon systems, and on whether this means an agreement to keep 'humans in the loop' for nuclear C2 system. However, there seems a general consensus based on the writings from policy experts, academics and some PLA officers at the unofficial level, indicating that when it comes to command and control at the strategic level, the role of AI should remain at an auxiliary level, and even if AI evolves rapidly in the future, humans should be the ones holding the authority to make the final decision.[47]

There seems a general consensus...that when it comes to command and control at the strategic level, the role of AI should remain at an auxiliary level, and even if AI evolves rapidly in the future, humans should be the ones holding the authority to make the final decision.

Impacts on strategic stability

Chinese discussion is divided on whether the application of AI could lead to stabilising or destabilising trends. On one hand, the application of AI could provide better situational awareness and therefore reduce the risk of being caught off guard. On the other hand, those with better AI-enabled nuclear C2 system, could gain asymmetrical advantages, raising doubt about the credibility of the second-strike capabilities of those nuclear states' with less advanced AI applications. This in turn could increase their temptation toward first strikes, undermining strategic stability.

"The most unstable impact of AI on nuclear deterrence will be the use of machine learning, which may change the survivability of safe and reliable nuclear deterrent forces from the past, and weaken nuclear-armed countries' confidence in their ability to survive the second strike. Regardless of whether it is a nuclear-armed country or a non-nuclear country, the possession of advanced AI technology means that the ability

to disarm a country's nuclear deterrent force through the use of conventional weapons will be greatly improved, the effectiveness of the first strike capability will be enhanced, and the opponent's second attack will be reduced. As such, the ability of AI technologies to locate and strike an adversary's strategic assets could undermine the fundamental principles of strategic nuclear deterrence, expose the survivability of its strategic nuclear forces to danger, and shift the motivation for nuclear deterrence from accepting each other's vulnerabilities in order to take advantage of the opponent's weakness, a situation of 'unilateral guaranteed destruction' is formed. Even if there is no intention of pre-emptive strikes, possessing pre-emptive strike capabilities will become the goal pursued by some countries. Although this will only increase the bargaining chips, it will also have a negative impact on strategic stability. [人工智能对核威慑最不稳定的影响，将是用一系列机器学习改变以往核威慑力量安全可靠的生存方式，削弱有核国家对二次打击能力生存的信心。不论是有核国家还是无核国家，拥有先进人工智能技术，意味着通过使用常规武器解除一个国家核威慑力量能力的极大提升，增强第一次打击能力有效性，并降低对手的第二次打击能力。正因如此，人工智能技术定位和打击对手战略资产的能力可能会破坏战略核威慑的基本原则，使其战略核力量的生存能力暴露于危险之中，并将核威慑动机从接受彼此的弱点转变为利用对方弱点，形成"单方面确保摧毁"局面。即便没有先发制人攻击的意图，拥有先发制人能力也会成为一些国家设法追求的目标，虽然这样仅仅增加彼此之间讨价还价的筹码，但也将对战略稳定产生消极影响。]"[48]

"Improvements in AI-enabled ISR systems would threaten the survivability of a second-strike force, given the ability of technologically-advanced nations to detect, identify, track, and destroy adversary mobile and concealed launch platforms. If a country acquires such an efficient countermeasure capability, it would not only hope to limit the damage in the event of a spiralling nuclear crisis, but also eliminate the opponent's nuclear strike force in a 'one-hit' manner. This potential capability will destroy the nuclear power of the opponent. The combination of AI and offensive and defensive cyber tactics has given new space for the development of intelligence activities, but it also directly increases the cyber risk escalating into nuclear crises. In addition, the increasingly autonomous intelligence decision-making mechanism will also bring the possibility of backlash to the nuclear early warning system. The application of AI technology in the above-mentioned means of intelligence, and its future potential development will undermine the strategic stability among major powers. [人工智能驱动的ISR系统的改进将威胁到二次核打击力量的生存能力，因为技术先进的国家有能力发现、识别、跟踪和摧毁对手的移动和隐蔽发射平台。一个国家如果获得了如此高效的反制能力，不仅有希望在核危机螺旋式上升的情况下限制损害，也可以"一击即中"地消灭对手的核打击力量，这种潜在能力将破坏核威慑的有效性。而人工智能技术与网络攻防手段的结合赋予了情报活动新的发展空间，但这也直接增加了网络冲突升级为核危机的风险。此外，日益自主化的情报决策机制也会给核预警体制带来反噬的可能性。人工智能技术在上述情报手段中的应用及其未来的发展潜力会破坏大国间的战略稳定。]"[49]

There are divergent views on the implication of military AI, especially on the extent to which AI application affects nuclear

deterrence and strategic stability. Some experts have expressed pessimistic views and stressed risks of potential arms race due to the AI application.

> "The continuous development of science and technology is eroding the foundation of strategic deterrence and shaking the strategic stability and expectations among major powers. A nuclear-armed state must deploy a powerful second-strike capability to ensure that opponents dare not take the risk of being destroyed by launching a first strike. Therefore, ensuring the credibility of retaliation has become an important basis for major powers' nuclear strategic game. However, AI does not need to completely destroy the basis of the strategic game of great powers, it is enough to weaken the credibility of nuclear strikes and retaliation... Facing nuclear deterrence, decision makers have to make decisions within an extremely limited time, so they have to bear greater pressure to deliver the first strike. Alternatively, states develop more dangerous weapons to balance deterrence deficits. The resulting arms race forces countries to deploy unsafe AI systems and further increases strategic instability. [科技的不断发展正在侵蚀战略威慑的基础，动摇大国间的战略稳定及其预期。拥核国家必然部署强大的第二次打击能力，确保对手不敢冒着同样被摧毁的风险而发动第一次打击。因此，确保报复可信度成为了大国核战略博弈的重要基础。可是，人工智能技术并不需要完全破坏大国战略博弈的基础，只需削弱核打击报复可信度就足够了…面对核威慑，决策者不得不在极其有限的时间内做出决策，因而要承受更大的发动第一次打击的压力。或者，国家发展更加危险的武器来平衡威慑不足。由此引发的军备竞赛迫使国家部署不安全的人工智能系统，并进一步加大战略不稳定。]"[50]

> "With regards to the nuclear war, the leading nations of the technique tend to utilise or threaten to use strategic nuclear weapons to gain overall advantages, while the prospect of failure in intelligentised warfare would stimulate nations to use tactical nuclear weapons to seek local initiative. Then, it will strengthen the nuclear weapon races among nations, and nuclear crisis control will be confronted with greater risks. New risks and unpredictable factors will be also created in the daily management of nuclear weapons. Intelligent autonomous weapons are the new driving force of international power struggles. The security dilemma of the international community will intensify and a new round of intelligent arms race will be inevitable. [在核战争领域，智能领先的国家会更加喜欢使用或者威胁使用战略核武器获得整体优势，而在智能战争中失败的前景则会刺激国家利用战术核武器谋求局部主动；它会强化国家之间的核军备竞赛，核危机管控也面临更大风险；它还会给核武器日常管理带来新的风险与不确定因素。智能武器在战争中的这些作用会成为国际权力斗争的新动力。国际社会的安全困境因而加剧，新一轮智能军备竞赛不可避免]"[51]

Meanwhile, some experts have expressed reservations on the strategic implication of AI application in the nuclear realm, especially in the short term. They contend that the use of AI in the military arena tends to have greater impact on conventional weaponry, warranting greater attention than its impact on nuclear arms.

> "At present, and in the foreseeable future, the strategic impact of AI still mainly remains in the field of conventional warfare

and has little impact on the effectiveness of nuclear deterrence and strategic stability. As an 'enabler', AI transforms the warfare into information-based warfare based on intelligent units, but it cannot fundamentally change the survivability and penetration capabilities of the nuclear weapons of major powers such as the United States, Russia, and China. Therefore, there is no fundamental impact on strategic stability in the nuclear realm. [当前以及可预见的未来，人工智能技术的战略影响依然主要存在于常规战争领域，对核威慑有效性和战略稳定性影响较小。人工智能技术作为“赋能器”，推动战争形态向基于智能单元的信息化战争转变，但其无法根本改变美国、俄罗斯和中国等大国核武器的生存能力和突防能力，因而对核领域的战略稳定没有根本性影响。]”[52]

“First of all, in theory, AI technology can of course improve the intelligence, surveillance, and reconnaissance capabilities of major countries against the nuclear weapons of other major countries, but in reality it is not so simple. … Second, even if AI systems enhance the ISR capabilities of major powers, they will not fundamentally change the survivability of major power nuclear weapons…Again, AI has little impact on the penetration capabilities of nuclear weapons…Since AI technology cannot have a key impact on the survivability and penetration capabilities of nuclear weapons, there will be no essential change in the strategic stability among major powers. [首先,理论上人工智能技术当然可以提升大国针对其他大国核武器的情报、监视和侦察能力,但在现实中并非如此简单。 … 其次,即使人工智能系统增强了大国的情报、监视、侦察能力,也不会从根本上改变大国核武器的生存能力。 … 再次,人工智能技术对核武器的突防能力影响很小。… 既然人工智能技术无法对核武器的生存能力和突防能力造成关键影响,那么,大国间战略稳定性就没有本质变化。]”[53]

“In fact, in the short term, the role of AI in conventional military deterrence and stability is considered greater than its role in nuclear deterrence and nuclear strategic stability. At present, there are still problems such as data limitation and data analysis in environmental reconnaissance, target positioning, early warning and other technologies for nuclear weapons. In terms of nuclear storage and transportation equipment and the survivability of nuclear weapons, there will be no significant changes due to the improvement of intelligence, surveillance and scouting ability. In the foreseeable future, the nuclear weapons used for the second strike can still survive the first nuclear strike or the conventional strike in the information age, and can break through the missile defence system to carry out retaliatory strikes against the enemy, causing unacceptable losses. Therefore, no major country has the motivation to launch a nuclear strike first. This means nuclear deterrence based on a second-strike capability will still be effective. Major powers will not change their nuclear strategies because of the application of AI. [事实上，在短时期内，人工智能对于常规军事威慑和稳定的作用被认为大于对核威慑和核战略稳定性的作用。目前，在针对核武器的环境侦察、目标定位、早期预警等技术上，还存在数据限制和数据分析等难题；在针对核存储和运输设备以及核武器的生存能力上，也不会因情报、监视、侦察能力的提升而产生显著变化。在可预见的未来，用于二次打击的核武器依然可以在第一次核打击或信息时代的常规打击中生存，并突破导弹防御系统，对敌方进行报复性打击，造成不可承受的损失，因此任何一个大国都没有首先发动核打击的动机。这意味着基于二次打击能力的核威慑仍将有效。大国也不会因为人工智能技术的应用而改变核战略。]” [54]

In the short term, the role of AI in conventional military deterrence and stability is considered greater than its role in nuclear deterrence and nuclear strategic stability.

Bottlenecks

Two major bottlenecks have been identified from the existing literature: first, a shortage of adequate training data and insufficient technological development to meet the growing need for AI technology in China. Second, the advancement of the AI industry, including critical applications in government, military, and various other sectors in China, largely relies on US technology.[55] This dependency poses a significant and worrisome risk to China. Notably, addressing these challenges has led to a focus on MCF. In addition, increased investment in fostering and attracting young talent from abroad has been prioritised as key solutions to this problem.

> "First, the maturity of AI is insufficient. Situational awareness, target allocation, and auxiliary decision-making are the key aspects of C2 and decision-making systems which are faced with the dilemma of a small amount of data and a lack of labels indicating correct judgments. Due to the small sample sizes, intelligent learning technology and data mining technology are not mature enough to support intelligent C2 and decision-making. Second, there is a lack of decision-making models. It is prominently manifested in the fact that AI's situational authenticity judgment and situational awareness under conditions with incomplete information are far from reaching the level of human cognition. Threat assessment, target allocation and effectiveness evaluation model algorithms have not yet been tested by actual combat data. The reliability cannot meet the practical requirements. [一是人工智能技术成熟度不足。在态势感知、目标分配和辅助决策等指挥决策和控制的关键环节，面临数据量少和缺乏判定正确性标签等困境，小样本情况下的智能学习技术和数据挖掘技术成熟度不够，难以支撑智能化指挥决策和控制。二是缺乏智能化决策模型。突出表现在人工智能对在不完全信息条件下的态势真伪判断和态势感知远远达不到人的认知水平，威胁评估、目标分配和效能评估模型算法还没有得到实战数据的检验，模型的可信度达不到实用要求等。]"[56]

> "Should be considered through MCF, using a large number of social resources, and maximally simulating, producing, and collecting large-sample spatial data for machine learning training through online war games, to solve the problem of lack of data in AI algorithm training. [应考虑通过军民融合的途径，利用大量社会资源，通过网络军事游戏最大限度地模拟、生产和收集用于机器学习训练的大样本空间数据，以破解人工智能算法训练缺数据的难题。]"[57]

> "The reserve of top talents is small and the basic innovation ability is insufficient. The shortage of high-level talents is also directly reflected in the lack of capabilities of key AI technologies and lack of algorithm innovation in China. Building a team with high-level talent and a team for innovation is an urgent need for the AI development of the country...[We should work on] attracting top global talent, accelerating the cultivation of young talents and the coordinated development of industry, academia and research. [顶尖人才储备少，基础创新能力不足。高层次人才的短缺也直接反映在我国人工智能关键根技术和算法创新方面能力的匮乏。建设高水平的人才队伍和创新团队是我国人工智能发展的迫切需求…引进全球顶尖人才资源 加速青年人才培养和产学研协同发展。]"[58]

5. Chinese observations on major powers' AI developments and military applications

As a late-comer to the field and one that aims to build a modern military that can fight and win future 'intelligentized' warfare, China is actively exploring both the civilian and military potentials of AI research, development, and applications.[59] Chinese analysts closely follow the developments of AI applications in military affairs in other major powers. These typically include the United States and key NATO members such as Britain and France, as well as Russia.

> "Military powers have been mindful of the critical role of nuclear weapons in maintaining global geopolitical stability. Assuming computing systems are always able to process incoming data quickly and accurately, decision makers should rely on AI to eliminate errors in situational analysis and increase efficiency when organizations use strategic weapons, including nuclear weapons. However, a large body of scientific research shows that AI systems cannot be fully trusted in the use of nuclear weapons; if they see the possibility of eventual superiority, AI may decide to use high-precision nuclear weapons to conduct pre-emptive global or limited strikes on enemy targets. [各军事强国一直注意核武器在维护全球地缘政治稳定方面的关键作用。假设计算系统总是能快速准确地处理传入的数据，那么在组织使用包括核武器在内的战略武器时，决策者应该依靠人工智能来消除对形势分析的错误，并提高效率。但是，大量科学研究表明，在使用核武器方面不能完全相信人工智能系统；如果看到最终获得优势的可能性，人工智能有可能决定使用高精度核武器对敌方目标进行先发制人的全球或有限打击。]"[60]

The United States

The United States is the focus of particular attention, as a model to be followed. PLA analysts note that the US Government, specifically the Pentagon, has issued numerous guidelines placing AI, machine learning, and autonomous systems as the top priorities for budgeting, R&D, recruitment, and application in the US military.

> "Over the past five years [2016-2021], the United States' understanding of AI has grown from shallow to deep, and its attitude towards AI has undergone a transformation process from relatively serious, considerable, to unprecedented attention. With the change of the United States' attitude towards AI, its systematic AI deployment measures have been introduced one after another, and an all-round AI governance system covering strategic policies, institutional reforms, legal systems, ethics, talent training, and international cooperation has been established. It has drawn a clear path and laid a solid foundation for the realization of the United States' AI development goals. [五年多来，美国对人工智能的认识从浅入深，对人工智能的态度经历了从比较重视、相当重视到空前重视的转变过程。随着美国对人工智能态度的转变，其体系化的人工智能布局措施陆续出台，构建起覆盖战略政策、机构变革、法律制度、伦理道德、人才培养、国际合作等的全方位人工智能治理体系，为美国人工智能发展目标的实现描绘了清晰的路径、打下了坚实的基础。]"[61]

> "With the help of a large number of basic innovations, the United States took the lead in the global AI field. Since 2016, it has issued a series of AI strategies and policies, and supplemented the introduction of unmanned systems, emerging technologies, and other related supporting policies, with the information in terms of the tittle, issuing organisation

and publishing time of the specific strategy or policy. The above-mentioned strategic policies have jointly established the top-level planning system of the US government in the field of AI, strongly driven its AI research and development and application, and raised the importance of AI in federal agencies. [借助大量基础创新成果，美国率先在全球人工智能领域布局，自2016年以来出台了一系列人工智能战略与政策，并补充出台了无人系统、新兴技术等相关配套政策，具体战略或政策的名称、发布机构及发布时间。上述战略政策共同建立起美国政府在人工智能领域的顶层规划体系，强力牵引了其人工智能研发应用，提升了联邦各机构对人工智能的重视程度。]"[62]

"Through a comprehensive layout, the U.S. government is continuing to enhance its global leadership, technological strength, influence, and combat application capabilities in the field of AI, and is moving towards its present development goals. Comprehensive analysis of its implementation measures can draw the following lessons. One is the top-level blueprint design guidelines to continuously improve strategic traction … Second, the gradual development is steady and far-reaching, and innovative means emerge endlessly ... The third is to implement technological nationalism and take multiple measures to attack in an all-round way. … During this process, the United States has adopted multiple measures to develop its own AI, paying close attention to the three important factors of technological development, namely investment, talent, and cooperation …Fourth, to lead the era and focus on efforts. The technology has shown leapfrog development. Based on the profound technical accumulation of DARPA [the Defence Advanced Research Projects Agency] for more than 60 years, the technology research and development of AI in the United States represents the mainstream trend of the development of AI in the world ... Fifth, it emphasises the morality of freedom and democracy, and has rich regulatory measures …, the prerequisite for the use of AI in the United States must be to ensure that it is effective, reasonable, legal, and controllable. [通过综合布局，美国政府正持续提升在人工智能领域的全球领导力、技术实力、影响力、作战运用能力，向着其预设的发展目标迈进。综合分析其实施举措，可得出以下经验启示。一是顶层蓝图设计指引，持续提升战略牵引。… 二是渐进发展行稳致远，革新手段层出不穷。… 三是执行科技民族主义，多措并举全面出击。… 这一过程中，美国采用了多措并举的方式发展自身的人工智能，极为关注技术发展的三大重要因素，即投资、人才、合作。… 四是引领时代集中发力，技术呈现跨越发展。基于DARPA六十多年的深厚技术积淀，美国人工智能的技术研发代表了全球人工智能发展的主流趋势。… 五是强调自由民主道德，监管措施手段丰富。… ，美国使用人工智能的前提必须是确保其有效、合理、合法、可控。]"[63]

In a broader context, discussions about US AI policies often centre on the competitive landscape with the US and the emphasis on techno-nationalism, a strategy employed by the US to secure and assert its global leadership in the field of AI.

China has been closely observing the research projects led by the U.S. Government, and vice versa. Specifically, China has shown keen interest in the technical advancements made by DARPA. In a broader context, discussions about U.S. AI policies often centre on the competitive landscape with the United States and the emphasis on techno-nationalism, a strategy employed by the U.S. to secure and assert its global leadership in the field of AI.

"In the development process of our army's command information, there was once a 'chimney' development status. For example, the development of various models was not systematic and scaled. The reason was that the top-level design

was not enough and there was a lack of a unified and effective plan. In this regard, we can learn from DARPA. The basic task of DARPA is to specialise in 'science and technology leading the future', open up new areas of national defence research, provide high-tech reserves for solving medium and long-term national security issues, and undertake research and analysis the emerging technology that have potential military value for military application. [在我国陆军指挥信息的发展过程中，曾经一度出现过“烟囱”式发展的现状，比如：各型号的发展不成体系、不成规模，究其原因就是顶层设计不够，缺乏一个统一有效的规划。这方面我们可以借鉴美国国防部高级研究计划局（DAPPA），DAPPA的基本任务是专事于“科技引领未来”，开拓新的国防科研领域，为解决中、远期国家安全问题提供高技术储备，研究分析具有潜在军事价值、高技术和新技术在军事上的应用。]”[64]

“After experiencing semi-automated, automated, and integrated C2 systems, the development of big data and AI technology has enabled the U.S. Army to discover new opportunities for the development of C2 systems. The following will take several attempts of the U.S. military in intelligent C2 systems as examples to analyse the development direction of the U.S. Army's intelligent C2 system. … [Take the] 'Dark Green' Auxiliary Decision-Making System.The original intention of the 'Dark Green' plan is to imitate the ability of 'Dark Blue' to predict the next move based on the opponent's actions. The action plan can be chosen by the commander, as the job of the commander is to select the best plan to implement, without having to care about the specific details of each plan … The original intention of the 'Dark Green' project is to automate a large amount of calculation and forecast work originally undertaken by staff officers, and greatly compress the time and space dimensions of OODA [Observe, Orient, Decide, Act]. [在经历了半自动化指挥控制系统、自动化指挥控制系统和一体化指挥控制系统后，大数据和人工智能技术的发展让美国陆军发现了指挥控制系统新的发展契机。下面将以几种美军在指挥控制系统智能化方面的尝试为例，分析美国陆军智能化指挥控制系统的发展方向。… “深绿”辅助决策系统。“深绿”计划的本意是要模仿“深蓝”能够根据对手的行动而预测下一步行动的能力，在指挥员进行决策前，根据对手的行动意图，结合预先设定的战场规则，生成多套可供指挥员选择的行动方案，指挥员所做的工作就是从诸多方案中遴选最优的方案进行执行，而不必关心每个方案的具体细节。… “深绿”计划的初衷是，将原来由参谋人员担负的大量计算和预测工作转化为自动化，对OODA的时间维和空间维进行大幅度的压缩。]”[65]

“The United States believes that once there is a technological 'generational gap' between countries, the gap in overall strength will be further widened, and the technological power will continue to expand its competitive advantages, enhance its global status and political influence, and even form a 'stronger, stronger, winners take-all' situation. Under such circumstances, it is very likely that a technologically powerful country will carry out political blackmail and technological surprise attacks on a weak country. Once a country lags behind in the field of AI, it will be at a disadvantage in the international strategic game. Therefore, the United States attaches great importance to whether it can maintain its global leadership in AI technology, which is essentially a competition for technological sovereignty. [美国认为，国家之间一旦形成技术“代差”，综合实力差距将被进一步拉大，技术强国会不断扩大竞争优势，提升其全球地位和政治影响力，甚至形成“强者愈强、赢者通吃”的局面。在这种情况下，

技术强国对弱国实施政治讹诈和技术突袭的可能性极大，一国一旦在人工智能领域落后，必将在国际战略博弈中处于不利地位。因此，美国极为重视自身能否保有人工智能技术的全球领导地位，本质是对技术主权的争夺。]"[66]

"In the future, in the field of AI, the Biden administration will still largely inherit the technological nationalism of the Trump era, and its blockade of China's key technologies and the suppression of high-tech companies will become more intense. However, it should also be noted that China and the United States have some basis for cooperation in the field of AI, such as the formulation of some technical standards, the expansion of the 'cake' of the digital economy, and the new risk management and control brought about by the combination of AI technology and nuclear weapons. At present, we still need to expand the basis of cooperation between the two sides and strive to avoid the complete decoupling of Sino-US technology. [未来，在人工智能领域，拜登政府仍将很大程度继承特朗普时期的技术民族主义，其对我关键技术的封锁以及高科技企业的打压力度将会愈发强烈。但是，也应该看到中美在人工智能领域存在部分合作的基础，例如部分技术标准的制定、做大数字经济"蛋糕"、人工智能技术与核武器结合所带来的新风险管控等。当下我方仍需扩大双方合作基础，力争避免中美科技的完全脱钩。]"[67]

Russian Federation

"Russia's application of AI in a military context has not surpassed that of the United States, but compared with other countries, it still has a relatively large advantage, mainly reflected in the high-precision AI technology research and development and the ratio of AI military equipment in various services and arms … The current situation and characteristics of the military application of AI in the Russian Federation can be summarised from four aspects: first, cutting-edge technologies such as tracking and breakthroughs are regarded as the basis for maintaining the advantages and development potential of AI weapons and equipment of the federal army; second, attaching importance to balanced development of both conventional weapons and AI; third, the construction of the remote information support system aims to be balanced and complete, coordinated, and efficient; fourth, the focus of equipment construction has shifted from traditional offensive and defensive weapons to space, cyber, unmanned, and other fields. [俄罗斯当前的人工智能军事应用水平尚未超越美国，但相较于其他国家而言，其仍具有较大优势，主要体现在高精度的人工智能技术研发与各军兵种的人工智能军事装备配备比率上。… 俄联邦人工智能军事应用的现状特点可从四个方面予以概括：首先，把跟踪、突破等前沿技术作为保持联邦军队人工智能武器装备优势和发展后劲的基础；其次，重视常规武器同人工智能武器间的均衡发展；第三，远程信息化保障系统建设以均衡完备、协同高效为目标；第四，装备建设重点由传统化的攻防式兵器向太空、网络、无人化等领域大幅度倾斜。]"[68]

"The control system endowed with AI is widely used in the Russian anti-missile system, air defence system, and anti-ship cruise missile system … Today, many countries, including Russia, already use AI technology at over-the-horizon radar stations to quickly identify military targets among the signatures of hundreds of air targets received … the Russian Armed Forces Automated Control System is the world's first

unified C2 system for all military units in the structure of the Russian Armed Forces. [赋予人工智能的控制系统，广泛用于俄军反导系统、防空系统以及反舰巡航导弹系统中。… 今天，包括俄罗斯在内的许多国家已经在超视距雷达站使用人工智能技术，可以在收到的数百个空中目标的标记中快速识别军事目标。… 俄军自动化控制系统是世界上第一个统一的指挥和控制系统，适用于俄武装部队架构中的所有军事单位。]"[69]

NATO

"The 'NATO AI strategy' proposes that AI is changing the global defence and security environment, providing unprecedented opportunities for strengthening NATO's technological advantages, but also accelerating the speed at which NATO faces threats. Therefore, one of the important goals of the alliance's launch of this strategy is to strengthen NATO's defence and technological capabilities by accelerating the construction of AI, so as to maintain NATO's technological advantages and minimize the threat of some countries and non-state actors using AI. [北约人工智能战略概要文件提出，人工智能正在改变全球防务和安全环境，为强化北约科技优势提供了前所未有的机会，但也加快了北约面临威胁的速度。 因此，同盟推出这一战略的重要目标之一是通过加速建设人工智能强化北约防务与技术实力，从而保持北约科技优势，最大限度减少一些国家和非国家行为体利用人工智能对北约产生威胁。]"[70]

"In order to achieve the intention of strengthening the alliance's defence and technological capabilities, NATO is actively trying to empower NATO's defence functions with AI technology. First, NATO hopes to use AI to improve the analysis and decision-making capabilities of the allied forces on the basis of deepening information exchange among countries. After training, machine learning and deep learning can help NATO achieve information prediction without complete metadata on the battlefield, entity recognition and extraction in the battlefield, and abnormal situation detection … Second, NATO seeks to empower the development of modern weapons and build a modern army with AI technology … Third, NATO uses AI technology for military and logistical support in simulated battlefields. [为实现强化同盟防务和技术实力的意图，北约积极尝试以人工智能技术赋能北约防务功能。第一，北约在深化各国信息互通的基础上，希望以人工智能提升 同盟军队的分析和决策能力。机器学习与深度学习能够在训练后帮助北约实现战场上不具备完整元数据的信息预测、战场中的实体识别与提取、异常情况检测等。… 第二，北约谋求以人工智能技术赋能开发现代化武器和打造现代化军队。… 第三，北约将人工智能技术用于非真实战场的军事和后勤支撑。]"[71]

If NATO can overcome the challenges, the alliance's defence and technological strength and governance influence will significantly benefit from this technology.

"The introduction of NATO's 'AI strategy' once again shows that NATO is pursuing an offensive strategy in cyberspace and striving to seize the strategic commanding heights of AI. At present, the effect of this strategy is not obvious, and the effect of the AI empowerment alliance still needs time to be tested. If NATO can overcome the challenges, the alliance's defence and technological strength and governance influence will significantly benefit from this technology, which is likely to be driven by a new round of technological competition, which will have a new impact on the international structure and international security situation. It is worth noting that this

strategy also fully reflects the two major trends of Western countries, mainly the United States and Europe, promoting the militarisation and alliance of AI, seeking to maintain the relative advantages of alliance technology and military strength, and to ensure absolute safety. [北约人工智能战略的出台再次体现北约正在网络空间奉行进攻性战略，努力抢占人工智能的战略制高点。目前，该战略的效果尚不明显，人工智能赋能同盟的效果仍需时间检验。如果北约能够克服挑战，同盟的防务和技术实力以及治理影响力将显著受益于此项技术，极可能以新一轮技术竞赛为牵引，对国际格局和国际安全形势产生新冲击。值得注意的是，这一战略也充分体现出以美欧为主体的西方国家力推人工智能军事化和同盟化的两大趋势，谋求维持同盟科技和军事实力的相对优势，确保地缘政治竞争中的绝对安全。]”[72]

6. Military applications of AI and risks mitigation: role of major powers

As previous sections make clear, AI's military applications, in particular as they relate to nuclear C2, bring both benefits and risks. The mitigation of risks to nuclear weapon systems but also, increasingly, autonomous weapons systems has been recognized as an important issue. The international community has already begun to carefully assess the implications of AI's military applications and call for negotiation of rules and agreements on their control. This will not be easy, given the different levels of AI developments and applications in major powers, and the diversity of views on the desirability and feasibility of effective controls. At the same time, there is also recognition that while the traditional arms control model can serve as a useful framework, the novelty and complexity of AI also sets it apart from previous weapon systems, including nuclear weapons and their associated delivery systems.

Chinese positions on AI's military applications remain ambivalent. Nonetheless, Beijing wants to be engaged and play an active role in discussing, negotiating, and setting rules on AI's military applications, including autonomous weapons and nuclear command and control at international forums. Specifically, China has established its own role within the mitigation of risk from military use of AI and autonomous weapons by:

a. Promoting arms control discussion under multilateral frameworks;

b. Calling for the establishment of an authoritative scientific development review mechanism;

c. Reaching bilateral and multilateral agreements for prohibiting the use of AI-enabled weapon systems, including autonomous weapons, in attacking each other's strategic assets.

The following are indicative of Chinese perspective and understanding of what are and should be involved in bringing controls of AI use, including in the nuclear domain.

> "In the current situation where the international community is increasingly discussing autonomous weapons, the United States actually has two goals in participating in the international arms control activities of autonomous weapons in the diplomatic field: one is to gain time and space for the United States to form an absolute competitive advantage in this field. The second is to call on the international community to pay attention to the security issues brought about by autonomous weapons, especially to prevent the abuse of autonomous weapons by any subject that may pose a 'threat' to US security and world dominance. [在当前国际社会对自主性武器的讨论日益热烈的情况下，美国在外交领域参与自主性武器国际军控活动实际上存在两个目标：一是为美国在该领域形成绝对竞争优势争取时间和空间；二是呼吁国际社会重视自主性武器所带来的安全问题，尤其是要防止可能会对美国安全和世界霸主地位造成"威胁"的任何主体滥用自主性武器。]"[73]

> "If China wants to play a critical role in addressing the challenges posed by autonomous weapon systems to global strategic stability, it must rely on the United Nations (UN), a global international security mechanism. China should coordinate its security demands with those of other

Beijing wants to be engaged and play an active role in discussing, negotiating, and setting rules on AI's military applications, including autonomous weapons and nuclear command and control at international forums.

countries under the UN framework, strengthen international communication and cooperation effectively, promote the process of arms control and crisis management on autonomous weapon systems in a timely and appropriate manner. Through fridnly consulations, China could reach the broadest strategic consensus on improving the strategic stability of autonomous weapon systems and promote the signing of relevant laws, regulations and conventions. [中国想要在应对自主武器系统对全球战略稳定性的挑战中有所作为，就必须依托联合国这一全球性国际安全机制，在联合国框架下统筹协调中国与世界各国的安全诉求，切实加强国际交流与合作，适时、恰当地推进自主武器系统军备控制和危机管控进程，通过友好协商的方式，就提升自主武器系统的战略稳定性达成最广泛的战略共识，推动相关法律、法规和公约的签署。]"[74]

"For our country [China], on the one hand, we must actively participate in relevant arms control negotiations, strive to maintain the authority of international conventions and regulations, and carry out dialogue and cooperation centred on the United Nations in order to solve the arms control of lethal autonomous weapon systems such as 'killer robots'. At the same time, on the basis of abiding by international laws and regulations, it is necessary to rationally develop relevant technologies and actively implement the military-civilian integration development strategy. We can focus on the development of highly intelligent autonomous robots from non-military fields and promote the improvement of military technology with the development of related civilian technologies. [对于我国[中国]来说，一方面要积极参与相关军控协商，努力维护国际公约和法规的权威性，要以联合国为中心开展对话合作，以求解决 "杀手机器人" 等致命性自主武器系统的军控问题；另一方面，要在遵守国际法规的基础上，合理发展相关技术，积极贯彻落实军民融合发展战略。可以着重从非军用领域发展高度智能化的自主机器人，以相关民用技术发展带动军用技术的提升。]"[75]

"At the 'Conference on Disarmament' in Geneva, China has repeatedly called for the establishment of an authoritative scientific development review mechanism as soon as possible to assess the prospects and risks of military applications of emerging technologies, negotiate and formulate relevant international norms, implement necessary preventive restrictions or prohibitions, and prevent the international community from re-emphasising the lesson from of 'development first, then disarmament' to prevent a new arms race. [中国在日内瓦裁军谈判会议上多次呼吁尽早建立权威的科学发展审议机制，对新兴技术的军事应用前景和风险进行评估，谈判制定相关国际准则，实施必要的预防性限制或禁止，避免国际社会重蹈 "先发展后裁军" 的覆辙，防止出现新的军备竞赛。] "[76]

"China can try to gradually reach bilateral and multilateral strategic agreements and cooperation content with countries leading in autonomous weapon technology development through joint declarations, codes of conduct, framework conventions, and information sharing mechanisms, so as not to use autonomous weapons to attack nuclear facilities, not to use autonomous weapons, etc. Constructive strategic agreements were reached on specific issues such as weapons attacking space assets, not using autonomous weapons to attack critical national infrastructure, and prohibiting the testing of autonomous weapons of mass destruction. [中国可以尝试通过共同宣言、行为准则、框架公约以及信息共享机制等多样化形式，

> 逐渐与自主武器技术领先国家达成双边、多边战略协定与合作内容，就不使用自主武器攻击核设施、不使用自主武器攻击太空资产、不使用自主武器攻击国家关键基础设施以及禁止大规模杀伤性自主武器试验等具体议题达成具有建设性的战略协议。]"[77]

Moreover, China has also suggested approaches that other major players in military AI could take to mitigate the associated risks. These include:

a. Avoid using AI-enabled weapons to attack critical military targets including nuclear infrastructure;

b. Avoid adopting AI technology in nuclear C2;

c. Seek consensus on the consequences of using AI-enabled weapon systems;

d. Call for establishing a non-binding agreement by drawing a bottom line on the use of autonomous weapons;

e. Promote exchanges, such as through track 2 dialogue;

f. Strengthen export controls regimes.

> "While developing AI technology to strengthen strategic deterrence, nuclear-weapon states should actively, proactively, and effectively avoid and control security risks caused by technology abuse and proliferation. The first step is to strengthen the concept of nuclear taboo, clarify the principle of 'no first use of nuclear weapons', and clarify the attack targets of autonomous weapon systems, especially the key military targets such as not actively attacking the other party's nuclear infrastructure; the second is to promote lethal autonomy under the framework of the United Nations. The arms control negotiating agenda for weapon systems will conditionally incorporate autonomous weapon systems into new strategic arms control agreements to prevent vicious arms races in the field of autonomous weapon systems. [核武器国家在研发人工智能技术强化战略威慑的同时，应积极、主动、有效规避及管控技术滥用和扩散引发的安全风险。一是强化核禁忌理念，明确 "不首先使用核武器" 原则，明确自主武器系统的攻击目标，尤其要明确不主动攻击对方的核基础设施等关键军事目标；二是推动在联合国框架下致命性自主武器系统的军控谈判议程，有条件地将自主武器系统纳入新的战略军控协议，防范自主武器系统领域恶性军备竞赛。]"[78]
>
> "In general, China's main position on autonomous weapons can be summarised in the following four points: first, it recognises the necessity of human-computer interaction measures; second, it doubts the effect of legal review; third, it emphasises that autonomous weapons arms control should avoid hindering the development of intelligent technology; the fourth is to support the formation of 'pre-emptive regulation'. However, as far as the issue of 'pre-emptive regulation' is concerned, China has not clarified whether to directly prohibit or control autonomous weapons on the premise of allowing their existence. But some unofficial sources suggest that China has once expressed support of an entire ban on lethal autonomous weapons systems (excluding research and development) . … It can be said that there is considerable ambiguity in China's position on the issue of arms control of autonomous

weapons. The absence of China's proposition is not only unproductive to our ability to exert influence in international security governance, guided by the concept of a community with a shared future for mankind, but also to the international community in producing meaningful outcomes on the issue of arms control of autonomous weapons. [总的看，中国针对自主性武器的主要立场可以概括为以下四点：一是认可人机交互措施的必要性；二是怀疑法律审查的效果；三是强调自主性武器军控应避免阻碍人工智能技术的发展；四是支持形成“抢先性规制”。但就“抢先性规制”这一问题而言，中国并未明确是直接禁止还是在允许自主性武器存在的前提下对其进行管控，但有部分非官方资料表明中国曾表示支持达成针对完全自主的致命性武器的适用（不包括研发）禁令。… 可以说，中国对自主性武器军控问题的立场存在相当大的模糊性，中国主张的缺失不仅不利于我们以人类命运共同体理念为导向在国际安全治理中发挥影响力，也不利于国际社会就自主性武器军控问题产生有意义的成果。]”[79]

‘Differences in the international community’s perception on the consequences of using autonomous weapons affect the process of arms control. The success of arms control also depends on the international community’s comprehensive consideration of two factors: on the one hand, the cognition of the military application value of weapons, and on the other hand, the cognition of the serious consequences caused by the use of weapons. Specifically, if people realise that a weapon has limited application value but its use will cause dire consequences, then the possibility of implementing arms control limiting its use is more likely to be successful; on the contrary, once a certain weapon can play a key role in determining the course of a war, even if its military application may have mass destruction consequences, the probability of successful arms control is still very small. [国际社会对自主武器应用后果的认知差异，影响军备控制的进程。军备控制的成功与否还取决于国际社会对于两方面因素认知的综合考量：一方面是对武器军事应用价值的认知，另一方面是对于武器使用所造成严重后果的认知。具体而言，如果人们认识到一种武器的应用价值有限但使用会造成可怕后果，那么，针对其实施军备控制的成功可能性较大；反之，一旦某种武器能够起到决定战争进程的关键作用，即便其军事应用可能带来大规模杀伤性后果，实施军备控制的成功可能性仍然很小。]”[80]

“Relevant arms control negotiations will not lead to a one-off, binding international treaty, but rather the adoption of a gradual process combining multiple arms control approaches to arrive at consensus-based ‘soft law’ once the bottom line on autonomous weapons has been agreed upon. This requires self-constrain by states so they may conclude non-binding agreements, such as a ‘code of conduct’ consistent with existing international law and international norms. This approach can address ethical and moral issues caused by autonomous weapons, but will have little effect on the maintenance of strategic stability. Perhaps the best approach is for countries that have not yet experienced fierce arms races, to make good use of the window of opportunity to draw a red line as early as possible to ensure human beings are in control of their destiny of life and death. [相关军控谈判不会是一次性达成具有约束力的国际条约，而是制定出致命性自主武器的底线后采取多种军控手段结合的渐进方式以建立共识性的“软法”。这需要国家采取自我限制，达成国家之间的非约束性协议，比如符合现行国际法和国际准则的“行为准则”。这种做法可以应对自主武器引发的

伦理道德问题，但是对于维护战略稳定作用不大。最好的方法或许是国家在尚未出现激烈的军备竞赛前，利用好窗口机遇期，尽早划出一条能够确保人类掌握自己生死命运的红线。]”[81]

“First, in the nuclear field, countries with nuclear weapons must strengthen cooperation, sign relevant bilateral and multilateral arms control agreements as soon as possible, prohibit the use of AI technology in nuclear C2 systems, and ensure that humans control all nuclear weapon launch platforms. The nuclear domain has the most devastating impact on international security and is a matter of life and death for the whole world, so managing the risks of AI in this domain is particularly urgent … The nuclear powers should promote dialogue as soon as possible and give priority to setting strong restrictions on the application of AI to nuclear weapon systems, especially the agreement among nuclear powers that human beings should strictly control the decision-making power of nuclear launches, so as to ensure that human beings control all nuclear weapon launch platforms … Countries must ensure that humans strictly control nuclear launch decisions, and at the same time make it clear that AI-enabled unmanned weapons and equipment should not be used as nuclear delivery platforms to avoid nuclear accidents or accidental nuclear wars caused by humans losing control of nuclear weapons. [第一，在核领域，拥核国家须强化合作，尽快签订相关双边和多边军控协定，禁止将人工智能技术用于核指挥控制系统中，确保人类控制所有核武器发射平台。核领域对国际安全的影响是最具毁灭性的，攸关全世界的生死存亡，因而管控人工智能在这一领域的风险尤为紧迫。… 核大国之间要尽快推进对话，优先对将人工智能应用于核武器系统的行为设定强有力的限制措施，尤其是有核国家间达成由人类严格控制核发射决定权的协议，确保人类控制所有核武器发射平台。… 各国必须确保人类严格控制核发射决策，同时明确人工智能赋能的无人武器装备不应用作核运载平台，避免人类失去对核武器的控制而发生核事故或意外核战争。]”[82]

“In terms of maintaining the stability of the arms race, China should clearly advocate that independent weapons research and development be placed under strict international supervision, and work together with other countries to increase the transparency of the research and development process. At the same time, China should issue initiatives to major countries that have mastered independent weapon technology, fully recognise the common threat to global security that terrorists and hacker organisations control independent weapon technology, strictly control the risk of key technology and key equipment spreading to terrorist organisations, and jointly build a global monitoring network to manage the proliferation of autonomous weapons technology. In terms of maintaining the stability of the crisis, China should clearly state its position in the international community, urge all countries to establish a bottom-line awareness of the use of autonomous weapon systems, comprehensively assess the safety and reliability risks in the deployment and use of their own autonomous weapon systems, and ensure that the military application of autonomous weapon technology is placed within the scope of human control, eliminating the potential risks of automatic crisis outbreak and automatic escalation. [在维护

军备竞赛稳定性方面，中国应当明确主张将自主武器研发置于严密的国际监管之下，并与各国一道共同致力于增加研发进程的透明度。同时，中国应向掌握自主武器技术的主要国家发出倡议，充分认清恐怖分子、黑客组织掌控自主武器技术对于全球安全的共同威胁，严控关键技术、关键设备向恐怖组织扩散的风险，共同构筑自主武器技术扩散的全球监控网络。在维护危机稳定性方面，中国应在国际社会上旗帜鲜明地阐明立场，敦促各国确立使用自主武器系统的底线意识，全面评估本国自主武器系统部署和使用过程中的安全性与可靠性风险，确保将自主武器技术的军事应用置于人类可以控制的范围之内，杜绝危机自动爆发和自动升级的潜在风险。]"[83]

"In the current reality of facing the above-mentioned multiple problems, it is more feasible to gradually reach a consensus at the level of experts from various countries through the second-track dialogue, and then try to promote the final conclusions through binding treaties and instruments between countries. This step-by-step approach is more feasible. In particular, it is necessary to speed up the construction of a dual-track exchange mechanism and promote dialogue and exchanges between the two tracks through multilateral or bilateral means. In this process, we must also actively play the positive role of global civil society, for example, to attract representatives from the fields of 'banning killer robots' and AI multinational companies to participate in the consultation and discussion, and fully pool the appeals and wisdom of all parties. [在当前面临前述多重问题的现实境况下，通过二轨对话方式在各国专家层面逐步达成共识，再尝试推动国家间最后达成有约束力的条约和文书，这样循序渐进的推进方式更具可行性。特别是要加快双轨交流机制的构建，通过多边或双边方式推进二轨对话交流。在此过程中，也要积极发挥全球公民社会的积极作用，例如，吸纳"禁止杀手机器人"、人工智能跨国公司等领域的代表参与协商讨论，充分汇集各方诉求和智慧。]"[84]

"Major countries with autonomous weapons need to strengthen export controls to limit the horizontal spread of autonomous weapons and related technologies to other state actors and non-state actors without adequate risk control measures. … Export controls from national sources of autonomous weapons are particularly important, especially to limit the widespread worldwide distribution of AI-enabled small arms and light weapons, which are prone to proliferation to non-state actors such as terrorist organisations. [拥有自主武器的主要国家需要加强出口控制，限制自主武器及相关技术向没有足够风险管控措施的其他国家行为体和非国家行为体的水平扩散。… 从拥有自主武器的国家源头进行出口控制尤为重要，尤其要限制人工智能赋能的轻小武器在世界范围内广泛传播，因为这些武器容易扩散到恐怖组织等非国家行为体中。]"[85]

7. Analysis

China is engaged in an all-of-government approach to AI development in recognition of its critical importance both when it comes to contributing to the country's economic development and to its military modernisation efforts. Since 2017, top Chinese leadership and the Government have clearly set the benchmarks and specific goals for China to become a leading power in AI research and applications for both civilian and military purposes.[86] A careful, albeit not exhaustive review of the Chinese literature reinforces this interpretation. However, unlike discussions by officials and analysts of other major powers regarding AI applications in nuclear command and control, similar discussions in China remain focused on its competitors. Our analysis therefore will be informed by available open-source data and secondary sources.[87]

Given the critical role of AI in economic development and military modernisation, the Chinese Government, apart from issuing the policy directives contained in various official documents and speeches made by Xi, has committed to significant investments in research and development, infrastructure, education, and administration over the past few years. As data collection and management is the key in AI application, China has created a National Data Bureau within the State Council at the 'Two Sessions' in early 2023.[88] While in the domestic political and economic domains, data access and use remain a matter of careful balancing between openness and control. The military application also involves trade-offs in benefits and risks. At the same time, China is clearly interested in influencing standard-setting through its participation in global AI governance, including regulations on lethal autonomous weapon systems (LAWS).[89]

Building a world-class military is one of the key objectives in China's pursuit of great-power status by mid-century. Chairman Xi in particular has placed great emphasis on applying military-technological innovations to enable the PLA to continue its transition from one of a traditional fighting force, to one of mechanisation, informatisation, and ultimately intelligentisation, with the last 'integrating AI, quantum computing, big data, and other emerging technologies into the joint force'.[90] AI is recognised as the essential technology that will greatly enhance China's military-strategic capabilities. It will be a critical ingredient of the PLA's transformation to unity in its force structure and doctrine, and in the development and deployment of weapons systems from precision-guided missiles to anti-space weapons.[91]

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AI, like all other emerging and disruptive technologies, provides great opportunities for China and, for that matter, for the PLA to short-cut the enormous time and resources required to build matching military capabilities of a superpower like the United States. These technologies will enable the Chinese military to narrow the capability gap and engage in what was characterised as 'unrestricted warfare' more than two decades ago by PLA analysts. They will do so by leveraging the newly acquired innovative - and often asymmetrical -capabilities for both deterrence and offensive purposes.[92] As this paper demonstrates, the PLA is clearly keen to integrate AI in its military C2, jointness, firepower, and decision-making and all other aspects of military operations. The Chinese analyses digested here provide information on what the PLA is likely to pay the most attention to and place its priorities. This is demonstrated by its focus on examining the USA and other major

powers' development and activities. There are clear signs of the PLA already achieving similar capabilities, even if not at the same level. However, given that these capabilities have never been tested in real-world scenarios, it remains to be seen if the PLA has charted the right course and whether it has been provided with the necessary resources, and is able to deploy AI-assisted capabilities. The USA is becoming increasingly aware of how important EDTs can enhance the capabilities of its peer competitors and strategic rivals; as a result, they are imposing ever more restrictive controls on technologies essential for AI development, such as semiconductors. These can represent significant obstacles to the PLA's aspiration for intelligentisation.

There is no question that the PLA is aware of the enormous benefits and potentials that EDTs such as AI can contribute to the enhancement of nuclear command and control; it is equally clear that Chinese analysts recognise the pitfalls and risks involved.[93] For China, with its relatively small - albeit rapidly growing - nuclear arsenal, it has always been essential to ensure its survival: that is, a reliable second strike capability. AI integrated into nuclear command and control therefore becomes critical as it can shorten the time needed to analyze and process data and presumably provide accurate information that allows for quicker decision-making. However, given all the potential risks involved, human control, i.e., 'staying in the loop' on the decision-making on nuclear use, has been and will remain a akey consideration. This is particularly relevant as the PLA moves towards greater AI integration into nuclear command and control. In addition, civil-military and, in China's case, Party-PLA relations and the tradition of the CCP exercising complete control over the military, i.e., 'commanding the gun' can also mitigate some of the risks. Therefore, for the time being, assessments of the risks are informed less by technical than political considerations. The recent shuffle of top leadership in the PLA's Strategic Rocket Force is a clear indication of this line of thinking.

8. Conclusion and recommendations

This chapter presents the overall conclusions of the paper and provides policy recommendations for mitigating the risks of applying AI technologies in the military domain, including nuclear command and control. These recommendations specifically focus on the measures for engaging with China.

Key findings

1. Chinese literature on AI related research surged in 2017. The focus of the expert debate in political science has shifted from a focus on the development in other countries, to the implications of AI on great power relations.[94] The literature written by PLA associated institutes indicates a strong focus on the developments in major powers' AI-enabled C2 and decision-making systems, with a general consensus that these developments will be key for winning future intelligentised warfare. While less explicit about China's own developments in the area, there are nonetheless suggestions that the experiences of other great powers could be emulated. Some of the lessons to be drawn include the importance of top-level designs in AI development, national and integrated strategies, budgeting and implementation, foundational research, as well as training and recruitment of personnel. This appears to be a pressing issue, especially in military AI in China, as many Chinese analysts readily admit.

2. There seems to be a divergent view on the extent to which AI will have an impact on nuclear deterrence and strategic stability. Some have suggested a very limited implication of AI on nuclear deterrence. In fact, the application of AI in the military domain will have more impact on conventional weapons than nuclear weapons. There is a recognition, due largely to ethic issues and the risk of losing control, that AI application, and especially in autonomous nuclear-weapon systems, remains tentative and limited, given the uncertainty and risks. This appears to be in line with the debates currently ongoing in the West regarding the benefits and risks of AI applications in the nuclear realm, including C2, as the narrower focus would refer to.

3. As a result, there is a consensus among the Chinese expert community that there is no clear indication that nuclear armed states intend to apply AI or autonomous systems to their nuclear weapons. Instead, AI will have a larger impact on nuclear deterrence architecture. In particular, the AI-enabled systems in nuclear weapons could include a range of aspects, from early warning to C2 and decision-making, from weapon delivery systems to air and missile defence. While recognising the potential risks that AI applications in nuclear-weapons systems may entail (for instance, crisis instability and escalation), overall there is confidence that the strategic stability can be maintained. This is largely because of the tentative and limited AI applications to date, and because nuclear powers tend to place greater efforts in securing the survivability of their nuclear retaliatory capabilities through hardening, concealment, and redundancy to minimise vulnerability to first strikes, including AI-enabled conventional precision strikes.

The literature written by PLA associated institutes indicates a strong focus on the developments in major powers' AI-enabled C2 and decision-making systems, with a general consensus that these developments will be key for winning future intelligentised warfare.

4. Both official perspective and expert community in China share a common sense that the application of AI will bring unprecedented complexity in decision-making process. While there are associated risks due to the application, this trend is inevitable and will become the key for winning future warfare. Meanwhile, there is also consensus on the centrality of human intervention in AI-enabled weapon systems in both Chinese literature and official doctrines, for the reasons discussed above. There is also recognition that arms control is needed in particular in addressing the potential risks that autonomous (nuclear) weapons to international security and strategic stability. There are increasingly more focused discussions on the motivations of great powers such as the US in introducing arms control measures in AI-related areas. China could learn and become more proactive in having a voice in determining the contours and contents of international agreements that will have impact not only on international security and the future of AI development and applications, but also on China's own national interests in these areas.

5. The future developments of China's AI will likely depend on both the hardware and software aspects. On the former, current US policy on restricting semiconductor technology transfers to China will have a significant impact in the short term. Overtime, China can overcome the bottleneck in chip making and its ability to access large datasets will help it with AI development. On the latter, apart from clearly articulated national strategies, training and retaining AI talents will be critical.

6. Literature suggests that the main approaches to mitigating risks from military application of AI technology come from multilateral frameworks. China has a strategic interest in preventing and reducing the risk of escalation involving AI-enabled weapon systems, but also in maintaining its own leverage.[95] While the proposed approaches suggest China is interested in a more active leading role, it remains to be seen what China can achieve in practical terms. In general, China has limited experience in arms control and the perception that arms control potentially limits its own power development still dominates.[96]

Policy recommendations

Based on these conclusions, the following recommendations emphasise measures to mitigate the risks associated with the military use of AI in nuclear C2 systems, particularly focusing on the steps that China could consider to enhance its practices.

1. Sharing views on the risks associated with the increasing military use of AI, especially with nuclear forces

In light of the limitation posed by the scarcity of open-source information concerning China's strategic thinking and adoption of military AI, it becomes crucial for China to engage in dialogues with other major powers with advanced AI capabilities and military AI applications. These dialogues serve as a platform for sharing views on their own threat perceptions, strategic intentions, doctrines and postures to reduce misinterpretation. These messages and stance may not be correctly captured or they may be exaggerated in the open literatures due to different personal perceptions.

While the proposed approaches suggest China is interested in a more active leading role, it remains to be seen what China can achieve in practical terms.

2. Further elaborating a framework outlining acceptable and unacceptable adoption of AI in nuclear C2 system

Although China advocates for the concept of 'keeping humans in the loop', there is currently a lack of benchmarks to assess the extent of the acceptability and manner in which AI is integrated into nuclear C2 system. It is of utmost importance to determine the military developments that could potentially lower the threshold for nuclear use, as well as identify China's red lines. Understanding these boundaries is crucial for preventing an escalatory scenario, particularly in the context of the volatile geopolitical environment and during times of crises.

3. Enhancing understanding of risks and implications of military use of AI for non-governmental actors

The risks associated with the military application of AI are not solely limited to end-users who determine the intended purpose and actual deployment. They also originate from the developers who lay the foundations, often found within tech companies. Moreover, it is crucial to acknowledge the involvement of other entities, such as companies within the arms industry, as they form part of the comprehensive spectrum of actors that should be included in discussions to comprehend the risks and implications of the military use of AI in the nuclear domain within China. It is important to facilitate greater engagement of non-governmental actors in the discussions at global fora, which could create a parallel channel, apart from the dialogue at official levels, for sharing views and concerns.

4. Providing targeted education and training

Regular and targeted education and training activities should be facilitated to effectively address the prevailing skills gap in the field of AI. Such initiatives are of utmost importance for equipping individuals with the essential expertise and knowledge needed to understand and responsibly navigate AI technology. This includes providing young IT talents with the necessary insights on effectively deploying AI while upholding ethical considerations. Similarly, policymakers would greatly benefit from educational programs that bridge the gap between strategic thinking and technical realities, enabling them to make informed decisions regarding AI adoption and regulation.

5. Developing rules of the road for military AI applications, especially in nuclear C2

The P5 states recently reiterated their commitments to the pledge that "nuclear war cannot be won and should not be fought" at the 2020 RevCon. However, while this is an important statement, it remains largely political, as opposed to prescriptive. And at the same time, major nuclear powers remain actively engaged in the research, development, and exploration of possible deployment of AI in nuclear C2, assuming others are doing the same. Clearly, there is a need for them to begin serious dialogue, within the broader framework of nuclear risk reduction, on specific rules and even prohibition regarding AI's role in nuclear C2 so that final decisions on nuclear use remain in the hand of political decision-makers than automated systems. The Conference on Disarmament (CD) could

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be a suitable venue to start the dialogue, which will involve the P5 and other de facto nuclear weapons states, and is more inclusive given the size of the CD membership.

In sum, active engagement is crucial, whether it is initiated by China or facilitated by other nation states or actors, in order to encourage the adoption of responsible risk mitigation strategies. Given the changing geopolitical landscape and the increased focus of states pursuing a much more active industrial technology policy intertwined with national security strategy, there is a risk of creating separate ecosystems or diminished incentives that could hinder the establishment of unified and cooperative global norms in the field of AI. In this context, the UK-sponsored inaugural AI Safety Summit and the Bletchley Declaration issued by the 28 participating countries, including China and the United States, represent a positive step forward in managing AI development and regulating its use.

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