# CHINA'S ARTIFICIAL INTELLIGENCE DREAM: A THREAT TO THE U.S. THIRD OFFSET STRATEGY

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The US announced the Defence Innovation Initiative in 2014 to pursue technological innovation resulting in the Third Offset Strategy. The Strategy focused on leveraging the US core competencies in the field of unmanned systems and automation. It sought to offset the progress of its competitors in the field of cyber, EW, counterspace, and the development of A2AD. In 2017, Chinese leadership riding on two decades of high economic growth and global ambition launched a Next Generation AI Development Plan (AIDP) to capitalize on the transformative potential of AI. Chinese leadership believes that being at the forefront of the AI technologies is critical to the future of global military and economic power competition. Both The United States and China recognize the AI's potential to change the character of the battlefield. Strategic competition between both countries for AI dominance is unprecedented due to economic gains, strategic risks, and fluid interactions between AI communities. With each country having fundamentally different advantages and disadvantages, the race for AI dominance will come down to a competition between AI strategies of both countries.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

CHINA'S ARTIFICIAL INTELLIGENCE DREAM: A THREAT TO THE U.S. THIRD OFFSET STRATEGY, by Major Kundan Kumar, 123 pages.

The US announced the Defense Innovation Initiative in 2014 to pursue technological innovation resulting in the Third Offset Strategy. The Strategy focused on leveraging the US core competencies in the field of unmanned systems and automation. It sought to offset the progress of its competitors in the field of cyber, EW, counterspace, and the development of A2AD.

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ACRONYMS

| | |
|---|---|
| A2AD | Anti-Access Area Denial |
| AAAI | Association for the Advancement of Artificial Intelligence |
| A-AITF | Army Artificial Intelligence Task Force |
| AI | Artificial Intelligence |
| AIDP | Artificial Intelligence Development Plan |
| APT | Advanced Persistence Threat |
| BRAIN | Brain Research through Advancing Innovative Neurotechnology |
| BRI | Belt and Road Initiative |
| C2 | Command and control |
| CCIMD | Central Commission for Integrated Military Development |
| CCW | Convention on Certain Conventional Weapons |
| CFIUS | Committee on Foreign Investments in the United States |
| CMC | Central Military Commission |
| CMF | Civil Military Fusion |
| CNAS | Centre for the New American studies |
| CSBA | Centre for Strategic and Budgetary Assessments |
| DARPA | Defense Advanced Research Projects |
| DOD | Department of Defense |
| EW | Electronic Warfare |
| FRPC | Facial Recognition Prize Challenge |
| IARPA | Intelligence Advanced Research Projects Activity |
| IC | Integrated Circuit |
| IPR | Intellectual Property Rights |

| | |
|---|---|
| ISR | Intelligence, Surveillance and Reconnaissance |
| JAIC | Joint Artificial Intelligence Center |
| JCIDA | Joint Capabilities Integration Development System |
| LAWS | Lethal Autonomous Weapon System |
| LOCUST | Low-Cost Unmanned Aerial Vehicle Swarming Technology |
| ML | Machine Learning |
| NIH | National Institutes of Health |
| NITRD | Networking and Information Technology Research and Development |
| NSF | National Science Foundation |
| NSTCS | National Science and Technology Council Subcommittee |
| ONR | Office of Naval Research |
| OODA | Observe, Orient, Decide, Act |
| OTA | Other Transaction Authorities |
| PGM | Precision Guided Munitions |
| PLA | People's Liberation Army |
| PNT | Position, Navigation, and Timing |
| R&D | Research and Development |
| RAS | Robotics and Autonomous System |
| SASTIND | The State Administration for Science, Technology and Industry for National Defense |
| STEM | Science, Technology, engineering, and Math |
| UCAV | Unmanned Combat Aerial Vehicle |

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# CHAPTER 1

# INTRODUCTION

The end of the Second World War produced an enduring international order. This international order was shaped and enforced by powerful countries, in a framework comprised of international organizations, international laws, and multilateral treaties. The United States, with its military and economic might, has led this world order unhindered from its adversaries and competitors. It has shaped and sustained a narrative of world peace and security that is possible only through American leadership. Its unchallenged superiority in technological innovation and adaptation provided the required capabilities that gave credence to its narrative of a bipolar or post 1991unipolar world. It has overcome any threat or competition to its dominance with "Offset Strategies" that provided the United States with asymmetric qualitative capabilities. The First Offset Strategy was coined in 1953 based on the United States superiority in nuclear weapons development and delivery mechanisms. The Second Offset was developed during 1974-75 based on US capabilities in precision-guided munitions and theatre level battle networks. These previous strategies have provided credible deterrence capabilities to the United States in the past. However, present geopolitical realities indicate that, as the effectiveness of the battle networks from the second offset is eroding, United States potential competitors have reached a level of parity in battle networks. Revanchist Russia and aspiring China are challenging the United States concept of international order that is

described in the National Security Strategy, 2015 as "a rule-based international order through strong and sustainable American leadership."[1]

Together, Russia and China are making consistent efforts to undermine US influence and increase their global footprints. A2/AD strategy and Near Abroad policy are threatening the United States power projection capabilities and its perceived commitment to its partner nations. Recognizing the threat of its eroding capabilities, the United States launched the Defense Innovation Initiative in 2014. This initiative was aimed to identify technologies and equipment that will eventually become the third offset strategy.

This coincided in time with China's undertaking of major reforms like Made in China 2025, Belt and Road initiative, and the modernization of the PLA. Capitalizing on the technical and economic progress of the country, China carved out its long-term vision to evolve as the global leader. It is focusing on artificial intelligence and autonomy as one of the critical technologies to fulfill its vision. In 2017, it published its artificial intelligence policy in line with its vision. These developments by China places it in fierce competition with the United States. Since most of the technological advancements driving the Third Offset Strategy of the United States and China's modernization policies are similar in nature, tempo and endurance of future innovations will determine the asymmetric edge to be gained by either of the countries. This thesis will focus on the

[1] The White House, Office of the Press Secretary, "Fact Sheet: The 2015 National Security Strategy," 06 February 2015, accessed 01 May 2019, https://obamawhitehouse.archives.gov/the-press-office/2015/02/06/fact-sheet-2015-national-security-strategy.

possibilities of China's technological progress outpacing the United States in innovation efforts in AI that can threaten the Third Offset Strategy of the United States.

## Purpose of the Study

The purpose of the thesis is to establish that China's growing technological capabilities in artificial intelligence threaten the United States Third Offset Strategy. It will focus on the elements of the Third Offset Strategy and technological capabilities provided by this strategy. Simultaneously, it will carry out research on technological, organizational, and institutional efforts by China to challenge US dominance. It will compare the abilities of both the United States and China in the field of technological innovation and adaptation that will provide the qualitative edge to either of the countries.

## Scope

The scope of the study is restricted to the developments in artificial intelligence and the Third Offset Strategy that are available in the open source domain. Due to the strategic applications of the technology, there is restricted availability of the classified articles that can elaborate on the issue. Hence, this study will focus more on commercial developments in the field of AI that can have military applications. By understanding the Third Offset Strategy and its underlying technical capabilities, it will carry out a comparative analysis of the China's AI strategy and the US Third Offset Strategy to determine the country that is better poised to exploit the advancements in AI.

## Primary Research Question

The primary research question is, can China's advancement in Artificial Intelligence (AI), make the "Third Offset Strategy" irrelevant? How can it neutralize the

United States innovation efforts, aimed at preserving its asymmetric qualitative advantages and revitalizing its conventional deterrence capability? The thesis will try to explore the possibility of China's ambitious AI plan replacing the US dominance in AI. It will then try to identify the military implications of this development. At last, it will identify policy challenges for the US to retain its global leadership.

## Secondary Research Questions

To answer the primary question, it is necessary to answer several secondary questions. They are, "What is the "Third Offset Strategy" and what capabilities it will provide to the United States?" What are the military applications of AI that can have a disruptive influence on present battlefield capabilities? What is the relative state of AI in the US and China, both current and in the near future?

## Assumptions

This thesis assumes there will be no near-term radical developments in the global environment in the form of an economic meltdown or limited war involving the US or China that can affect the pace of innovation in either of the countries. It also assumes the information published on AI and its military applications by both the countries in the open domain is factually correct.

## Limitations

A significant limitation of this study is the emergent nature of the Third Offset Strategy. The Third Offset Strategy is in the initial stage, and much of the initial framework is in the cognitive domain. Hence, it is difficult to pinpoint the technological capabilities that will be the outcome of this strategy. The other limitation is the nature of

AI technology that makes it difficult to chart the progress of AI in a graph and predict future outcomes. The nature of the technology envisages that some development in AI has the potential to overshadow decades of growth in the field. The most famous example is the defeat of "Go" world champion Ke Jie by a supercomputer named Alpha Go that has reinvigorated the AI research prospects. At this event, an artificial intelligent machine defeated a human champion in what might be mankind's most complicated board game. It showcased a breakthrough in machine learning that was being considered at least a decade away at that moment.[2]

## Delimitations

Both the Third Offset strategy and Artificial intelligence, have broad scopes. The level of comparison required a detailed analysis of all the components of artificial intelligence, and the Third Offset Strategy exceeds the time available and the scope of this thesis. This will be mitigated using authors who have published materials on the previous offset strategies and limiting the scope of the Third Offset Strategy to the elements connected to artificial intelligence. The second de-limitation is to explore only those portions of AI that have strategic importance and can impact the defense preparedness of the countries involved. Thus, the focus of the thesis will be restricted to comparison of AI strategies of both the US and China.

[2] Paul Mozur, "Google Alpha Go defeats Chinese Go Master in Win for AI," *The New York Times*, 23 May 2017, accessed 10 February 2019, https://www.nytimes.com/2017/05/23/business/google-deepmind-alphago-go-champion-defeat.html.

# CHAPTER 2

# LITERATURE REVIEW

## Introduction

The literature review is designed to cover four main topics; Third Offset Strategy of the United States; AI's applications in defence that can disrupt the current battlefield; China's AI strategy, and a comparative study of the United States and China's advancements in AI.

The Third Offset Strategy and the related Defence Innovation Initiative covers technological capabilities that will potentially provide the asymmetric qualitative edge to the United States. This topic also explores the role of other instruments of national power besides military in the Third Offset Strategy. AI applications in defence focuses on the role of AI in enhancing national security. It deliberates on the characteristics and potential of AI technology that makes it essential for the future battlefield. The third topic regarding China's AI strategy focuses on strengths and weaknesses of China's innovation ecosystem. It analyses China's Next Generation Artificial Plan and various initiatives undertaken by the Chinese government as part of this plan. The final topic covers artificial intelligence progress in the US and China to determine if China has the potential to usurp the US from its leadership position in AI. It explores various institutional, structural, technical, and organizational developments taking place in either country to exploit the maximum benefits of AI technology.

A comparative study of the developments in the field of AI, in both countries, is essential to establish the technological pace of either of the nations. As both countries

will focus on the similar technologies to develop an edge over each other, the pace and endurance of the technological advancements will establish the dominant nation.

## Offset Strategy

As per Dr. Melissa Flagg, Deputy Assistant Secretary of Defense for Research "an offset is some means of asymmetrically compensating for a disadvantage, particularly in military competition. Rather than match an opponent in an unfavorable competition, changing the competition to more favorable footing enables the application of strengths to a problem that is otherwise either unwinnable or winnable only at an unacceptable cost."[3]

The United States had adopted two offset strategies in the past to overcome the numerical superiority of the Warsaw Pact.[4] The United States first adopted an Offset strategy in 1953 with the development of the "New Look Strategy." It was developed to counter the numerical superiority of USSR. The United States did not want to match the Soviets numerically and in process heavily strain the US economy in an arms race. Because the United States had achieved considerable advances in the miniaturization of nuclear weapons that could be used throughout the depth and breadth of battle space, it chose to exploit advances in the nuclear weapons program to outmatch the Soviets. Apart from the development of a tactical nuclear weapon, it had also developed the capability to

[3] Melissa Flagg, "DoD Research and Engineering" (Power Point Presentation, 2016 Ground Robotics Capabilities Conference, National Defense Industrial Association, 02 March 2016), slide 5, accessed 24 September 2018. https://ndiastorage.blob.core.usgovcloudapi.net/ndia/2016/GRCCE/Flagg.pdf.

[4] Ibid., slide 6.

deliver the nuclear weapon in the battlespace. By 1961, the US had built 108,000 nuclear-tipped artillery rounds in addition to those designed for the use by the US Air Force. These technological advances gave a military edge to the US to counter Soviet traditional military superiority.

The Second Offset Strategy was adopted during the 1970s aimed at countering Soviet advances in both numerical and technical parity in nuclear arsenals. Coupled with sustained numerical superiority in conventional forces, these advances made the offset based on nuclear deterrence obsolete. This led to long-range research and development program between 1973-75 focussed on integrating existing US capabilities in precision-guided munitions and theatre level battle networks. The resulting Second Offset Strategy emphasized Intelligence, Surveillance and Reconnaissance (ISR) platforms; precision guided weapons; stealth and the expansion of space role in military communication and navigation.[5]

Dissolution of USSR in 1991 neutralized the fundamental threat around which the Second Offset Strategy was formed. However, the resultant concept of Air-Land battle was successfully employed in the First Gulf War. It helped the US to achieve a swift and decisive victory in Operation Desert Storm. Since then, the US has been building on that basic construct to incorporate emerging technological advancements to develop theatre wide battle networks, and Precision Guided Munitions (PGM). These battle networks and PGMs have provided conventional deterrence for the US for the last 30 years. However, the United States potential competitors, Russia and China have reached a level of parity

[5] Flagg, "DoD Research and Engineering," slide 6.

in battle networks and its effectiveness as deterrence is eroding. Now competitors are investing in counter network operations to degrade the effectiveness of these battle networks. They are spending money on cyber, EW and counter space capabilities. The United States adversaries are making rapid progress in these areas due to the proliferation of technology in the commercial domain. They have not only achieved parity in some of these aspects but have also outmatched some of these capabilities.[6]

According to the Center for Strategic and Budgetary Assessments (CSBA), the United States military is facing four core operational challenges arising due to the developments as mentioned earlier. The first challenge is that the strategic reach and strategic mobility of US forces are threatened by the increased vulnerability of US regional bases (ports, airfields, installations) around the world. Another challenge is that large surface combatants and aircraft carriers at sea are becoming easier to detect, track, and engage at an extended range from an adversary's coast. Also, growing capabilities of US adversaries in the interdiction of airfields, radar spoofing, and cyber-paralysis of air command and control (C2) has the potential to offset the US advantages in fighter quality and quantity. Lastly, Russia and Chinese progress in cyberspace and A-Sat capabilities can threaten the battle networks which forms the backbone of the US C4ISR capabilities.[7]

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[6] National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission* (Washington, DC: National Defense Strategy Commission, November 2018), accessed 01 March 2019, https://www.usip.org/sites/default/files/2018-11/providing-for-the-common-defense.pdf.

[7] Robert Martinage, *Towards a New Offset Strategy: Exploiting US Long-term Advantages to Restore US Global Power Projection Capability,* Center for Strategic and

Recognizing the threats to its conventional deterrence capabilities, former Secretary of Defence, Chuck Hagel, opined in 2014, "if we don't take these challenges seriously our military could arrive in a future combat theatre facing an arsenal of advanced, disruptive technologies that thwart our technological advantages, limit our freedom of maneuver, and put American lives at risk."[8] Hagel announced the Defense Innovation Initiative which would manifest into the Third Offset Strategy.

## Third Offset Strategy

The objective of the Third Offset Strategy is to offset the progress of US competitors like Russia and China in the fields of Cyber, EW, counter space, and the development of A2AD (Anti Access Area Denial) strategy. Both China and Russia have developed the capability of "long-range precision strike in volume" in land, sea, air, space, and cyberspace domains and are challenging US power projecting capabilities. While China is employing these capabilities to pursue its expansionist policies in the South China Sea, Russia is using them to project its vision of near abroad in the Baltics.

### Focus Areas for Third Offset Strategy

While announcing the Defence Innovation Initiative, former Secretary of Defence, Chuck Hagel did not specify a single technological innovation that would

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Budgetary Assessment, 2014, accessed 01 May 2019, https://csbaonline.org/uploads/documents/Offset-Strategy-Web.pdf.

[8] Secretary of Defense, "Defense Innovation Days," (Opening Keynote Speech, Southeastern New England Defense Industry Alliance, delivered by Chuck Hagel, Newport, RI, 03 September 2014), accessed 12 September 2018, http://archive.defense.gov/Speeches/Speech.aspx?SpeechID=1877.

provide the required offset. However, he emphasized three key areas for sources of innovation: long-range research and development, new operating concepts and reenergizing wargame efforts and techniques. The announcement attracted a lot of panel discussions and think tank studies to explore the focus areas for the Third Offset Strategy.

Robert Work, Former Deputy Secretary of Defence has been the most quoted speaker on the subject. In a seminar hosted by the Center for Strategic and International Studies (CSIS), titled "assessing the third offset," Robert Work explained the key areas as, "Initial vector is to exploit all the advantages of Artificial intelligence and autonomy and insert it to achieve a steep increase in performance that will strengthen conventional deterrence."[9] He identified five initial vectors for the strategy. They are: Autonomous Learning Systems, Human-Machine Collaborative Decision-Making, Assisted Human Operations, Advanced Manned-Unmanned System Operations, and Network-Enabled autonomous weapons hardened to operate in a future cyber/EW environment.

Dr. Melissa Flagg, Deputy Assistant Secretary of Defence for research, while speaking at 2016 Ground Capabilities Conference explained the DOD Research and Engineering's interpretation of these vectors. The focus of Autonomous Learning System will be on delegating decisions to machines in applications that require faster than human reaction times like cyber defence, electronic warfare, and missile defence. Autonomous Human-Machine Collaborative Decision Making will exploit the advantages of both humans and machines for better and faster human decisions. In short, it can be termed as

[9] Moon Terry Cronk, "Work Calls for Third Offset Strategy to Bolster Future of Warfighting," US Department of Defense, 10 September 2015, accessed 29 September 2018. https://dod.defense.gov/News/Article/Article/616806/work-calls-for-third-offset-strategy-to-bolster-future-of-warfighting/.

"human strategic guidance combined with the tactical acuity of a computer. Assisted Human operations comprises of machines and devices that can help people in multiple ways in performing their primary tasks like, wearable electronic devices or exoskeletons helping soldiers to carry heavy loads or move quickly. Advanced Manned and unmanned System operations will employ innovative cooperative operations between manned and unmanned platforms like MUM-T concept. Network-enabled Cyber and EW Hardened Autonomous and High-Speed Weapons will allow for cooperative weapon concepts in communication denied environments.[10]

In another seminar hosted by Center for the New American studies (CNAS), experts deliberated on the specific capabilities or the technologies needed to maintain the US military advantages into 2030. The experts found common ground in the following capabilities: data collection and intelligence, communication, offensive and defensive cyber capabilities, autonomy and robotics, C4ISR, and PNT capabilities. These capabilities are closely related to the initial five vectors identified.[11]Post announcement of the Third Offset Strategy, such seminars were not uncommon that tried to decode the third offset strategy. However, in recent past, the term Third Offset Strategy has not been very widely publicized. Much of these discussions have narrowed down to the role of AI and autonomy in the national security.

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[10] Flagg, "DoD Research and Engineering," slide 7.

[11] Alexandra Sander, "Third Offset Tech: What the Experts say," *War on the Rocks,* 12 May 2015, accessed 12 February 2019, https://warontherocks.com/2015/05/third-offset-tech-what-the-experts-say/.

Third Offset Strategy and AI

AI has been the cornerstone of the Third Offset Strategy since the launch of the Defense Innovation Initiative in November 2014.[12]In a panel discussion organized by CSIS on the Third Offset Strategy on 28 October 2016, AI and autonomy have gained multiple references by the panelists to including Ash Carter, then SecDef, Robert Work, former Deputy Secretary of Defense, and General Paul J Selva, Vice Chairman Joint Chief of Staff among others. At that point of time, AI was considered as one of the many technologies that can have a transformative effect, and the world was slowly awakening to the potentials of AI. The debates and discussions that focused on the possible technological solutions considered AI as one of the potentially transformative technologies. However, the defeat of Lee Sedol by Alpha Go on 15 March 2016, where the machine defeated the human champion in an enormously complex game of Go, became the milestone in the field of AI, and significantly altered the discussions centered on retaining US technological superiority. The scientific community realized the groundbreaking potential of machine learning and governments throughout the world launched steps to exploit the wide-ranging possibilities of the AI.

Since March 2016, AI has been at the forefront of the government initiatives to maintain the US technological superiority and has dominated discussions on Third Offset Strategy. The Obama administration initiated sincere and concerted efforts to maintain its dominance and discover the potential of artificial intelligence. It created new

[12] Statements of Robert Work during Defence Innovation initiative and Keynote Address at the CSIS conference, and presentation of Melissa Flagg.at Ground Robotics Capabilities Conference, National Defense Industrial Association.

organizational structures in the form of National Science and Technology Council Subcommittee (NSTCS) on Machine Learning and Artificial intelligence and NITRD Task Force on Artificial Intelligence to help coordinate and prioritize federal activities in AI. It also sponsored several significant studies on the future of AI and its implications for governance and national security.[13]

These studies recognized the risk of loss of US leadership in AI that would make the US vulnerable to authoritarian regimes like Russia and China that may have less restrictive policies and CONOPs governing their employment of lethal autonomy.[14] These reports by various organizations, and think tanks have established the dominant role of AI in national security and helped narrow down the discussion around the Third Offset Strategy. It also emphasized the role of AI in the Third Offset Strategy by bringing to the fore AI applications in the defense that can have the transformative implications on the battlefield.

[13] For example: June 2016-Defense Science Board, "Summer Study on Autonomy"; July 2016-Department of Defense Office of Net Assessment, "Summer Study: (Artificial) Intelligence: What questions should DoD be asking"; October 2016-National Science and Technology Council, "The National Artificial Intelligence Research and Development Strategic Plan"; October 2016-National Science and Technology Council, "Preparing for the Future of Artificial Intelligence"; December 2016-Executive Office of the President, "Artificial Intelligence, Automation, and the Economy"; January 2017-JASON, "Perspectives on Research in Artificial Intelligence and Artificial General Intelligence Relevant to DoD."

[14] Defense Science Board, *Summer Study on Autonomy* (Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, June 2016), accessed 01 May 2019, 42, https://www.hsdl.org/?abstract&did=794641.

AI Applications for National Security

A study by Belfer Center for Science and International Affairs on behalf of US IARPA in July 2017, argues that future progress in AI has the potential to be a transformative national security technology, on par with nuclear weapons, aircraft, computers, and biotech. The study provided 11 recommendations for the national security community with respect to R&D in AI. Primary of these recommendations were to invest heavily in Counter AI capabilities for both offense and defense, increase funding for the AI related basic research, and collaboration between the national security community and the commercial AI industry. It observed that the advances in AI will accelerate the shift from manned to unmanned combat missions and with falling prices of these systems, it may lead to shifting the balance of power from well funded and technologically sophisticated militaries. This might have a disruptive influence on the battlefield where military power will be disconnected from population size and economic strength.[15]Therefore the study recognized that maintaining the US global leadership in the field of AI is vital for the US national security.

Congressional Service Reports on "US Ground Forces Robotics and Autonomous System(RAS) and Artificial intelligence (AI): Consideration for Congress" and " Artificial Intelligence and National Security," in 2018 explores AI applications in defense. It identifies the role of AI in ISR, Cyberspace, Command and Control,

[15] Greg Allen and Taniel Chan, *Artificial Intelligence and National Security*, (Cambridge, MA: Belfer Center for Science and International Affairs on Behalf of Director of IARPA, July 2017), accessed 28 November 2018, https://www.belfercenter.org/sites/default/files/files/publication/AI%20NatSec%20-%20final.pdf.

Autonomous vehicles, Swarming, lethal Autonomous Weapon System (LAWS).[16] AI is expected to play a dominant role in intelligence due to the availability of large data sets for analysis. Integration of computer vision and machine learning algorithm into intelligence collection cells would allow an operator to sift through the vast amount of data to identify hostile targets. In the process, it would automate the role of human analysts, and significantly increase the reaction time. It would also economize on the workforce requirements.

According to top US national security officials, AI will have revolutionary impact in the field of cybersecurity and cyberwarfare.[17] AI and machine learning will drastically reduce the number of persons needed to perform specific tasks in the cyber domain. AI cyber tools will make the conventional cyber offense and defense obsolete since intelligent automation can enhance the capability to probe weaknesses, patch vulnerabilities or attack an opponent's vulnerabilities. In the field of cyber defense, they can present a more comprehensive barrier to previously unobserved attack methods by recognizing changes to patterns of behavior in a network and detect anomalies.[18]

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[16] Congressional Research Service (CRS), *US Ground Forces Robotics and Autonomous System (RAS) and Artificial Intelligence (AI): Consideration for Congress,* Congressional Research Service Report for Congress (Washington, DC: Library of Congress, 20 November 2018), accessed 01 May 2019, 39, https://fas.org/sgp/crs/ weapons/R45392.pdf.

[17] Ibid.

[18] Scott Rosenberg, "Firewalls Don't Stop Hackers, AI Might," *Wired*, 27 August 2017, accessed 01 May 2019, https://www.wired.com/story/ firewalls-don't-stop-hackers-ai-might/.

The advancements in AI would have a disruptive effect on the cyber supremacy of the powerful nation-state actors. Countries or organizations will not be constrained by labor or talent, but only be limited by the capital requirements. Thus, it forecasts a situation wherein an actor with the financial ability to buy an AI Advanced Persistent Threat (APT) system could wreak havoc in the cyber domain without the requisite technical know-how. Additionally, with the cost of software replication decreasing with passing time, weaponizing cyber capabilities will not require massive investments as the requirements for high-skill human operators and customization are reduced or eliminated. This disruptive nature of AI brings a perspective where a country does not have to be the leader in the foundational R&D in AI to present a credible threat.

In the field of Command and control, with the maturing complexity of AI systems, AI algorithms may provide commanders with viable courses of actions based on real time analysis of the battle space, which would enable faster adaption to changing battlefield conditions. It may also be used to identify disruptions in the communication links and find alternate means to distribute information. Thus, AI may provide a speedy and steady means of interpretation and dissemination of information that will help commanders to deal with the fog of the war.

The autonomous vehicle is an area of AI R&D that has the maximum potential of benefitting from the commercial R&D in the self-driving vehicles. Piggybacking on the commercial sector, militaries around the world are pursuing this technology. Primary motivators for the use of the autonomous or unmanned system on the battlefield include force multiplication, expansion of the battlespace, expanding the war fighter's reach, and

casualty reduction.[19] Swarming is another area where the employment of an autonomous system can have a disruptive effect on the battlefield. AI-fueled cooperative behavior, or swarming, is a unique subset of autonomous vehicle development, where large formations of low-cost drones can be employed to overwhelm defensive systems, high payoff targets, and high-value targets like Aircraft carriers.[20] Swarming may be a particularly useful technology for PLA that has been exploring disruptive military capabilities to target US vulnerabilities rather than competing to match US capabilities.

Lethal Autonomous Weapon System is a weapon system that can select (i.e., search for or detect, identify, track, select) and attack (i.e., use force against, neutralize, damage or destroy) targets without human intervention."[21] This is perhaps the most controversial application of the AI, where leading researchers in science and technology have expressed apprehension about the possible catastrophic implications of developing killer robots. At present, US DOD has delayed LAWS development indefinitely on moral grounds. However, the US may be compelled to address the development of LAWS to

[19] Ronald C Arkin, *A Roboticist's Perspective on Lethal Autonomous System,* United Nations Office for Disarmament Affairs (UNODA) Occasional Papers No. 30 (New York: UNODA, November 2017), accessed 10 December 2018, https://s3.amazonaws.com/unoda-web/wp-content/uploads/2017/11/op30.pdf.

[20] Kevin Paulsen, "Why the US Government is Terrified of Hobbyist Drones," *Wired*, 02 May 2015, accessed 09 December 2018, https://www.wired.com/2015/02/white-house-drone/.

[21] Hayley Evans, "Lethal Autonomous Weapon System at the First and Second UN GGE Meetings," *Lawfare* (blog), 09 April 2018, accessed 09 December 2018, https://www.lawfareblog.com/lethal-autonomous-weapons-systems-first-and-second-un-gge-meetings.

find its vulnerabilities because potential US adversaries like Russia and China are opposed to the international ban, moratorium, or regulation on such weapons.

These applications of AI present opportunities in the combat environment that are distinct from the existing systems. Adaption of AI systems will enhance the capability and productivity of individual soldier, enable unbiased decision-making overcoming enemy OODA loop, overwhelm the enemy sensors and decision makers with enhanced tempo, and reduce human casualties. One can find the linkage between the potential applications of AI with the five initial vectors of Third Offset Strategy. Thus, for the Third Offset Strategy to be successful global leadership of the US in AI will be imperative. The breakthrough progress in deep learning has also spurred its competitor China to launch a government-driven AI strategy to emerge as the global leader in AI. Hence, the relative progress of AI between the US and China will determine the possibility or longevity of the third offset strategy.

## The US and AI

The United States has been the leader in foundational research in AI, primarily supported by federal research funding and work at government laboratories. In 2015, the United States led the world in total gross domestic R&D expenditures, spending $497 billion.[22] The US Federal Government's support for unclassified AI R&D is managed through the Networking and Information Technology Research and Development (NITRD) program, and supported primarily by the Defense Advanced Research Projects

[22] National Science Board (NSB), *2018 Science & Engineering Indicators*, (Alexandria, VA: NSB, January 2018), accessed 14 November 2018, https://www.nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf.

Agency (DARPA), the National Science Foundation (NSF), the National Institutes of Health (NIH), the Office of Naval Research (ONR), and the Intelligence Advanced Research Projects Activity (IARPA). Major national research efforts such as the National Strategic Computing Initiative, the Big Data Initiative, and the Brain Research through Advancing Innovative Neurotechnology (BRAIN) Initiative also contribute indirectly to the progress of AI research.

Currently, DARPA is pursuing more than 20 programs to advance the state-of-the-art in AI, going beyond second wave machine learning techniques towards contextual reasoning capabilities. At present, it has more than 60 active programs applying AI in some capacity. Over the next year, DARPA plans to issue multiple Broad Agency Announcements for new programs that advance the state of the art in AI.

Structured on the model of the DARPA, IARPA is sponsoring several AI research projects intended to produce tangible tools for the intelligence community. Some of its programs are four to five years from completion and include developing algorithms to achieve multilingual speech recognition and translation in noisy environments, fusing 2-D images to create 3-D models, geo-locating images with no associated metadata, models, and tools to infer a building's function based on the pattern of life analysis.

On 02 March 2016, the USG launched Defense Innovation Board to enable civil-military collaboration and to bring the technological advancements and the best practices of Silicon Valley to the US military. Currently, under the chairmanship of Eric Schmidt, former Google CEO, the board has 14 members with diverse expertise including prominent business leaders, scholars, entrepreneurs, inventors, scientists, and technologists. It works in collaboration with the Defense Innovation Unit, Defense

Digital Service, and with service members and civilians across DOD looking to bring entrepreneurship and innovation to the department.

Apart from existing agencies and institutions, US DOD has created new organizations like Project Maven, Joint Artificial Intelligence Center (JAIC), and Army Artificial Intelligence Task Force (A-AITF). Project Maven was launched in April 2017 to incorporate AI into existing DOD systems to demonstrate the current technology potential. It was set to exploit the potential of AI to analyze vast data sets in a brief period.[23]In June 2018, DOD set up the JAIC to synchronize DOD AI activities and accelerate the delivery of AI-enabled capabilities to the joint force. To support the efforts of JAIC, the US Army announced the creation of the Army Intelligence Task Force on 02 October 2018 to lead army AI efforts and support DOD projects.

Apart from the government organizations, the US private tech giants like Google, Facebook, and Amazon have ensured US leadership in AI. There are various structural and cultural advantages to the US innovation efforts that are fueling its dominance. The US with its strong academic base, conducive industrial ecosystem and, a culture of innovation have traditionally led the foundational research in AI. With the dual nature of AI, leadership in commercial AI will also enable AI leadership in the defense sector that would consequently deliver the offset. However, the US ability to transfer the advancements in the commercial AI to the defense sector will prove crucial for the Third Offset Strategy.

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[23] Kelley M. Sayler and Daniel S. Hoadley, *Artificial Intelligence and National Security,* Congressional Research Service Report for Congress (Washington, DC: Library of Congress, 30 January 2019), accessed 01 May 2019, https://www.hsdl.org/ ?abstract&did=821457.

## China's Artificial Intelligence Program

China, with its growing ambition of global and regional dominance, has identified AI as a strategic force multiplier and has been frantically working towards developing the technology. The defeat of "Go" world champion, Ke Jie by Alpha Go encouraged the Chinese government to revamp their AI strategy to fulfill their dreams of global leadership. China had missed the previous revolutions in information technologies and related revolutions in military affairs due to its poor economic and technical base. As a result, China spent the last decade trying to catch up with the US, investing in disruptive technologies aimed at targeting US vulnerabilities rather than competing with the US. So, when this breakthrough event in deep learning took place during March 2017, spurred by its recent economic and technological successes, China was determined to exploit its potentials to realize its dream. Since then, it has taken a multipronged approach to emerging as a global leader in AI. Some of the steps taken include the framing of national policies, improving research infrastructure, providing educational climate, civil-military fusion, and displaying commitment at the highest level by the formulation of governing bodies for monitoring progress.

### Next Generation Artificial Intelligence Development Plan

State Council of China announced its Next Generation Artificial Development Plan in mid-2017 to become world leader in both application development and fundamental research in AI by 2030.[24] This plan included the development of AI for

[24] Comet Lab Research Team-Beijing, "Ambition and Reality: China's AI Policy," *Medium*, 06 September 2018, accessed 22 October 18, https://blog.cometlabs.io/ambition-and-reality-chinas-ai-policy-892318f84490.

military applications.[25] China intends to pursue advances in big data, human-machine hybrid intelligence, swarm intelligence, and automated decision-making, along with autonomous unmanned systems and intelligent robotics. Accordingly, it seeks to ensure that scientific and technological advances can be readily turned to dual-use applications, while military and civilian innovation resources will be "constructed together and shared."[26]

This plan is divided into three steps. By 2020, China desires to achieve parity with the leading countries in the world in overall technology and application of artificial intelligence. By 2025, it plans to make a significant breakthrough in artificial intelligence basic theory where parts of the technology and application will be at a world leading level. Then, by 2030, it plans to make artificial intelligence theory, technology and application achieve the world's leading level, to be the major artificial intelligence innovation center of the world, to build intelligent economy and intelligent society and lay an essential foundation for China's entry into the forefront of the innovative countries and economic powers.[27]

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[25] Elsa B. Kania, "China's Artificial Revolution," *The Diplomat*, 27 July 2017, accessed 23 October 2018, https://thediplomat.com/2017/07/chinas-artificial-intelligence-revolution/.

[26] The State Council of the People's Republic of China (PRC), "Notice of the Council Issuing the New Generation of Artificial Intelligence Development Plan," State Council Document [2017] No. 35, 08 July 2017, accessed 22 October 2018, https://flia.org/wp-content/uploads/2017/07/A-New-Generation-of-Artificial-Intelligence-Development-Plan-1.pdf.

[27] Ibid.

China's AIDP does not exist in a vacuum, but it interacts with other initiatives for strategic technologies like National program to promote the IC Industry Development (2014), Internet Plus plan (2015), Made in China 2025, and China Brain Project (2016). Some of these historical initiatives have started yielding results, like the number of Fabless IC design companies doubled from 736 at the beginning of 2015 to 1362 at the end of 2016, due to the IC Industry Development Plan.[28] Such developments also paint a bright future for state-driven development projects.

China's National Initiatives in Artificial Intelligence

China is not developing its AI vision and associated policies in isolation. It is making deliberate efforts to create a climate of innovation in the country that will nurture its policies to achieve that vision. It has recognized the lack of original result, gaps in the basic theory, the core algorithm, critical equipment, high-end chips, major products and systems, components, software, and interface.[29] Its Next-Generation Artificial Intelligence Development Plan highlights the need for improvement of infrastructure, policies, and regulations, and the standard system adapted to the development of AI. It has taken deliberate measures to remove these shortcomings.

China is building an ecosystem for the sustainable development of indigenous research and development talent to overcome the shortcomings in the core technologies

[28] Trend Force, "China's National Fund Will Begin to Shift its Development Focus from Foundries to Fabless IC Design, says Trend Force," Press Release, 19 December 2016, accessed 23 October 2018, https://press.trendforce.com/press/20161219-2717.html.

[29] State Council PRC, "Notice of the Council Issuing the New Generation of Artificial Intelligence Development Plan."

of AI, such as hardware and algorithm. In this direction, its AIDP directs the universities to improve the AI discipline structure, establish the AI specialty, and promote AI as a first-level discipline.[30]China's focus on Science and technology have started showing results with China's AI papers as a percentage of the global total increasing from 4.26% in 1997 to 27.68% in 2017 second only to the USA.[31] Apart from the papers, there has also been a significant increase in Authors presenting at Association for the Advancement of Artificial Intelligence (AAAI) conference with 23 percent Chinese authors in 2017.[32] However, the numerical advantage does not necessarily qualify in the qualitative edge, as US and UK research papers remain more influential in comparison to China. However, there are numerous indications that Chinese research in AI has progressed towards cutting edge, including in speech recognition and computer vision. For instance, Chinese teams dominated the ImageNet large scale visual recognition challenge, in 2016 and 2017.[33]

[30] China Institute for Science and Technology Policy at Tsinghua University, *China's AI Development Report 2018* (Beijing, China: Tsinghua University, July 2018), accessed 1 May 2019, http://www.sppm.tsinghua.edu.cn/eWebEditor/UploadFile/China_AI_development_report_2018.pdf.

[31] Dave Gershgorn, "Europe-Not the US or China Publishes the Most AI Research Papers," *Quartz*, 22 December 2018, accessed 28 January 2018, https://qz.com/1490424/europe-publishes-more-ai-papers-than-the-us-or-china/.

[32] Dan Kopf, "China is Rapidly Closing the US lead in the AI Research," *Quartz*, 5 February 2018, accessed 28 January 2018, https://qz.com/1197174/china-is-the-rising-artificial-intelligence-power/.

[33] Aaron Tilley, "China's Rise in the Global AI Race Emerges as It Takes Over the Final Image Net Competition," *Forbes*, 31 July 2017, accessed 30 January 2019, https://www.forbes.com/sites/aarontilley/2017/07/31/china-ai-imagenet/#37138d57170a.

China has also allocated billions of dollars towards developing infrastructure to house hundreds of AI businesses in dedicated industrial parks. It is trying to create an ecosystem on the lines of Silicon Valley where IT companies can benefit from talent and resource sharing. Bolstered by the government push the local administrations are investing heavily in the development of technology hubs to attract top talents and companies. As a result, a total of 156 state-level tech zones scattered across the country are supporting industries deemed national priorities.[34]

Critics may dismiss these developments as initial enthusiasm for a government initiative in China and be skeptical about the success and long-term implications of these developments. This skepticism may be true to a certain extent, as the initial enthusiasm may fizzle out in a few years and the country may not achieve the milestones or the intended effects in timelines established. However, China's recent history of government-led initiatives presents a favorable forecast of these initiatives with many success stories to quote. Between 2007 and 2017, China went from having zero high-speed rail lines to having more miles of operational high-speed lines than the rest of the world combined. Similarly, during the mass innovation and mass entrepreneurship campaign that began in 2014, a flurry of incentives created 6,600 new startup incubators and shifted the national culture around technology startups.[35]

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[34] Bloomberg Businessweek, "China's Technology Sector Takes on Silicon Valley," 10 July 2018, accessed 24 January 2019, https://www.bloomberg.com/news/articles/2018-07-10/china-s-technology-sector-takes-on-silicon-valley.

[35] Shunsuke Tabeta, Yusho Cho, and Naoki Matsuda, "Billion Dollar Tech Start-ups Hold Promise for China's Economy," *Nikkei Asian Review*, 09 November 2018, accessed 28 January 2019, https://asia.nikkei.com/Spotlight/Startups-in-Asia/Billion-dollar-tech-startups-hold-promise-for-China-s-economy.

Role of Private Tech Giants

In addition to government supported Academic research, the industry has also been very active in AI exploration. Like Google, Amazon, and Facebook leading innovation in AI in the US, China's trio of Baidu, Alibaba, and Tencent (BAT) are at the forefront of China's AI development. These companies, over a period have showed extraordinary competitive spirit and had successfully driven out their US competitors from the Chinese market. After establishing their dominance in the Chinese market, these companies are now on a global juggernaut.

Currently, Baidu has emerged as a global leader in speech recognition and self-driving cars, launching DuerOS, its voice interaction system, and Apollo, an autonomous driving platform.[36]Tencent has opened a research lab in the Seattle area to mine the city's talent pool, where global leaders like Amazon and Microsoft are already headquartered.[37] It is also using an abundance of data through its super app WeChat to attract and empower top AI researchers.[38] For example, Dr. Dong Yu who is heading up the Seattle lab had spent the past two decades at Microsoft Research and was part of a team that found a significant breakthrough in speech recognition. Alibaba has invested in seven

[36] Jessi Hempel, "How Baidu will Win China's AI Race and, Maybe, the World's," *Wired*, 08 September 2017, accessed 30 January 2019, https://www.wired.com/story/how-baidu-will-win-chinas-ai-raceand-maybe-the-worlds/.

[37] Taylor Soper, "Chinese Tech Giant Tencent is Poised to be a Leader in AI Says Head of New Seattle Research Lab," *Geek Wire*, 14 December 2017, accessed 24 October 2018, https://www.geekwire.com/2017/chinese-tech-giant-tencent-poised-leader-ai-says-head-new-seattle-research-lab/.

[38] Kai-Fu Lee, *AI Super-Powers, China, Silicon Valley, and the New World Order* (Boston, MA: Houghton Mifflin Harcourt, 2018), 85.

research labs that will focus on artificial intelligence, machine learning, network security, natural language processing and more. It is also investing overseas for the AI talent development and harnessing AI talent, e.g. a joint research institute in Singapore on 28 February 2018.[39]

Apart from leading China's AI innovations efforts, these companies are also creating a vibrant ecosystem for the growth of numerous AI startups. While the majority of the startups may not succeed and wither due to lack of continuous funding, demand for commercial output and economic slowdown, some of these startups have excelled at the international level for example, Chinese AI startup Malong Technologies, Yitu Tech, Face++, and Megvii emerged as winners at various AI related international challenges and thus demonstrating China's advantage in the AI race over the United States.

Despite these significant developments, the US remains the global leader in AI. However, Chinese technical advancements and the focused government approach has led to a debate on the possibility of China overtaking the US in the coming years as stated in the next generation AIDP.[40] While these persons/ reports have been explicit in their claims, they do not outline exactly what will drive China's AI growth or how China might win the AI race. This lack of clarity has led to critics arguing that these statements and reports are pressure tactics to arm-twist the government to increase R&D funding by

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[39] Leiphone, "Alibaba Sets Up Joint Research Center in Singapore to Focus on AI," *Pandaily*, 2 March 2018, accessed 05 February 2019, https://pandaily.com/alibaba-sets-joint-research-center-singapore-focus-ai/.

[40] Eric Schmidt, Keynote Address at the Center for a New American Security Artificial Intelligence and Global Security Summit, 01 November 2017, accessed 01 May 2019, https://s3.amazonaws.com/files.cnas.org/documents/CNAS-Eric-Schmidt-remarks-at-AI-Summit-11.1.17.pdf?mtime=20171113135639.

rumor mongering. Hence, to put forward a credible argument to decide the winner in the AI race, it is imperative to objectively analyze the Chinese advantages that will give credence to the argument.

Chinese Advantages in AI

Dr. Kai-Fu Lee, Chairman, and CEO of Sinnovation Ventures has been the most vocal proponent of Chinese leadership in AI. He has identified four areas namely, entrepreneurship, access to data, AI expertise and government support to analyze the competitive balance between the world's two superpowers. As per Lee, "Chinese entrepreneurship will be the secret sauce that helps China to become the first country to cash in on AI's age of implementation." Chinese companies like Alibaba, WeChat, DiDi Chuxing, and Meituan have evolved from being copycats of the Silicon Valley to formidable competitors.[41] This growing entrepreneurship climate of China has been conducive to the growth of commercial enterprises. As a result of this, 120 Chinese companies made the Fortune Global Top 500 list in 2018, closing the gap with the United States with 126.[42] These commercial enterprises have started investing in the development of an innovation climate in China, but more importantly they have provided China the capability to replicate commercial AI advancements on a very large scale. The growing entrepreneurship climate is attracting the top Chinese CEOs and scientists from

[41] James Crabtree, "DiDi Chuxing Took on Uber and Won. Now it's Taking on the World," *Wired*, 09 February 2018, accessed 03 February 2019, https://www.wired.co.uk/article/didi-chuxing-china-startups-uber.

[42] Chu Daye, "Chinese Firms to Rival US Companies on Fortune List," *Global Times*, 20 July 2018, accessed 03 February 2019, http://www.globaltimes.cn/content/1111716.shtml.

all over the world to return to China and start their own companies which are now ready to take over the center stage in their fields.

Training a successful deep learning algorithm requires computing power, technical talent, and lots of data. Out of these three, data will be the most significant material for the development of AI technologies. That is because computing power and technical talent required may reach a certain threshold beyond which availability of more and more data will be the deciding factor in the competition. In terms of access to data, China has an advantage of 802 million internet users over 290 million users in the US. However, China's data extends from quantity to quality. Chinese consumers, the source of this data, are tech-friendly and have adapted to the Chinese alternate internet universe of mobile payments and Online to Offline (O2O) services. They are keen to embrace products and services sold online and in turn equipping companies with diverse datasets that be beneficial in the development of Business AI.

However, the factor which gives a decisive edge to China is not just the availability of data, but the access to that data by the private companies and government agencies, due to weak privacy laws and enforcement.[43] Kai-Fu Lee succinctly summarizes the Chinese data advantage as, "If data is the new oil, then China is the new Saudi Arabia." However, as per a study paper by Mckinsey Global Institute, China is lagging behind the US in creating a data-friendly ecosystem with unified standards and cross-platform sharing. Also, limitations on the cross border dataflows put China at a

[43] Li Yuan, "How Cheap Labor Drives China's AI Ambitions," *The New York Times*, 25 November 2018, accessed 17 May 2019, https://www.nytimes.com/2018/11/25/business/china-artificial-intelligence-labeling.html.

disadvantage for global collaboration. The study also points to the lack of a vibrant AI ecosystem and AI talent as a significant bottleneck.[44]

AI talent is one area where China has a considerable disadvantage as compared to the United States. According to a report released by China's Tsinghua University, by the end of 2017, China had accumulated an AI talent pool of 18,232 people, accounting for 8.9 percent of the world's total AI talent and well behind the 13.9 percent share held by the US. The difference is starker in high-level AI talent where China is only having one-fifth of the number by the US. Although the Chinese government has started taking steps to reduce the gap, it will not yield results in the immediate future. Hence, the Chinese government is also taking short term measures to overcome this shortage like poaching top talents from around the world, investing in AI companies abroad and buying stakes in AI startups and companies. For example, Tsinghua Unigroup's R&D lab in San Jose currently employs 50 engineers, and most of these are Americans or from Asian Multi-National Corporations American offices.[45]

The other source of acquiring technology is leveraging private companies to buy the latest American technology, thereby acquiring not just the talent, but acquiring a technology, bypassing years of investment and research in the development process. For

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[44] Mckinsey Global Institute, "Artificial Intelligence: Implications for China" (Discussion Paper Presented at the 2017 China Development Forum, Beijing, April 2017), accessed 04 March 2019, https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/China/Artificial%20intelligence%20Implications%20for%20China/MGI-Artificial-intelligence-implications-for-China.ashx.

[45] Cheng Ting Feng and Hiromi Sato, "Chinese Chipmakers Poach Talent from Global Rivals," *Nikkei Asian Review*, 25 April 2018, accessed 05 February 2019, https://asia.nikkei.com/Business/Business-Trends/Chinese-chipmakers-poach-talent-from-global-rivals.

example, Chinese investor deals with US tech startups had jumped 185 percent from 2013 to 2015.[46] In addition to these methods, government focus and investment climate in the country is resulting in the reverse brain drain for China. These steps are unlikely to compensate for the talent gap between both the countries and AI talent shortage will remain significant crimp in the AI race for China.

However, as per Kai-Fu-Lee, AI technology has moved from the age of development to the age of implementation with the invention of deep learning. Age of implementation plays to a different set of strengths, like the abundance of data, competitive landscape, adaptability to the technology, and government policies. Hence, at this stage, while AI talent is a must for the development of the technology, it takes a backseat as compared to other factors like government support and adaptability.

A supportive policy environment is essential for the development of AI technology. As machine learning is based on the ability of machines to train its algorithm with the data, deployment of AI technology for the user trial becomes a vital issue. Hence, how do the respective governments of both countries approach the implementation of this technology, holds the key for the future of the technology. Two contrasting examples in this regard are the development of autonomous vehicles and adoption of facial recognition technology. While in the US, safety and privacy issues have influenced and slowed the adoption of such technologies, the Chinese government is

[46] Cory Bennett and Bryan Bender, "How China Acquires the Crown Jewels of US Technology," *Politico*, 22 July 2018, accessed 29 April 2019, https://www.politico.com/story/2018/05/22/china-us-tech-companies-cfius-572413.

aiding the development with clear national policies and support minus safety and privacy-related debates.

The other facet of technological adaptation is the aspect of ethical and cultural differences. Multiple instances of technological adoption have indicated China's different ethical standards in the attainment of its stated objectives. China's genetic engineering trials, facial recognition technology, its stand on the LAWS at the United Nations Convention on Certain Conventional Weapon indicates that China will pursue its AI dream without similar ethical considerations as the US. This analysis drives us to a conclusion that in a race for the development of AI enabled weapons, China will have the definitive edge. Thus, in the near future, dual-use applications of AI like Autonomous systems, facial recognition, or decision making is likely to be more widely employed by China than the US. However, as per Benjamin Boudreaux, a political analyst at RAND ethical conduct by US DoD could be a source of strength to bolster domestic popular support and the legitimacy of military action. It could become a fundamental component of how the U.S. builds the partnerships and capabilities essential for both its hard and soft power.[47]

While the commercial aspect of the race between China and the US is important to determine the AI leadership in the future, PLA's adaptation of AI would finally decide its relevance to the Third Offset Strategy. How PLA envisions employment of AI in the military capabilities would have a decisive impact on Third Offset Strategy, as per Elsa

[47] Benjamin Boudreaux, "Does the US Face an AI Ethics Gap," *RAND* (blog), 11 January 2019, accessed 04 March 2019, https://www.rand.org/blog/2019/01/does-the-us-face-an-ai-ethics-gap.html.

Kania, an adjunct senior fellow at the Center for a New American Security focusing on Chinese military innovation in emerging technologies.

PLA's Pursuit of AI

Chinese leadership prioritizes AI as a critical technology for national and military power.[48] PLA leadership anticipates that AI will accelerate the process of military transformation and will ultimately lead to a military revolution. Hence, PLA intends to capitalize on the national focus on the AI to enhance its future military capabilities by a mixture of R&D efforts in the public and private sector. PLA's initial thinking on the AI in military technologies has been shaped by tracking US military initiatives, especially the Defense Innovation Initiative. However, due to the PLA's distinctive strategic, command, and organizational culture, their thinking and approach may differ from the United States. In the past, PLA has been exploring disruptive military capabilities to target US vulnerabilities rather than competing to match US capabilities. Some of the writings on the subject indicate that China may still be exploring disruptive technologies like swarming. This may be significant as it presents a scenario where China does not necessarily have to be the leader in the AI to pose a credible threat to the Third Offset Strategy. Even if it comes close to exploring AI applications targeting US vulnerabilities, it will challenge the US military superiority.

[48] Elsa B. Kania, *Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power* (Washington, DC: Center for a New American Security, November 2017), accessed 24 January 2019, https://s3.amazonaws.com/files.cnas.org/documents/Battlefield-Singularity-November-2017.pdf?mtime=20171129235805.

PLA leadership and academics have highlighted the need for achieving civil-military fusion for frontline technologies. It has established organizations like Central Commission for Integrated Military Development (CCIMD), CMC Military Scientific Research Guidance Committee, and an Intelligent Unmanned Systems of Science and Technology Domain Expert Group to enable this civil-military fusion. These agencies have been empowered to take incremental reforms, simplifying regulations, and policy formulations to incentivize CMF. Chinese Civil military Fusion (CMF), being top driven will prove to be the distinctive advantage for the PLA. This facilitates partnerships between military and civilian research institutes or companies allowing a seamless flow of technology from the private sector into military context. This also allows the Chinese government to exploit top talents and resources in the private sector for the development of military capabilities. Conversely, it will also provide these private companies access to vast amount of government data to train their AI algorithms.

PLA Projected Employment of AI for Military Applications

PLA has pursued research and development in multiple military applications of AI, particularly in "intelligent and autonomous unmanned systems, such as swarm intelligence; AI-enabled data fusion, information processing, and intelligence analysis; applications in simulation, war-gaming, and training; the use of AI for defense, offense, and command in information warfare; and intelligent support to command decision-making."[49] These efforts roughly correspond to the third offset strategy of the United States and related Defense innovation initiative. However, PLA is highly focused on the

[49] Kania, *Battlefield Singularity*.

use of AI in simulation, war gaming, and training as well as support to situational awareness and command decision making.

Currently, China has actively pursued the US military initiatives and has been successful in replicating or surpassing US efforts in some areas. For example, in November 2018, China airshow in Zuhai demonstrated CH-7 stealth drone and J-20 stealth fighter bearing strong resemblances to Northrop Grumman X-47B drone and Lockheed Martin's F-22 Raptor's respectively. Similarly, at the 2017 Global Fortune forum in Guangzhou, it displayed 1180 Ehang drones, autonomously interacting and synchronizing movements on the lines of US Low-Cost Unmanned Aerial Vehicle Swarming Technology (LOCUST) program.[50] A numerical comparison of swarms indicates that China has overtaken the US in swarm technology by demonstrating a larger Swarm of UAVs at a much lesser cost (15000$ of US to 1500 $ of China).

While experts like Sam Brannen, who runs the risk and foresight group at the CSIS fears that China is poised to surpass US in UCAV technology, there are experts who are skeptical about the capabilities of such replicated technology. Ron Huisken, a regional security expert at Australian National University argues that the fact China is willing to sell the CH-7 abroad indicates the technology is less than cutting edge, given China's desire to guard its technological edge in such areas.[51] The true dominance of

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[50] Brian Wang, "Over 1000 Chinese Drones Swarmed and Put on an Aerial Show," *Next Big Fixture*, 09 January 2018, accessed 19 February 2019, https://www.nextbigfuture.com/2018/01/over-1000-chinese-drones-swarmed-and-put-on-an-aerial-show.html.

[51] CBS News, "China's Unveils Stealth Combat Drone Under Development," 07 November 2018, accessed 02 March 2019, https://www.cbsnews.com/news/china-stealth-combat-drone-ch-7-under-development-middle-east/.

either country can only be determined by evaluating the mission efficiency of comparable systems in either country, which is currently unavailable.

## Conclusion

Analysis of the Chinese AI reforms indicates that it is trying to emulate US systems and structures in the technical fields. Whether in modeling its R&D on the lines of Silicon Valley, or imitating DARPA projects one can see the US influence on its drive to become the AI leader. It establishes that China recognizes the US leadership in AI, and as a result, is trying to emulate the US. However, their goal is not to follow US models, but to leapfrog the US in terms of AI development. Hence, it not only following the US, but also capitalizing on its strengths of Communist regime, informed leadership, civil-military collaboration, and loose privacy and ethical norms. It is using a "whole of government" approach to acquire the crucial building blocks of AI development like software, hardware, AI talent, and Data. Chinese techno-utilitarian culture is different from the US idealist culture. As a result, China does not shy away from poaching talents, copyright infringements, and economic takeover of startups. The absence of moral and ethical debates in pursuant of its goals makes it highly conducive for the deployment of immature or controversial AI technologies.

Analysis of the discussions around the Third Offset Strategy indicates that AI is a key technology for the offset. Hence, for the offset to be credible, US leadership in AI will be necessary. Currently, the US has the upper edge in the overall AI race. However, China is rapidly narrowing the gap. Also, Transformative potential of AI in defense and PLA focus on disruptive applications in AI indicates that China does not necessarily has to outpace US in AI to threaten the third offset strategy. Hence how the Chinese and the

US governments implement the AIDP and the Third Offset Strategy respectively will determine the efficacy of the Third Offset Strategy.

# CHAPTER 3

# RESEARCH METHODOLOGY

The purpose of the research is to determine the effect of China's advancements in the field of artificial intelligence on the United States' Third Offset Strategy. To complete the thesis in a reasonable period, the thesis investigates the general nature of the underlying technologies in the Third Offset Strategy such as autonomous machine learning systems, collaborative decision making, assisted human operations, and cooperative weapon concepts, that seeks to exploit advances in AI and Autonomy. As AI is a key component in the US Third Offset Strategy, USG AI efforts will be crucial for achieving the required offset. However, US near-peer competitor China, that is the target of the Third Offset Strategy also believes AI as a critical technology to the future of global military and economic power competition. China has also taken significant efforts to exploit the transformative potential of AI on the battlefield. Considering AI as the focus of the great power competition between the US and China, for the US Third Offset Strategy to succeed, the US will not just have to be the leader in AI but should also have a significant advantage over its near-peer competitor, China.

At present, the US is the leader in R&D in AI. This leadership is the result of the interaction of various tangible and intangible factors that hitherto have been favorable to the US. Some of these tangible factors, such as AI talent, software, hardware, and algorithm, are products of strong US culture of innovation. This culture of innovation had emerged because of various intangible factors such as US economic superiority, government support to R&D, and US entrepreneurship climate which tilted heavily in favor of the US in absence of serious competition. Hence, the current leadership of the

US in AI R&D is the result of structures and policies placed decades earlier. However, in recent times, there has been a change in the geopolitical and geo-economic realities with the emergence of China. China's nearly two decades of the highest economic growth and resultant commercial and technological rise has placed China in a position to contest US dominance. In 2017, China announced its *Next Generation Artificial Intelligence Plan* and declared its desire to claim global leadership in AI by 2030.

Post-2015, the US government was also exploring the technological capabilities required for the Third Offset Strategy. Advancements in machine learning shaped the discussions on the technological capabilities required for the offset. However, China's rapid economic rise and determined central leadership's efforts in AI was steadily putting its own structures and policies in place to rival US leadership. Chinese efforts under the Next Generation AI development Plan are slowly changing the status of those intangible factors that had put the US in its current leadership status. Thus, although the US still leads AI R&D, holistically if one compares the status of AI development as an interaction of various tangible and intangible factors mentioned above, US AI leadership may be under threat. To determine the effect of China's AI strategy on US AI leadership, the thesis will create a framework based on these tangible and intangible factors in two different periods; 2014, when the US was an unrivaled leader in technology and 2019, when the US leadership is being rivaled.

There is a realization in the US scientific community that the US can no longer take its AI leadership for granted. Alarmed scientific and business experts goaded the USG to take credible steps to retain its leadership in AI. However, for the Third Offset Strategy to be credible, the US AI strategy should comprehensively hinder the progress of

Chinese AI strategy. The desired capabilities for the Third Offset should provide credible deterrence to Chinese global ambitions. To achieve this end state, third offset technologies should provide a significant asymmetric advantage to the US military capabilities in comparison to PLA one. This researcher will be conducting a mix of qualitative and quantitative analysis of relevant articles, journals, and research papers on advances in artificial intelligence with applications for national security.

This research has adopted this method as only one method, either qualitative or quantitative will not cover the holistic nature of the AI strategy. While qualitative analysis will theoretically examine both the tangible and intangible factors, it will not provide a framework for the comparison. On the other hand, while quantitative analysis provides a framework to compare both countries' progress and establishes their relative position, it can only compare the tangible factors like the number of research papers, scientists, institutions, or tech companies. But, as quantitative advantages do not necessarily indicate superiority, quantitative analysis will fail to encompass the true impact of tangible factors. It will also fail to compare the role of intangible factors like readiness to accept technology or ethics and cultural aspects. Thus, to overcome the limitations of individual methods and integrate the true impact of both tangible and intangible factors, this researcher will conduct a mixture of quantitative and qualitative analysis.

For the above comparison and analysis, the author will use the Diplomatic, Informational, Military, Economic (DIME) framework. In the diplomatic domain, the thesis will explore various strategic documents laying out the focus of both the countries. It will investigate various government initiatives to promote development of AI. In the

informational domain, the author will analyze the information campaigns designed to facilitate economic and technical collaboration between nations. In the military domain, the focus will be on systems and processes in place to facilitate the transfer of commercial AI to military applications. The researcher will also explore how the respective militaries interpret AI strategies and carry out reforms to absorb AI related capabilities. In the economic domain, the thesis will compare efforts to create an innovation climate promoting both private and government AI efforts. The thesis will illuminate which country is better poised to exploit transformative potentials of AI in the coming decade and, subsequently, determine the effectiveness of the Third Offset Strategy.

However, considering AI as a disruptive technology, China does not necessarily have to be the leader in the AI to threaten the US offset strategy based on AI. China only has to reach a certain level of expertise to exploit the disruptive applications of this technology. China needs to be able to weaponize the progress in commercial AI to threaten US vulnerabilities in military systems and platforms. The idea of China investing in asymmetric capabilities targeting US vulnerabilities is not new.[52] Hence, if PLA's approach to combat US superiority in AI remains unchanged, then a token US superiority in AI weapons will not deliver the sought-after offset. This thesis will analyze the Chinese potential to challenge the US Third Offset Strategy in five vectors of this strategy. However, there are factors which might slow down China's ambitious AI plan,

[52] Guo Woei Jinn, "China's Development of Asymmetric Warfare and the Security of Taiwan, Republic of China" (Master's Thesis, Naval Postgraduate School, Monterey, CA, December 2004),13, accessed 20 April 2019, https://apps.dtic.mil/dtic/tr/fulltext/u2/a429889.pdf; Kania, *Battlefield Singularity.*

including potential US actions hampering Chinese progress in AI. This thesis will explore those factors and provide policy recommendations for the US policymakers.

# CHAPTER 4

# ANALYSIS

## Introduction

The United States and China have fundamentally different approaches to drive technological innovations. In the United States, private entrepreneurs seeking returns on future breakthroughs, drive the commercial market and commercial R&D in new and emerging technologies. There is very little interference from the US government in commercial sector in terms of setting the agenda or the target deadlines for private companies. However, the US government takes legislative or executive actions to safeguard or promote US national interests in the commercial sectors. This provides the necessary independence for the private sector to pursue their R&D in potentially commercially profitable technologies. In part, this also characterizes the US innovation ecosystem that is conducive for the growth of R&D.

By contrast, China's R&D activities are centrally controlled and directed by a series of interlocking planning and guidance documents. This goal-oriented planning process spans both commercial and defense sectors. The Chinese government supports AI as a strategic area supported by centralized high-level policies, inter-ministry coordination, government funding in R&D, support for infrastructural development, and ambitious and quantifiable objectives. Thus, to ascertain the future of AI development in both countries, the thesis will carry out analysis of each country's AI strategy and determine the best innovation climate in respective countries as it relates to AI development.

## Analytical Framework for the China-US Competition in AI

Long term forecasts for any strategic competition are challenging, especially in the areas of emerging technologies. Both the US and China have identified AI as a key component in their strategic competition and are poised to exploit the benefits of this technology for national security and prosperity. Thus, distilling this competition through the four basic instruments of national power (DIME) driving this competition will provide a basic analytical framework. However, the interaction in and across these instruments will focus on three basic variables: commercial industry, academia, and defense industry.

### Diplomatic Domain

Until 2016, the US government, confident in its own technological superiority, charted its future policies based on domestic considerations only. This was apparent from Obama administration's National Artificial Intelligence Research and Development Plan in 2016 outlining seven strategic priorities for the development of AI that were domestically focused. There was no mention of threats to US superiority in AI from growing international competition, and therefore, a strategy to engage the international community to enhance/preserve the US leadership in AI was missing.

This sense of superiority received a serious jolt in 2017, when reports of threats to its AI superiority started pouring in due to rapid Chinese technological growth in various high-tech areas like supercomputers, facial recognition, unmanned systems, and aircraft. Inherent in the threat were growing concerns of intellectual theft by China to secure the crown jewels of US technologies. After a brief period of inactivity, amidst growing clamor from the tech community, the US government initiated steps to curb the Chinese

illicit methods to acquire tools for the Chinese AI plan. Some of these steps include implementing a set of tariffs, and investment and academic visa restrictions targeted at China as retaliation for stealing US intellectual property. The US Congress is also considering overhauling the Committee on Foreign Investments in the United States (CFIUS) to stop Chinese companies from acquiring stakes in US companies focused on key technologies. One example of this is blocking acquisition attempts of telecommunication company Qualcomm by a Singaporean company Broadcom with alleged Chinese links, on the recommendation of CFIUS.[53] The United States is also engaging with its EU and NATO allies to ban or restrict Chinese companies' access to global technological markets. The most recent example is the US pressing its EU allies to take a stronger stance against Chinese telecom vendors such as Huawei and ZTE.[54] However, this attempt to garner international collaboration against China is not yielding desired outcomes as the individual national interests guide respective countries policies regarding a trade war with China.[55]

[53] Ambrose, Mitch, "US Confronting Threat of Chinese Exploitation of Intellectual Property," American Institute of Physics, 16 March 2018, accessed 18 March 19, https://www.aip.org/fyi/2018/us-confronting-threat-chinese-exploitation-intellectual-property.

[54] Laurens Cerulus, "Trump's war on Huawei splits Europe," *Politico*, 13 December 2018, accessed 18 March 2019, https://www.politico.eu/article/telecoms-donald-trump-war-on-huawei-zte-splits-europe/.

[55] Tao Li, "EU Ignores US Call for Blanket Ban on Huawei in Europe as Chinese Company's 5G Expertise Helps Its Cause," *South China Morning Post*, 27 March 2019, accessed 28 April 2019, https://www.scmp.com/tech/big-tech/article/3003345/can-huawei-continue-fend-us-pressure-europe-its-reputation-quality-5g. Even in Africa, Chinese telecom companies are increasing their footprint.

Being at the forefront of technological innovation, the US was also in a lead role in framing rules of employment for these technologies. The US is seeking to shape the discussions around the development of Lethal Autonomous Weapon Systems (LAWS), and is opposed to any ban on or treaty regularizing the development of LAWS. The US wants to exploit its technical superiority in AI for the development of LAWS that will provide it a decisive edge over its adversaries. This is in line with the development of previous strategic technologies like nuclear, biological, and chemical weapons, where the US favored the need of regulation or banning the development of these technologies only after it achieved a decisive capability. Thus, in the future, one can expect the US collaboration with other tech advanced countries to promote the development of LAWS to achieve decisive LAWS capabilities. Additionally, in a significant departure from the 2016 AI strategy, the newest DoD AI strategy released on 12 February 2019, lists international engagement as one of the five pillars of AI strategy. It mentions personal exchanges, combined portfolio planning, and deepened interoperability to exploit critical perspectives and AI talent of other countries.[56]

China's diplomatic efforts in terms of "International market access" and "International cooperation" is shaped by China's relative position as an emerging AI power as compared to the US. China as an emerging power is endeavoring to gain international market access and laid bare its ambitious plans to dominate the world in AI with its ambitious AI development plan and international collaboration. It is utilizing

[56] Office of Science and Technology Policy, "Accelerating America's Leadership in Artificial Intelligence," The White House, 11 February 2019, accessed 18 March 2019, https://www.whitehouse.govee/articles/accelerating-americas-leadership-in-artificial-intelligence/.

various diplomatic forums to forward its views on the AI arms race and the need for international cooperation. It is also seeking to exploit initiatives like the UN Convention for Certain Conventional Weapons (CCW) to establish its role as a rule maker, a position which hitherto has been enjoyed by the US and Europe. It is utilizing these forums not only to regulate the development of AI technologies and related capabilities, but also signaling the entire world that China is a force to be reckoned with in AI. Thus, in establishing itself as the rival to the US in terms of AI capabilities, it is projecting an alternative market for nations looking to acquire such capabilities at minimal cost and legal and procedural scrutiny.

While US diplomatic efforts are focused at the denial of access to material, technological research and market to China, Chinese diplomatic efforts are focused on gaining access to international markets, raw material, and technological research to offset its shortcomings in AI talent, hardware, and software. Currently, much of China's success has been enabled by access to global technology research. Many seemingly Chinese achievements are actually achievements of multinational research teams and companies, signifying critical role of international collaboration in China's research progress.[57] The Chinese leadership has identified the need for maintaining international market access as its near-term goals.[58] China, through its diplomatic efforts and application of soft power,

[57] As per Tsinghua University, "More than half of China's AI papers were international joint publications. Even purely Chinese successes often build upon open source technologies developed most often by international groups.

[58] Gregory C Allen, *Understanding Chinas AI Strategy: Clues to Chinese Strategic Thinking on Artificial Intelligence and National Security* (Washington, DC: Center for a New American Security, February 2019), 10, accessed 01 May 2019,

is ensuring uninhibited access to foreign tech and markets. Recently, Chinese companies have signed deals with the semiconductor equipment manufactures in Europe to import critical 7 nanometer (nm) manufacturing equipment. This is a particularly significant development as this addresses one critical Chinese weakness in semiconductors and reduce their dependence on the US for the same.

AI will also benefit from China's Belt and Road Initiative that promotes economic cooperation among countries across Asia, Europe, and Africa. The initiative provides new markets for China's products and services, including technology such as AI. For example, Alibaba Cloud recently launched a project with Malaysia called City Brain. This project uses AI, big data, and cloud technologies to support smart city applications.[59]

To summarize, the relative position of China and the US in terms of "International market access" and "Collaboration in R&D," both the US and China have equal international market access, but the US enjoys advantage in terms of international collaboration in R&D. While the US has traditionally enjoyed international market access due to its economic and technological leadership position, China's economic growth, and emergence as low cost, no restriction attached alternative to the US is rapidly enhancing its market access. However, China still has a long way to go in garnering international

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https://s3.amazonaws.com/files.cnas.org/documents/CNAS-Understanding-Chinas-AI-Strategy-Gregory-C.-Allen-FINAL-2.15.19.pdf?mtime=20190215104041.

[59] Soo Zen, "Alibaba Helps Malaysia Implement Smart City Programme," *South China Morning Post*, 29 January 2018, accessed 29 April 2019, https://www.scmp.com/tech/china-tech/article/2131006/chinas-alibaba-helps-malaysia-implement-smart-city-programme.

collaboration in R&D due to their relative weak innovation ecosystem. Hence, in the author's assessment, he has given a value of one to both the US and China in International market access. In terms of collaboration in R&D, due to US superior position, he has given a value of one to the US and zero to China.

## Informational Domain

China's rapid economic and technological growth and its open declaration of ambition to lead the world in AI had an unintended consequence. Chinese hyper-nationalistic and chauvinistic rhetoric antagonized developed countries, particularly the US. The Chinese licit and illicit methods of acquiring the AI tools and techniques, which hitherto received little action, suddenly caught the attention of US lawmakers and tech giants.[60] This prompted the US government to undertake efforts to restrict Chinese access to US talent and R&D. Alarmed by the adverse impact of the American restrictive policies that was hurting Chinese AI growth, the Chinese government's belligerent attitude underwent a perceptible change. The Chinese government started reigning in jingoism and began sending out messages about its vulnerabilities and challenges in achieving its stated goals. The state-run propaganda organization was asked to downplay its government's ambitious plans and achievements.[61]

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[60] Bennett and Bender, "How China Acquires the Crown Jewels of US Technology."

[61] State news agency Xinhua referred to Made in China 2025 policy more than 140 times in the first half of 2018, but abruptly stopped doing so after June 5. Chinese streaming platforms were asked by state propaganda department to take down a film touting the nation's achievements over the past five years under Xi Jinping.

On multiple platforms, Chinese envoys and officials are carrying out publicity U-turns to tone down their rhetoric. In December 2018, the Chinese envoy to the US, Li Kexin conceded the artificially created nationalist bubble deserves much of the blame for the supposedly exaggerated threat of the country's strengths. However, the biggest admission of its vulnerabilities came from Chinese Premier Le Keqiang. In an opening statement to the National People's Congress, Le avoided any reference to China's "Made in China 2025" policy and instead admitted weakness in Chinese capacity for innovation and core technologies. This change in direction is also being considered as a strategic retreat, concealing the country's emerging strengths rather than proclaiming its desire to challenge the US global dominance in high tech areas.[62] The Chinese leadership is hoping to take off some pressure from the US trade wars that is proving an impediment to its global ambitions. China is also making efforts to secure access to raw materials by projecting its peaceful uses of AI, as raw materials in terms of hardware and software requirements was identified as a weakness for Chinese AI development.[63]

The US efforts in the informational domain are focused at highlighting China's malicious use of AI that are undercutting the human rights around the world, particularly in China itself. The US is also highlighting the China's IPR theft and technical espionage activities to force China to check their illegal activities. The US, through its informational

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[62] Robyn Dixon, "China's Surprising Admission at National People's Congress: Its People are Dissatisfied," *Los Angeles Times*, 05 March 2019, accessed 20 March 2019, https://www.msn.com/en-us/news/world/chinas-surprising-admission-at-national-peoples-congress-its-people-are-dissatisfied/ar-BBUpMfR?ocid=spartanntp.

[63] Zachary Kallenborn, "The Race is on: Assessing the US-China Artificial Intelligence Competition," Modern War Institute, 16 April 2019, accessed 02 May 2019, https://mwi.usma.edu/race-assessing-us-china-artificial-intelligence-competition/.

campaign is also seeking international collaboration to prevent Chinese tech companies' access to international market and raw materials. In essence, the US efforts in the information domain is restricted to curtailing China's AI growth. The USG is not taking efforts to enhance/ project the attractiveness of US R&D innovation ecosystem. The recent anti-immigrant policies of trump administration is hurting the US' image as a preferred destination for tech researchers and developers.

In the researcher's assessment, he has given a value of one to both China and the USA in terms of "uninterrupted flow of raw materials" and "continued access to raw materials," as there has not been significant activities from both the countries in this domain. As a result, the impact of these activities in the informational domain is not very distinctive.

## Economic Domain

In the economic domain, the thesis will include analysis of five distinct indicators of AI development: entrepreneurship climate, AI talent, data, implementation and adaptability, government support, and cultural considerations. The first indicator to be considered is entrepreneurship climate.

### Entrepreneurship Climate

The United States has been leading in AI research due to its strong culture of innovation, technological base, and academia to name a few factors. The US research in AI is led by private tech companies like Google, Amazon, Microsoft, and Facebook. These companies have hitherto led the R&D in the technological field and inspired technological drives of their rivals like China. Until 2013, Chinese tech companies were

merely labeled as the copycats of Silicon Valley and were referred to with their Silicon Valley analogy like Facebook of China or twitter of China. However, while copying US products and services and adopting and evolving to compete with the United States, they built a strong culture of entrepreneurship and competitiveness.

Chinese companies like WeChat, DiDi Chuxing, and Meituan that started as copies of US companies such as WhatsApp, Uber, and GroupOn respectively have emerged as their formidable competitors. For example, by late 2017, when the Groupon's market cap shriveled to $2.58 billion, Meituan emerged as the fourth most valuable startup in the world, valued at $30 billion. Similarly, in e-retail business, Alibaba and Amazon are locked in stiff competition. However, in the quarter ending April 2018, Alibaba's operating margin was 31.25% while Amazon's was 2.31..[64] Another example is the competition between DiDi Chuxing and Uber. DiDi currently delivers 25 million rides a day, roughly twice as many as Uber and all other global sharing apps combined. Didi has emerged as the most valuable startup with a $56billion valuation, speeding past Uber with a worth of $48billion..[65]

While these developments may be dismissed as a "bet on the stock" which is often widely speculative, they do not necessarily indicate the superiority of Chinese

[64] Panos Mourdouloutas, "Why Alibaba is More Profitable than Amazon," *Forbes*, 06 May 2018, accessed 03 February 2019, https://www.forbes.com/sites/panosmourdoukoutas/2018/05/06/why-alibaba-is-more-profitable-than-amazon/#750802001678.

[65] Crabtree, "DiDi Chuxing Took on Uber and Won. Now it is Taking on the World."

companies. It indicates that while the Chinese companies may not be innovative and lacks basic research, it is strong in applied research. It shows prowess of Chinese companies to replicate technological advancements of other countries, and in the process even outpace the innovators. For example, while Microsoft's speech recognition software surpassed human-level language recognition in October 2016, Baidu has already achieved this feat in 2015.[66] So, even if, the US AI giants like Amazon, Facebook, and Microsoft achieves a R&D breakthrough in AI, Chinese companies' ability to replicate will not allow an asymmetric lead to the US.

The growing entrepreneurial climate has resulted in 120 Chinese companies making the Fortune Global Top 500 list in 2018. If the trends continue, according to Li Jin, an expert on state-owned enterprise reforms, China will overtake the US in Fortune Global Top 500 listings in 2019.[67] This conducive climate has given birth to Chinese entrepreneurs who are ready to take on top US competitors and lead China's AI efforts. They have already started their efforts in the form of venture capital funding and raising and supporting startups. One example of this is the trio of Baidu, Alibaba, and Tencent holdings who either control or back 50.8 percent holdings of China's 124 unicorns.[68]

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[66] Paul Mozur and John Markoff, "Is China Outsmarting America in AI," *The New York Times*, 27 May 2017, accessed 01 May 2019, https://www.nytimes.com/2017/05/27/technology/china-us-ai-artificial-intelligence.html.

[67] Daye, "Chinese Firms to Rival US Companies on Fortune List."

[68] Iris Deng, "True Dominance of China's Baidu, Alibaba, Tencent Revealed – and How Their Influence Extends Worldwide," *South China Morning Post*, 24 January 2019, accessed 03 February 2019, https://www.scmp.com/tech/china-tech/article/2154437/true-dominance-chinas-baidu-alibaba-and-tencent-revealed-and-how.

Thus, apart from developing an entrepreneurship culture, these companies are also laying seeds for culture of innovation. In addition, the success stories of Baidu, Alibaba, and Tencent attest to their ability to achieve the government ambitions and provide confidence to the Chinese government to set ambitious goals and deadlines.

AI investment trends are another indication of Chinese entrepreneurship that might be decisive in the AI race. In 2017, Chinese companies accounted for 70 percent of the US$39.5 billion raised worldwide for AI investments. Chinese AI startups raised US$5 billion in venture capital funding in 2017 and overtook their U.S. counterparts.[69] Although this investment drive may not be sustainable in the long term, the PwC report on the AI gives a definitive edge to China's entrepreneurship efforts. According to the report, AI deployment in the decade ahead will add $15.7 trillion to global GDP with China predicted to take $7 trillion and North America $3.7 trillion.[70]

The Chinese entrepreneurship climate has fueled its global ambitions by ensuring a high economic growth. It has resulted in emergence of Chinese companies that are challenging the global leaders in AI and emerging victorious. In July 2017, Chinese AI startup Malong Technologies won the inaugural AI vision contest, which leverages

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[69] ABI Research, "Chinese AI Start-ups Overtake American Peers for Venture Capital Investments, Taking Away US$5Billion," *CISION PR Newswire*, 27 August 2018, accessed 21 March 2019, https://www.prnewswire.com/news-releases/chinese-ai-startups-overtake-american-peers-for-venture-capital-investments-taking-away-us5-billion-300702606.html.

[70] Jonathan Gillham, Lucy Rimmington, Hugh Dance, Gerard Verweij, Anand Rao, Kate Barnard Roberts, and Mark Paich, *The Macroeconomic Impact of Artificial Intelligence* (London, UK: PricewaterhouseCoopers, February 2018), accessed 01 May 2019, https://www.pwc.co.uk/economic-services/assets/macroeconomic-impact-of-ai-technical-report-feb-18.pdf.

'Noisy' or corrupt data rather than labeled data. In November 2017, Yitu Tech, a Chinese facial recognition start-up, took first place in the Facial Recognition Prize Challenge (FRPC) hosted by the US Intelligence Advanced Projects Agency (IARPA).[71] Similarly, Chinese companies Face++ and Megvii took first place in the COCO image recognition competitions in 2017 and 2018, respectively.[72] Thus, based on the successes of Chinese entrepreneurs and their role in the AI development, the author assesses that entrepreneurship will be more favorable to China than US, and their ability to replicate technological advancements will help China to compensate the US innovation advantages.

AI Talent

The next big thing in the economic domain is AI talent. The US has a clear advantage over China when it comes to AI talent. By virtue of a strong academic base and research environment, the US has a 13.9 percent share of global AI talent as compared to 8.9 percent in China. At the higher level in AI talent, China only has one-fifth of the US number.[73] However, both countries are competing furiously for the edge in AI technology. The US is trying to extend the lead by securing the top talents in AI by recruiting people across the globe. Google set up an AI center in Beijing in 2018 to

[71] Kania, *Battlefield Singularity.*

[72] Peter Kontschieder, "Announcing the Winners of the Joint COCO and Mapillary Recognition Challenge Workshop for ECCV 2018," *Mapillary* (blog), 10 September 2018, accessed 30 January 2019, https://blog.mapillary.com/update/2018/09/10/coco-joint-recognition-challenge-winners-at-eccv.html.

[73] China Institute for Science and Technology Policy, *China's AI Development Report 2018.*

recruit innovative students in China. Similarly, it has opened AI labs in Toronto and funded a public-private partnership with the Universities of Toronto and Montreal to develop and commercialize AI talent and ideas.[74]

Besides private sector, the US government has also announced certain steps to retain its talent edge. President Trump's administration has released "the Federal Government Plan for STEM Education" to increase education funding and opportunities for science, technology, engineering, and mathematics. The American AI initiative formally named "Executive Order on Maintaining American Leadership in AI" has recognized sustained investment in AI R&D as one of six strategic objectives. However, these steps do not indicate a significant departure from existing US academic policies. The latest US "Executive Order on Maintaining American Leadership in AI", while exhorting the private sector to lead efforts in AI, lacks funding details for the purpose of R&D. Additionally, the US' ability to draw top talent from around the world to US universities has been a core advantage. However, the Trump Administration's anti-immigration policies and rhetoric have led to a decline in enrollment of international students in US universities.[75]

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[74] Cade Metz, "For Google AI Talent Race Leads Straight to Canada," *Wired*, 30 March 2017, accessed 21 March 2019, https://www.wired.com/2017/03/google-ai-talent-race-leads-straight-canada/.

[75] National Foundation for American Policy (NFAP), "Declining International Student Enrolment at US Universities and Its Potential Impact," (NFAP Policy Brief, NFAP, Arlington, VA, February 2018), accessed 29 April 2019, https://nfap.com/wp-content/uploads/2018/02/Decline-in-International-Student-Enrollment.NFAP-Policy-Brief.February-2018-2.pdf.

In contrast, there is recognition in the Chinese government about the AI talent shortage in China. It has adopted multiprong efforts to ensure development and recruitment of Ai talent. The Next Generation Artificial Intelligence Development Plan directs colleges and universities to improve the AI discipline structure, open their AI colleges, and increase the quotas of doctoral and master's candidates in AI and related disciplines. China also opened its first dedicated AI school in September 2018. It is also introducing an AI textbook series. However, the lack of foundational research facilities will hurt Chinese AI growth. Therefore, to overcome this disadvantage and retain the ability to fuel its AI ambitions, it is using various legitimate and illegitimate means to secure AI talent. International collaboration and partnership in AI research are the primary means to exploit the readymade global AI expertise pool. This has enabled China to overtake the United States in terms of AI research papers. While there are arguments about the quality of the papers, a recent study by the Allen Institute of Artificial Intelligence predicts China is poised to overtake the US in terms of AI research. According to the report, "China will overtake the US in the most cited 50 percent paper by 2019, in the most cited 10 percent papers by 2020, and in the one percent most cited papers by 2025."[76] Apart from international collaboration, China is also utilizing the global research environment by enrolling students in foreign universities and colleges to develop its talent pool. In 2017, China sent a record total number of 608,400 students to

[76] Carissa Schoenick, "China to Overtake US in AI Research," *Medium*, 13 March 2019, accessed 21 March 2019, https://medium.com/ai2-blog/china-to-overtake-us-in-ai-research-8b6b1fe30595.

study abroad.[77] Out of this, 80 percent of students returned home, hopeful of a promising career fueled by Chinese economic growth. In the United States, 30 percent of international students enrolling in 2018 were Chinese. Thus, the US innovation climate is contributing to China's AI dream by compensating for its lack of AI talent.

China is also exploiting the available AI talent pool by recruiting a talented workforce in the core technologies. China's development of semiconductor chips is an example of China developing key components of AI despite talent shortcomings. There are three major segments of the semiconductor value chain: design, manufacturing, and assembly. In designing, Chinese companies have demonstrated high quality and competitive semiconductor design, exemplified by Huawei's Kirin 980, one of only two smartphone processors in the world to use seven nanometer processor technology. In manufacturing, it has signed deals with semiconductor equipment companies in Europe to export critical seven nanometer manufacturing equipment. In the assembly arena, China has recruited workers and executives from leading Taiwanese semiconductor companies, including SMIC's new CEO, who has a history of stealing intellectual property.[78]

Thus, China is using a myriad of ways to overcome its talent limitations and further its AI dream. However, it will take some time for China to replicate the US climate of innovation and research. Hence, considering the US advantages in AI talent, I have ascribed a value of one to the US and zero to China.

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[77] Kennedy Kerrie, "China Outbound Student numbers at Record High," *The Pie News*, 17 April 2018, accessed 29 March 2019, https://thepienews.com/news/outbound-student-numbers-increased-2017/.

[78] Allen, *Understanding Chinas AI Strategy.*

Availability and Access to Data

The next most important aspect for the development of AI is the availability of and access to data.[79] China has a decisive advantage in both categories for the R&D. China has 802 million internet users versus 290 million users in the US.[80] However, China's data advantage exceeds from quantity to quality. China's population is keener to embrace products and services sold online enabled by the internet, from live-streaming to food delivery. 90 percent of China's internet users access internet through mobiles phones, that helps in diversification of online commerce, generating more data. This widespread application not only provides companies access to an individual's personal data, but also an insight into his life style, food habits, spending patterns, shopping habits, and so on, all collated on a single platform. Apart from the domestic consumers, government initiatives like "Social Credit Scheme" and "Skynet program," which use facial recognition technology are also a source of quality data that can be used for training algorithm for the development of AI applications for military purposes.[81] Chinese companies are also exporting AI surveillance technology to at least 54 countries.

[79] Berin Martens, "The Importance of Data Access Regimes for Artificial Intelligence and Machine Learning," Joint Research Center, December 2018, accessed 02 May 2019, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3357652.

[80] Lee, *AI Super-Powers, China, Silicon Valley, and the New World Order.*

[81] This assumptions is based on strong Civil Military Fusion in the country, and Chinese state directed AI development efforts, wherein China has nominated AI champions in the country to lead the AI efforts.

Frequently, this technology is packaged as part of China's Belt and Road initiative.[82] This is increasing the quality and diversity of available database for the Chinese companies.

This data advantage is further enhanced by cultural differences in the US and China. While in the US, there is considerable concern with individual privacy and data protection, In China, people are less concerned with such issues, if it aids to their security and comfort. This allows companies to collect more diverse set of data based on multidimensional applications. China is also increasing breadth of its datasets by acquisition of US AI companies that also provides them access to hundreds of user data in the US without contending with strict European laws or the threat of privacy lawsuits in the US. Thus, in terms of data availability and access, China has a distinct advantage over the US. Therefore, the author has provided a value of one to China in comparison to the US in this factor.

Government Support for Policy Implementation

Government support for policy implementation is another factor for the development of AI technology. The US government has always prided itself on its leadership in emerging technologies. Since, the United States has identified AI and autonomy as the key technology for the Third Offset Strategy, it has developed two AI plans namely, "National Artificial Intelligence R&D Strategic Plan, 2016", and

[82] Steven Feldstein, "How Artificial Intelligence Systems Could Threaten Democracy," Phys.Org, 22 April 2019, accessed 01 May 2019, https://phys.org/news/2019-04-artificial-intelligence-threaten-democracy.html.

"Accelerating America's Leadership in Artificial Intelligence, 2019." However, no significant change in policies or federal funding allocation has followed these plans.

Despite a series of recommendations from several congressional reports, the USG has failed to create a policy environment that facilitates the adoption of AI technology. The manifestation of AI R&D into deployable products is still facing legal and cultural hurdles.[83] One example of such hurdle is lack of public faith in organizations for data security, as pointed by a Pew Research Centre Study, which will hinder adoption of technologies by US public.[84]

In contrast, when the Chinese government announced AI as the top priority, it sent a message to local government officials that they will be rewarded for their contributions to the adoption and implementation of the technology. It galvanized local Chinese officials to create an AI supportive policy environment in their provinces and cities. They set forth developing infrastructure and systems that might encourage adoption of AI technology by users. Reflecting this initiative, for the development of autonomous cars, Shanghai and Beijing municipal corporations created pilot zones for testing under real life conditions. It also spurred massive investments from the regional governments with at least two regional governments committing to invest 14.7 billion

[83] US citizens are protective about their data privacy. Sharing AI useful data with the private companies will be a nightmare. Similarly, companies refuse to work with government agencies on account of procedural hurdles or ethical issues.

[84] Kenneth Olmstead and Aaron Smith, *Americans and Cybersecurity* (Washington, DC: Pew Research Center, 26 January 2017), accessed 29 April 2019, https://www.pewinternet.org/2017/01/26/americans-and-cybersecurity/.

dollars over next ten years.[85] In April 2018, China also rolled out a set of national standards for testing smart autonomous cars on roads. China has continued to refine its policies and procedures on autonomous vehicles despite a series of accidents involving the driverless cars in the US and China. After these incidents involving Uber and Tesla, in the US, these leading giants stopped testing vehicles on public roads, before restarting again in December 2018.[86] There has also been an uproar in the public as well as by lawmakers regarding the public safety aspects. This is in stark contrast to the Chinese autonomous landscape, where the government is aiding the development with clear national policies and support, minus safety related debates.[87] Chinese national focus has also resulted in a massive influx of funding in AI. In 2017, the total spending on AI systems in China was $12 Billion and is expected to increase to 70 billion by 2020.[88]

The government also contributes indirectly towards AI development by its cyber security and commercial policies. For example, in case of autonomous vehicles Chinese law requires US companies like Tesla and others to send the government constant

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[85] Allen, *Understanding Chinas AI Strategy.*

[86] Peter Lyon, "Why the Rush? Self-driving Cars Still Have a Long Way to Go Before Safe Integration," *Forbes*, 31 March 2019, accessed 01 May 2019, https://www.forbes.com/sites/peterlyon/2019/03/31/why-the-rush-self-driving-cars-still-have-long-way-to-go-before-safe-integration/#2058200a722a.

[87] Jack Stewart, "Inside China's Plan to Beat America to the Self-Driving Car," *Wired*, 15 June 2016, accessed 01 May 2019, https://www.wired.com/2016/06/chinas-plan-first-country-self-driving-cars/.

[88] Steve Andriole, "Artificial Intelligence, China and the US- How the US is Losing the Technology War," *Forbes*, 09 November 2018, accessed 01 May 2019, https://www.forbes.com/sites/steveandriole/2018/11/09/artificial-intelligence-china-and-the-us-how-the-us-is-losing-the-technology-war/#d9eb92d61957.

updates on its vehicles, including real time locations, as well as 60 other data points, everything from the EV's motor function to its battery status. This allows China access to data from US companies, wherein the US, the USG officials would likely need a court order to access such kind of information.[89] Due to determined role of Chinese government in setting the AI goals and milestones, and facilitating AI development by infrastructural and policy changes, the author has assessed China to have an upper hand in terms of government support to AI.

Adaptability

As per a PWC report, readiness for adoption will be one of the largest drivers of economic impact in North America.[90] Groundbreaking research in the AI are few and spaced out in decades or years.[91] With deep learning, the R&D in AI has moved from the age of innovation to the age of implementation, where speed of adaptation of AI systems holds the key for the future. In this age, the AI R&D has moved beyond the laboratories into the real world, where fielding and deploying AI system are vital for development and maturing of these systems. The age of implementation plays to a different set of strengths like abundance of data, competitive landscape, speed of adaptation to the technology, and government policies. Thus, a country that is more conducive to the deployment of AI systems, has an advantage over its adversaries.

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[89] Kristin Houser, "China forces Tesla and Other EV Makers to Turn Over Driver Data," *Futurism*, 29 November 2018, accessed 29 April 2019, https://futurism.com/tesla-china-ev-track-citizens.

[90] Gillham et al., *The Macroeconomic Impact of Artificial Intelligence.*

[91] Lee, *AI Super-Powers, China, Silicon Valley, and the New World Order.*

A study by the Sinovation ventures indicates that Chinese people are more open to adoption of technology than their American counterparts.[92] Chinese people have a techno-utilitarian approach where they prefer the utilization of technology for the betterment of their lives rather than being deterred by privacy or security concerns. While the threat of job losses due to automation remains a significant discussion point in the US, China is taking enormous strides in automation in public services such as health and judiciary unfazed by the threat of job losses.[93] Currently, some 131 companies are working on applying AI in China's health care sector. International Data Corporation predicted that China's market for AI health-care services will reach 5.9 billion yuan ($930 million) in 2022.[94]

Chinese techno-friendly population contributes to the AI R&D by adopting AI systems and generating useful data for the refinement of those systems. This techno-utilitarian approach is also enabling the government and private companies to field AI

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[92] Sinovation Ventures, "China Embraces AI: A Close Look and Long View," Eurasia Group, December 2017, accessed 01 May 2019, https://www.eurasiagroup.net/files/upload/China_Embraces_AI.pdf; Zigor Aldama, "Going Cash Free: Why China is Light Years Ahead in the Online Payment Revolution," *South China Morning Post*, 9 September 2017, accessed 01 May 2019, https://www.scmp.com/magazines/post-magazine/long-reads/article/2110118/going-cash-free-why-china-light-years-ahead; Robert Ferris, "The Chinese are Much More Positive About Autonomous Vehicle Than Americans," *CNBC*, 7 December 2017, accessed 01 May 2019, https://www.cnbc.com/2017/12/07/the-chinese-are-more-positive-about-autonomous-vehicles-than-americans.html.

[93] China is using AI to overcome lack of doctors by automating routine works. So far there is little debate on fixing accountability for mistakes when medical diagnosis are outsourced to algorithms.

[94] Yiting Sun, "AI Could Alleviate China's Doctor Shortage," *Technology Review*, 21 March 2018, accessed 07 February 2019, https://www.technologyreview.com/s/610397/ai-could-alleviate-chinas-doctor-shortage/.

technologies like facial recognition systems or immature autonomous systems. Thus, the Chinese policy makers can draft policies better suited for technological adaptation without being concerned with public reprisals. This helps in creating a more conducive policy environment for deployment of AI systems by private companies aimed at further maturing AI technologies. It allows the government to have liberal data privacy norms and security policies, thereby assisting deployment of AI systems. For example, while, the autonomous vehicle project hit a roadblock in the US following a series of incidents in year 2018, China is building highways with dedicated lanes for self-driving cars.[95] China's communist regime and the single-party system are also beneficial in promoting the government agenda. It shields policymakers from public scrutiny. They can push the governmental agenda without getting too concerned about the political consequences. While this approach may have drawbacks to include frequent wasteful spending, this is also instrumental in fast-track achievement of policy goals.

Ethical and Cultural Differences

Ethical and cultural difference are another area where the US has a significant disadvantage as compared to China.[96] In the US development and deployment of AI

[95] Dan Robitzski, "China's rolling out dedicated highway lanes for self-driving cars," *Futurism*, 15 April 2019, accessed 30 April 2019, https://futurism.com/the-byte/china-dedicated-highway-lanes-self-driving-cars.

[96] Lei Ma, Zhongqiu Zhong, and Nana Zhang, Ma, Lei, Zhongqiu Zhong, and Nana Zhang. "Ethical Dilemma of Artificial Intelligence, and Its Research Progress," *IOP Conference Series: Materials, Science, and Engineering,* no. 392 (2018): 1-4, accessed 06 May 2019, https://iopscience.iop.org/article/10.1088/1757-899X/392/6/062188/pdf.; Bryan Lufkin, "Why the Biggest Challenge Facing AI is an Ethical One," *BBC*, 07 March 2017, accessed 07 May 2019, http://www.bbc.com/future/story/20170307-the-ethical-challenge-facing-artificial-intelligence.

systems receive a lot of public scrutiny on the ethical and moral grounds. In contrast, China's AI dream may not be hampered by the same ethical considerations due to the cultural differences in both the countries. Due to this cultural difference, while the US citizens may consider deployment of AI systems like facial recognition technology, unethical and a breach of individual privacy, for Chinese citizens, it may be a routine security measure by the government. As a result, Beijing is embracing facial recognition technology on the national level to track its 1.4 bn population. These AI-powered surveillance devices are distributed throughout the country to track their population.[97] This is in contrast with the US where ethical and moral issues hinder such freewheeling use of technology. On December 2018, Google announced it will not offer facial recognition through its cloud API until it comes up with the policies to prevent its misuse[98]. Similarly, Microsoft's President, Brad Smith, asked the US government to adopt laws regulating the use of facial recognition technology.

This apparent cultural difference also empowers the Chinese government to acquire critical pieces of AI technology by various means like espionage, infringement of IPR rights, or clandestine takeovers of US companies, that may be considered illegal in some other country. In my assessment, the ethical and cultural consideration might

[97] Paul Mozur, "Inside China's Dystopian Dreams: AI Shame and Lots of Cameras," *The New York Times*, 08 July 2018, accessed 06 February 2019, https://www.nytimes.com/2018/07/08/business/china-surveillance-technology.html.

[98] Kent Walker, "AI for Social Good in Asia Pacific," *Google in Asia* (blog), *Google*, 13 December 2018, accessed 06 February 2019, https://www.blog.google/around-the-globe/google-asia/ai-social-good-asia-pacific/amp/.

become a significant crimp for the US in the development of AI systems or adoption of AI for the security needs.

## Military Domain

To fully exploit the transformative potential of AI for national security, it is imperative that the technological developments in the private sector are subsumed in the military domain. To understand the approach of respective governments and militaries, the thesis will analyze five distinct indicators of AI development with an emphasis on security needs of the country: Civil-Military Fusion (CMF), acquisition and adaptability, strength versus vulnerability, and capability development process.

### Civil-Military Fusion

The first factor that directly relates to the capability development is civil-military fusion. Realizing the need for civil-military collaboration, the US launched the Defense Innovation Board in 2016 to bring the best practices of Silicon Valley to the US military. However, this board remains advisory only and their suggestions are not binding for private companies and defense establishments. In the US, there is no law that directs collaboration between private companies and defense industries. Private companies are reluctant to work with the DOD, citing bureaucratic hurdles, long acquisition timelines, and IPR and data rights, besides other issues.[99] This reluctance is also related to cultural perspective in the US which upholds ethical values and individual privacy. For example, Google decided to withdraw from the Project Maven image recognition contract with the

[99] Sayler and Hoadley, *Artificial Intelligence and National Security*.

US DOD due to ethical objections expressed by employees about using their research for the business of war. Additionally, privacy concerns in the US will hinder access to government data by private companies that are crucial for the training of machine learning algorithms. Thus, there are several challenges in the civil-military collaboration for commercial AI advancements to manifest into military capabilities in the US.

In contrast, China's commercial market success in AI directly increases technological capabilities available to China's military and intelligence community due to its unique civil-military relationship. Civil-military fusion has been included in nearly every major initiative during Xi Jinping's tenure. PLA leadership, and academics have highlighted the need for achieving civil-military fusion for frontline technologies like AI. To strengthen the civil-military collaboration, China initiated the civil-military integration strategy in March 2015 that could cover multiple areas and generate high returns.[100] This effort got a significant boost in 2017 with the establishment of the Central Commission for Integrated Military Development (CCIMD). In January 2017, Chinese President Xi Jinping took over as the chairperson of this body, highlighting the commitment of China to exploit advances in technology for its military modernization.[101] The State Administration for Science, technology and Industry for National Defense (SASTIND) and key agencies within CMC have undertaken incremental reforms like

[100] Xiang Bo, "China's Xi Calls for Closer Civil-Military Integration to Boost Army Combativeness," *China Daily Asia*, 12 March 2015, accessed 23 October 2018, https://www.chinadailyasia.com/nation/2015-03/12/content_15238328.html.

[101] Leo Lin, "China's Answer to the US Military-Industrial Complex," *The Diplomat*, 11 April 2017, accessed 23 October 2018, https://thediplomat.com/2017/04/chinas-answer-to-the-us-military-industrial-complex/.

simplifying the contracting process, declassifying defense patents, and opening more contracts for private company participation. There is also a push for close partnerships between military and civilian research institutes or companies.[102]

All major technology firms in China cooperate extensively with China's military and security service. Article 7 of China's National Intelligence Law gives the government legal authority to compel such assistance.[103] In addition, the government has powerful non-coercive tools to incentivize cooperation. In 2018, China's government announced Baidu, Alibaba, Tencent, iFlytek, and SenseTime as the country's AI champions. This status gave these companies privileged positions for national technical standard settings and safeguarded them from competition from state-owned enterprises. In turn, these companies are required to cooperate extensively with China's national security community.[104] Thus, China's success in commercial AI has direct relevance to China's military and AI capabilities. As a result, consider a scenario where Chinese civil-military fusion enmeshes private and defense companies into a single entity working for the development of national security capabilities. As a result, this single entity just has to outpace US federal agencies like DARPA and IARPA engaged in the development of military AI capabilities. It does not necessarily have to overtake US AI giants like Google

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[102] Lorand Laskai, "Xi Doubles Down on Civil-Military Fusion," *Real Clear Defense*, 10 May 2018, accessed 01 May 2019, https://www.realcleardefense.com/articles/2018/05/10/xi_doubles_down_on_civil-military_fusion_113431.html.

[103] Samantha Hoffman and Elsa Kania, "Huawei and the Ambiguity of China's Intelligence and Counter-Espionage Laws," *The Strategist*, 13 September 2018, accessed 29 April 2019, https://www.aspistrategist.org.au/huawei-and-the-ambiguity-of-chinas-intelligence-and-counter-espionage-laws/.

[104] Allen, *Understanding China's AI Strategy.*

or Facebook. Hence, considering the China's substantial efforts in civil-military integration, the author assesses China to be in advantageous position in CMF.

AI Acquisition and Adaptability

The next aspect for the development of AI-related military capability are the challenges related with AI acquisition and adaptability, in other words, how ready are the US and China to incorporate AI capabilities in their respective militaries? Traditionally, the US military has been very tech-friendly, however, AI adaption will present significant challenges. The first issue is unit manning changes. There will be significant issues with organization, equipping and manning. While in some cases, it may lead to a reduction in the workforce, in others it may lead to an increase in manpower required to support the AI systems.[105] Another significant issue will be the legal and ethical considerations to use of AI by the military. However, while there is a debate among scholars, policymakers, and scientists on the development of AI weapons, their use by the military will not be a significant concern once they are developed. Already, there are some who consider LAWS a necessity, citing its development by adversaries.[106]

Yet another significant challenge is aligning civilian and military standards of safety and performance. An acceptable failure rate for a civilian AI application may not be acceptable in a combat environment. For example, employment of AI in decision

[105] In data analysis, it may lead to reduction in manpower. AI systems can analyse large volume of data in a shorter time frame. But, employment of UAVs has also led to an increase in manpower requirement for operation of UAVs and processing of Information.

[106] CRS, *US Ground Forces RAS and AI*, 39.

making in the defense environment will generally be more consequential, with human lives routinely held at risk.[107] There will be a significant need for validating AI system performance and enforcing safety standards prior to adoption as human lives will routinely be at stake. The other significant barrier to the adoption of the technology will be the issue of "explainability".[108] in other words, an explanation of the path the system took to arrive at the solution. The opacity of AI reasoning may cause an operator to have either too much or too little confidence in the AI system. Thus, decisionmakers may not be confident enough to accept an AI generated analysis or recommendations. This may be a significant challenge in the adoption of AI systems.

These issues of manning, training, legal, ethical, safety, predictability, and explainability will be a challenge for both the US and China. However, China might be better poised to incorporate AI systems in the military in some of these aspects. For example, the Chinese conscript military may find the solution for the manning challenge through its centrally directed efforts to recruit a more educated workforce. As per Elsa Kania, the PLA could potentially be the first to conceptualize or operationalize the new concept of operations for AI in future warfare to overcome their limitations in lack of combat experience.[109] In the absence of combat, People's Liberation Army (PLA) has traditionally focused extensively on simulation and wargaming to derive appropriate military concepts and theories. AI will assume a greater role in driving these efforts

[107] Sayler and Hoadley, *Artificial Intelligence and National Security*.

[108] Ibid., 31.

[109] Kania, *Battlefield Singularity.*

forward. The PLA approach where technology determines tactics is more likely to provide acceptance to experiment with AI.[110] The PLA's relative lack of trust in human personnel could also see AI as more reliable.

There is also a significant difference in PLA and US approaches to AI. Multiple indications in PLA literature suggest the PLA thinkers have moved from informationized to intelligentized warfare due to rapid advances in artificial intelligence and its applications.[111] PLA thinkers and researchers appear razor focused on applications of AI in simulations, wargaming, training, and command decision making, in addition to the unmanned systems and intelligence analysis. The US military has seemingly concentrated on more tactical-level, immediate applications of autonomy and AI so far.[112]

Based on these considerations, the researcher has assessed PLA to be in an advantageous position in terms of AI acquisition and adaptability over the US military. However, this will not be a distinctive factor in the AI race in comparison to other factors. According to a Belford Center Study report on AI and National Security, "The applications of AI to warfare and espionage are likely to be as irresistible as aircraft. Preventing expanded military use of AI is likely impossible."[113]

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[110] Kania, *Battlefield Singularity*.

[111] Elsa Kania, "Quest for an AI revolution in Warfare," *Strategy Bridge*, 8 June 2017, accessed 30 April 2019, https://thestrategybridge.org/the-bridge/2017/6/8/-chinas-quest-for-an-ai-revolution-in-warfare.

[112] Kania, *Battlefield Singularity.*

[113] Allen and Chan, *Artificial Intelligence and National Security*, 15.

Asymmetric Approach to Capability Development

Another significant obstacle to the US adoption of AI weapons is a "Sunk cost trap" due to its massive investments in conventional capabilities. It would be difficult for the US to adapt to changing environmental realities and adopt new AI weapons while condemning some of its conventional capability to irrelevance. The process will likely face massive bureaucratic and organizational resistance. In contrast, the PLA, since 1990, has been involved in developing a "trump card" capabilities to target US vulnerabilities.[114] If this asymmetric thinking persists in the PLA's approach to AI, the PLA does not necessarily have to build AI weapons that are superior to US AI weapons to beat them. It just has to make an effective AI system, good enough to target vulnerabilities in a US AI system and not necessarily an efficient system to match US strengths. Thus, I have given a value of one to China and zero to the US in this factor.

Capability Development Timeline

The next big challenge identified is the US DOD acquisition process. The defense acquisition process might not be agile enough to meet the requirements of a fast-paced technology like AI.[115] Currently, the Joint Capabilities Integration Development System (JCIDS) process takes an average of 91 months to move from the capability gap analysis,

[114] Jinn, "China's Development of Asymmetric Warfare and the Security of Taiwan, Republic of China," 13.

[115] Andrew Ilachinski, *AI, Robots, and Swarms: Issues, Questions, and Recommended Studies,* White Paper (Arlington County, VA: Center for Naval Analysis, January 2017, 190-191, accessed 01 May 2019, https://www.cna.org/CNA_files/PDF/DRM-2017-U-014796-Final.pdf.

defining the requirements for a system, to an initial operational capability.[116] In contrast, commercial companies adopt an iterative development process for the development of capabilities like AI and can take six to nine months to deliver the product. Thus, DOD needs a new acquisition process specifically for information technologies. Although, some promising developments have occurred with creation of rapid-acquisition organizations with Other Transaction Authorities (OTA), critics point out that these are "workarounds instituted by DoD to facilitate rapid acquisition of systems rather than wholesale changes applied to stove piped processes of the Defense Acquisition Process itself."[117]

In absence of a faster acquisition process, the US faces a serious threat from China that is infamous for stealing technology and reverse-engineering or replicating that technology to meet domestic requirements. Considering China's CMF, if PLA displays a shorter capability development timeline, then it will be better poised to exploit the technological breakthroughs in the commercial domain to develop AI systems for national security purposes. Consequently, even if a breakthrough takes place outside China, the open data sharing and notorious history of espionage will help PLA acquire that capability without having to achieve an R&D breakthrough.

The issue is significant considering China's emergence as an alternative supplier of affordable, high-tech military equipment to the US. Today, 80 percent of trainer jets

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[116] Sayler and Hoadley, *Artificial Intelligence and National Security*, 14-15.

[117] Ilachinski, *AI, Robots, and Swarms*, 190.

across Africa are Chinese made K8 planes.[118] China's UAV industry has emerged as the world's leading exporter of armed drones and with low cost and less employability restrictions has expanded its customer base to 53 countries.[119] Although experts argue about the competitiveness of these products vis-a-vis US products, a 2017 DoD report on "China Military Power" notes that "Chinese arms are also of lower quality and reliability, but they still have advanced capabilities."[120] It is an undisputed fact the Chinese defense industry is growing rapidly. The fact 53 countries are importing arms from China is testimony that China may not be developing the best products but is developing good enough products that can be used in combat.

## Summary of Findings

The author's overall assessment of the AI race between both countries is documented in two parts. The first table depicts the relative positions of the US and China around 2014 when China's regional and global aspirations started emerging.

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[118] Benjamin David Baker, "Chinese Companies are Picking Up Pace in Africa and the Middle East," *The Diplomat*, 21 October 2015, accessed 29 April 2019, https://thediplomat.com/2015/10/chinese-arms-companies-are-picking-up-the-pace-in-africa-and-the-middle-east/.

[119] Stockholm International Peace Research Institute (SIPRI), "Global Arms Trade: USA Increases Dominance; Arms Flow to Middle East Surges, Says SIPRI," SIPRI, 11 March 2019, accessed 30 April 2019, https://www.sipri.org/media/press-release/2019/global-arms-trade-usa-increases-dominance-arms-flows-middle-east-surge-says-sipri.

[120] Office of Secretary of Defense, *Military and Security Developments Involving the People's Republic of China 2017,* Annual Report to Congress (Washington, DC: Office of Secretary of Defense, 15 May 2017), accessed 30 April 2019, https://dod.defense.gov/Portals/1/Documents/pubs/2017_China_Military_Power_Report.PDF.

Around 2014, China started its modernization reforms buoyed by three decades of highest GDP growth and launched a series of policy initiatives to assume a leadership role in world politics. In the diplomatic domain, China was trailing the US in both international market access and collaboration in R&D. During this period, China had limited market access and had started initiatives like Belt and Road initiative (BRI) to gain access to international markets. It was also trying to increase collaboration in R&D, leveraging its economic strength. In the informational domain, the relative position of both the countries is of little significance as the US had enjoyed unchallenged technological supremacy and there was no effort necessary in this domain prior to this period.

In the economic domain, the US had a leadership role in AI talent, a superiority it continues to enjoy today. Entrepreneurship climate was another factor where the US had an upper edge whereas China's entrepreneurship climate was still evolving. In addition, as this was not an age of implementation, but an age of innovation, the US was a clear leader in this factor. China had superiority in data owing to its vast population that only increased post this period from quantity to quality owing to its techno-friendly population. China's centralized government push and lack of ethical concerns were assets in this period that helped it reduce effect of shortcomings in foundational R&D.

In the military domain, Civil-military fusion was in favor of the US, as China's tech companies were still emerging and were unable to contribute to the military AI. Doctrinal readiness was the other factor which was in favor of the US. While the US has always boasted of an established organizational construct for doctrinal development, PLA military modernization just started and PLA was in the process of carrying out massive

institutional and organizational reforms. The factor, which favored China in this domain was PLA's concept of targeting US vulnerabilities; as historically it was never strong enough to challenge the US strengths. The factor which has remained a positive aspect for both the militaries was the readiness to accept technology. Both the US armed forces and the PLA had been pro-technology to either increase their combat potential or overcome their shortcomings.

Thus, the author's assessment for relative state of AI R&D in 2014 is summarized in the table 1 in the next page However, in last five years, China has made rapid progress in all four domains as reflected in the thesis. Based on analysis of these domains, the author has summarized the relative state of AI R&D in 2019 in table 2.

Table 1. Relative Position of US and China in 2014

| Domain | Factors | Weight | US | China |
|---|---|---|---|---|
| Diplomatic | International Market Access[1] | 3 | 1(3) | 0 |
| | Collaboration in R&D[1] | 3 | 1(3) | 0 |
| | Total | | **6** | **0** |
| Informational | Uninterrupted flow of raw materials[2] | 1 | 0 | 0 |
| | Continued access to global markets[1] | 3 | 0 | 0 |
| | **Total** | | **0** | **0** |
| Economic | AI talent[3] | 3 | 1(3) | 0 |
| | Data[3] | 3 | 0 | 1(3) |
| | Entrepreneurship[4] | 1 | 1(3) | 0 |
| | Government support[5] | 2 | 0 | 1(2) |
| | Age of implementation/adaptability[6] | 3 | 1(3) | 0 |
| | Ethical/ Cultural differences[7] | 2 | 0 | 1(2) |
| | **Total** | | **9** | **7** |
| Military | Civil-military fusion[8] | 3 | 1(3) | 0 |
| | Acquisition and adaptability[9] | 1 | 1 | 1 |
| | Asymmetric approach[10] | 1 | 0 | 1 |
| | Capability development timeline[11] | 3 | 0 | 0 |
| | **Total** | | **4** | **2** |
| | **Grand Total** | | **19** | **9** |

*Source:* Created by author.
NOTE: Author employed a binary system of evaluation. 1 is assigned if the factor is in favor of the country; a value of 0, if the factor is not in favor of the country.

Explanation of Weight of Various Factors

1. Weight of 3 due to their critical role in ensuring a steady supply of AI talents, raw materials, and technology; essential for maturation of technology. Also see p 46-50.

2. Weight of 1 as multiple study have brought out aspects of hardware and software requirements for the AI development, but they find significantly less mentions than other factors. Also see p 52.

3. Weight of 3 as all the discussions focused on comparison between the US and China mention AI talent and Data as critical to AI development. Also see p 57-61.

4. Weight of 1 as although crucial, there has not been lot of literature crediting entrepreneurship as a critical component in the AI race. Also see p 53-57.

5. Weight of 2 as most of the studies on the AI, recommend structural and organizational reforms for the development in AI, and a supportive policy environment is essential for that. Also see p 62-64.

6. Weight of 3 as multiple reports indicate readiness for adoption will be one of the largest drivers of economic impact in north America. Also see p 65-68.

7. Weight of 2, due to its significant impact on development of AI capabilities; also, a major AI integration challenge. Also See p 67-68.

8. Weight of 3 considering its key role in subsuming commercial AI advances in to military domain; also, identified as key focus area by both the US and China. Also see p 68-71.

9. Weight of 1 as despite its importance, this will not be a distinctive factor in the AI race in comparison to other factors. Also see p 71-74.

10. Weight of 1 as PLA targeting of US vulnerabilities not a new concept and its overall impact in the development of military capability is not significant. Also see p 74.

11. Weight of 3 considering the disruptive potential of a shorter capability development timeline; also, a significant AI integration challenge. Also see p 75-76.

Table 2. Relative Position of US and China in 2019

| Domain | Factors | Weighte | US | China |
|---|---|---|---|---|
| Diplomatic | International Market Access | 3 | 1(3) | 1(3) |
| | Collaboration in R&D | 3 | 1(3) | 0 |
| | **Total** | | **6** | **3** |
| Informational | Uninterrupted flow of raw materials | 1 | 1 | 1 |
| | Continued access to global markets | 3 | 1(3) | (3) |
| | **Total** | | **4** | **4** |
| Economic | AI talent | 3 | 1(3) | 0 |
| | Data | 3 | 0 | 1(3) |
| | Entrepreneurship | 1 | 1(1) | 1(1) |
| | Government support | 2 | 0 | 1(2) |
| | Age of implementation/adaptability | 3 | 0 | 1(3) |
| | Ethical/Moral | 2 | 0 | 1(2) |
| | **Total** | | **4** | **11** |
| Military | Civil-military fusion | 3 | 0 | 1(3) |
| | Acquisition & Adaptability | 1 | 1 | 1 |
| | Asymmetric approach | 1 | 0 | 1 |
| | Capability development timeline | 3 | 0 | 0 |
| | **Total** | | **1** | **5** |
| | **Grand Total** | | **15** | **23** |

*Source:* Created by author.
NOTE: Author employed a binary system of evaluation. 1 is assigned if the factor is in favor of the country; a value of 0, if the factor is not in favor of the country.

To summarize, when one considers only the technological aspects, one finds the US in a leadership position in AI R&D currently. But if one carry out a holistic appraisal incorporating various tangible and intangible factors, China is better poised to take over leadership from the US. This overall leadership does not imply that China has overtaken the US in AI but it implies that current Chinese systems, structures, and policies are better suited for the growth of AI systems catapulting China ahead of the US in the

coming decade. However, this is a projection based on the current growth of China's progress. There is a number of significant challenges that can potentially alter China's projected growth potential. These challenges will be disused in subsequent paragraphs.

## China's AI Integration Challenges

In the diplomatic domain, growing global concerns about China's strong arms tactics have the potential to alienate countries. This would restrict their access to the global market, AI talents, and raw materials. The US government launched trade wars as a retaliation of unfair trade practices by China in 2018. These trade wars have resulted in significant losses to China, especially to obtain raw materials like semiconductors.

In the economic domain, China's continued growth is contingent on various factors. China's strengths are mainly in AI applications and are still lacking in core AI technologies. In addition to lack of AI talent, it lacks hardware and algorithm that point to its weak foundations of AI development. It is taking significant efforts to develop its indigenous capabilities, but international market access and collaboration is a vital component for that. China's other significant weakness is the lack of international standards that are essential for interoperability and market growth. Historically, Chinese companies have developed very few standard essential patents (SEPs). However, China has made rapid progress in this field with hundreds of SEPs related to the 5G cellular standards. Another significant weakness identified is in the field of software frameworks and platforms. Currently, none of the most popular machine learning software frameworks like Tensor Flow, Google, Spark, CNTK, and Pyrotech have been developed in China. Chinese R&D of domestic AI products and applications is mainly based on Google and Microsoft. It has started to make some progress in this field with SenseTime

developing its own machine learning framework called Parrots. However, Sense time is facing challenges in promoting its adoption.[121]

Chinese weaknesses in Semiconductor is another key obstacle in China's AI growth. The US ban on critical input products like semiconductors had driven Chinese electronics manufacturer ZTE to near bankruptcy. The Chinese government recognized its weakness in the semiconductor as early as 2014 and had launched National integrated Circuit industry investment fund to boost semiconductor development. It had reportedly invested $20.5 billion as part of that fund. It also launched a second fund in 2018 to invest $44.5 billion for semiconductor development. It had also outlined in Made in China 2025 to reduce all external dependencies and increase domestic semiconductor manufacturing as a share of domestic consumption to 80 percent by 2030. As a result of these efforts, China has increased its share of domestic consumption from 29 percent in 2014 to 49 percent in 2019.[122]

China's AI entrepreneurship climate is powered mainly by returned overseas top talents. This talent is returning to China inspired by rapid economic growth and emerging opportunities. However, China's continued rapid growth is not guaranteed and an economic depression can have drastic implications for this entrepreneurship climate. Additionally, Chinese illicit methods of acquiring key technologies by espionage or clandestine takeovers are under scrutiny by the US government. The US has been a major victim of technological theft and recently has taken several steps to curtail this theft. Its

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[121] Allen, *Understanding Chinas AI Strategy.*

[122] Ibid.

trade restrictions resulted in companies like Foxconn, and Samsung relocating their Chinese operations to other low-cost countries like Vietnam and India.[123] In another move to sabotage Chinese high-tech plans, in June 2018, the US treasury department adopted a policy to block firms with 25 percent or more Chinese ownership from acquiring US companies with industrially significant technologies.[124]

In the military domain, the unique nature of PLA as a party military and not a national military, can inhibit the adoption of the AI technology, if it is considered a threat to the communist party.[125] In addition, PLA culture of command micromanagement and distrust may also make the PLA's leadership reluctant to delegate decision making to the AI systems and risk losing control. In addition, the effective employment of AI will also require attention to complex human factors like specialized training and new organizational structures.

### China's Progress in Five Initial Vectors of the Third Offset Strategy

In addition, there is another aspect of the discussion that relates to the feasibility or longevity of the offset. To make US offset irrelevant, does China need to develop the best AI systems or has to make AI systems good enough to target US vulnerabilities?

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[123] Ralph Jennings, "Why Taiwanese Firms are Scaling Back their China Operations," *Forbes*, 20 November 2018, accessed 30 April. 2019, https://www.forbes.com/sites/ralphjennings/2018/11/20/why-taiwanese-firms-are-scaling-back-their-china-operations/#66686ce52ef5.

[124] Rachel Kraus, "US Will Block Chinese Firms From Acquiring American Tech Companies," *Mashable*, 25 June 2018, accessed 09 April 2019, https://mashable.com/article/us-blocks-chinese-tech-acquisition/#_8oPHr4ykmqk.

[125] Kania, *Battlefield Singularity.*

Even if the US succeeds in developing better AI systems in five initial vectors of Third Offset Strategy, China just has to make its own AI systems in those five vectors good enough to prevent any asymmetric advantage to the US. The PLA has closely tracked the third offset strategy and the PLA's projected employment of AI in military applications is shaped by the US approach.[126] China's efforts in the five initial vectors of US Third Offset Strategy range from developing a similar operational approach as the US to utilizing AI as a "leapfrog technology" to offset US conventional superiority.

Autonomous Learning Systems

The PLA has pursued R&D, and testing for AI-enabled defense, offense, and command in information warfare and intelligent support to command decision making. PLA leadership is speculating a singularity in the battlefield where the war will occur at machine speed. The speed of the war will be beyond human cognitive abilities and the decision making must be delegated to the machines. PLA theorists have already started incorporating humans in the loop and humans on the loop in their writings.[127] This indicates that PLA thinkers are not discounting the employment of full autonomous system with no human supervision. In contrast, the US leadership believes in human intuition and ingenuity and declared that the US military will never pursue true autonomy.[128]

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[126] Kania, *Battlefield Singularity*.

[127] Ibid.

[128] Sydney J. Freedberg and Colin Clark, "Killer Robots? 'Never,' Defense Secretary Carter Says," *Breaking Defense*, 15 September 2016, accessed 01 May 2019, http://breakingdefense.com/2016/09/killer-robots-never-says-defense-secretarycarter/.

In addition, PLA researchers and academics are also pursuing conceptual and technical research to support new operational approaches where AI could enable intelligence analysis on the front end. Thus, autonomous learning can be utilized for developing a multi-dimensional, multi-domain unmanned combat weapon system of systems. As per Elsa Kania, PLA's efforts have started to advance considerably in deep learning to enable such application of unmanned systems.[129]

Human Machine Collaborative Decision Making

The PLA has closely tracked the third offset strategy and is likely to pursue similar forms of human-machine integration for decision making. With PLA's anticipation of a battlefield singularity and its focus on achieving situational understanding and informed decision making through AI systems, human-machine collaborative decision making will be a critical area. The PLA has already made significant progress with respect to command intelligentization. As of December 2015, the PLA has created an "external brain" to assist commanders, enhancing their situational awareness and battlespace management.[130]

Assisted Human Operations

China's advancements in robotics, nanotechnology, and AI demonstrate China's ability to develop this capability. China has already displayed a disregard for ethical and scientific concerns associated with the genetic engineering and delivered genetically

[129] Kania, *Battlefield Singularity.*

[130] Ibid.

modified babies.[131] Thus, incorporating these factors together, it is safe to assume that China has the potential to not only develop assisted human operations, but going a step further, it can also experiment in genetically enhanced human operations.

Advanced Manned-Unmanned Systems Operations

The PLA defense industry has pursued options for manned-unmanned teaming and multi-teaming operations. According to Ma Hongzhong, chief engineer at China Aerospace Science and Industry Corporation, China has acquired this technology of the future with the development of Sky Hawk, a high altitude, long range, and high speed unmanned aerial vehicle, China's newest stealth drone features technology that allows it to communicate and collaborate with manned aircrafts during surveillance and combat operations.[132] However, critics are skeptical of Chinese capability to apply MUM-T concept in the battlefield.

In addition, China has also displayed considerable progress in swarm intelligence and collaborative behavior of multiple manned and unmanned systems. China successfully tested a swarm of one thousand drones at Global Fortune Forum at Guangzhou on 07 Dec 2017. China is also looking to take its drone swarms into near

[131] Eileen Hunt Botting, "A Chinese Scientist Says He Edited Babies Genes. What are the Rights of the Genetically Modifies child?" *The Washington Post*, 06 December 2018, accessed 12 April 2019, https://www.washingtonpost.com/news/monkey-cage/wp/2018/12/06/a-chinese-scientist-says-hes-edited-babies-genes-what-are-the-rights-of-the-genetically-modified-child/?noredirect=on&utm_term=.e870329901b0.

[132] Kristin Huang, "China's Sky Walk Stealth Drone has the Capability to Talk to Fighter Pilots, Developer Says," *South China Morning Post*, 11 January 2019, accessed 12 April 2019, https://www.scmp.com/news/china/military/article/2181731/chinas-sky-hawk-stealth-drone-has-capability-talk-fighter-pilots.

space, alongside a planned arsenal of hypersonic spy planes, high altitude airships, and anti-stealth drones.[133] China's academicians and thinktanks on multiple occasions have quoted use of swarms as an asymmetric way of targeting US high-value weapon platforms with low-cost options like a drone swarm targeting an aircraft carrier.[134]

Network Enabled, Autonomous Weapons Hardened to Operate in a Future Cyber/EW Environment

Besides developing its own autonomous weapon systems, Chinese strategists consider developing countermeasures against US unmanned systems as a necessity. Chinese researchers have published extensively on soft kill countermeasures to blind, confuse, or jam unmanned systems. With increasing US emphasis on unmanned systems in Third Offset Strategy, Chinese countermeasure development efforts will intensify.[135]

Summary

A comprehensive analysis of relative progress of AI in both countries establishes that while the US still leads the world in AI development, China is rapidly narrowing the gap. China's determined push towards fulfilling its regional and global ambitions has

[133] Jeffrey Lin and P. W. Singer, "China is Making 1,000 UAV Drone Swarm Now," *Popular Science*, 08 January 2018, accessed 12 April 2019, https://www.popsci.com/china-drone-swarms.

[134] Kania, *Battlefield Singularity.*

[135] Jonathan Ray, Katie Atha, Edward Francis, Caleb Dependahl, Dr. James Mulvenon, Daniel Alderman, and Leigh Ann Ragland-Luce, *China's Industrial and Military Robotics Development,* Research Report Prepared on behalf of the US-China Economic and Security Review Commission (Vienna, VA: Defense Group Inc., October 2016), accessed 12 April 2019, https://www.uscc.gov/sites/default/files/Research/DGI_China%27s%20Industrial%20and%20Military%20Robotics%20Development.pdf.

shown some remarkable progress so far particularly in high tech sectors like supercomputers, industrial robotics, aviation, and unmanned systems. While some critics argue that China's growth is like a bubble and not sustainable, it is difficult to outrightly dismiss China's growing capabilities. While based on its recent capabilities, China may not be in a position to challenge the US technological superiority, it has developed structures, organizations, and policies that may prove to be decisive in the coming decade. While for the most part, these structures and organizations mirror the US R&D ecosystem, they are also unique as they are tailored to capitalize on its domestic strengths. China has learned and evolved from the US system and learnt the best US practices and discarded bureaucratic and idealistic hurdles in AI R&D.

This growing threat to US superiority has not gone unnoticed by US policymakers. In last three years, the US National Security Strategies have mentioned China as a threat to world peace, stability, and democratic values. However, the US has not shown a determined commitment to stem the Chinese tech advancements. The US continues to enjoy technological superiority, but the systems and processes that have propelled it to this place will not guarantee its future leadership role. The US' closest adversary China, has successfully learned from the US and in a holistic comparison has already surpassed the US.

However, this analysis of the possible future is based on the current state of certain tangible and intangible factors and is not a definitive picture of the future. There are economic, political, and social impediments to the Chinese AI dream. However, China's success story since 1978, when it launched its modernization reforms, attests to the fact that it has been successful in maintaining a steady development course

overcoming obstacles. China's AI dream is likely to follow the same course in absence of an outside interference. The US will have a central role in creating that outside stimulus that will hinder the Chinese growth. It will be incumbent on the US policymakers to realize the growing threat and take measures to retain its global supremacy.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## Introduction

This paper constitutes an attempt to explore the impact of China's progress in AI on the US Third Offset Strategy. During the research, it emerges that great power competition between the US and China hinges on the progress of AI in either of countries. While the US was the first to officially announce a strategy to retain its global leadership in the form of the Defense Innovation Initiative, China followed suit with its *Next Generation Artificial Intelligence Development Plan*. However, there was a significant difference in both government's approaches. China's AI plan was facilitated by an informed government push, adopting a whole of government approach. It led to a slew of investments, policy reforms, and numerous startups. The US Third Offset Strategy did not receive a similar kind of government attention, and the AI R&D continued its normal course.

To compare the relative positions of both the US and China, the author analyzed various tangible and intangible factors, crucial for development of AI. Based on the advantages and disadvantages of either of countries on these factors, several challenges in the development and integration of AI into the military domain were identified. To overcome these challenges, and to ensure US strategic and military superiority in AI, the following actions are recommended for the US. These actions are arrayed along four lines of effort: recognizing and understanding the emerging strategic threat, adopting a whole of government approach to maintain the US leadership in AI, disrupting Chinese progress in AI development, and mitigating catastrophic risk.

## Recognizing and Understanding the Emerging Strategic Threat

### Understanding China's Strategic Thinking

China's advancements in the technological field have been inspired by the US. China has a role model in the US that has a stable innovation and entrepreneurship climate. China learned and evolved from the US systems and procedures. In the process, it attempted to remove the organizational and bureaucratic hurdles existing in the US innovation culture. Thus, the US has been the biggest asset in developing China's approach towards AI development. Chinese government organizations and think tanks routinely analyze US government and think tank reports on AI. Similarly, to counter Chinese advances, the US should be able to gain insight into Chinese thinking in AI. For this, US policymakers ought to be similarly effective in understanding, analyzing, and disseminating Chinese AI publications.

### Understanding the Impact of AI on the Battlefield

The US DoD should conduct wargames, exercises, and researches to understand the impact of AI on the battlefield. It should identify applications of AI in battlefield that have a disruptive effect. However, this should be conducted with an awareness of the PLA's approach regarding military applications of AI. It should also be able to track progress of the PLA's defense innovation ecosystem. Additionally, to develop countermeasures for the PLA's capability, it should pay attention to the uniqueness of the PLA's strategic culture and organizational dynamics. For example, while the United States may choose not to pursue autonomous weapons due to moral, ethical, and legal considerations, other nations might not feel so obligated, and aggressively develop these capabilities for possible use against U.S. forces. In such a situation, the US armed forces

could be required to develop new systems, tactics, and operational concepts to counter the threat posed by enemy AI systems.

### Revisit and Prioritize AI R&D Spending on Areas That Can Provide Sustainable Advantages

The transformative impact of AI can nullify certain assumptions about future battlefield scenarios that form the basis of some of DoD long-term investments and procurement projects. DoD needs to revisit some of the existing long-term investments like aircraft carriers, considering the possibility that these aircraft carriers may no longer be relevant for the conflict of the future. It should limit spending on military AI technologies that can be easily replicated by the US adversaries, including non-state actors, and subsequently become a vulnerability for the US.

### Investment in Counter AI Capabilities

Machine learning systems are vulnerable to counter-AI due to their dependence on data sets. A competent adversary can induce error in the training data sets that can cause the algorithm to mischaracterize the result. Combined with "explainablity" and "predictability" challenges, AI systems will lose their reliability or significance in the face of an adversary with such counter-AI capabilities. Thus, the US should endeavor to secure a leading position in counter AI capabilities, both offensive and defensive

## Adopting A Whole of Government Approach to Maintain the US Leadership in AI

### Developing Policies and Procedures to Overcome AI Integration Challenges

The US has significant AI integration challenges as identified in the previous chapter. The biggest hurdle identified is the lack of cooperation from the private sector,

bureaucratic hurdles, and cultural differences. DoD should make efforts to resolve disputes related to copyright and data privacy. The other significant effort towards AI integration should be to fast-track JCIDS progress for high-tech capabilities like AI. This might require creation of new organizations focused on high-impact technologies or a change in DoD policies regarding standards and safety norms.

### Review Federal Laws and Regulations to Improve Adaptability of AI Systems

Adaptability has been identified as a major challenge preventing deployment of AI systems in the US. Stricter privacy laws and safety norms prevent deployment of immature AI products for validation and user trials. It may be a significant obstacle for development of machine learning systems that improves itself by an iterative process of deployment, data collection, and algorithm improvement. The US must build a conducive ecosystem for the deployment of AI systems. Another significant step will be to increase data access to private and government agencies for development of machine learning systems. This would require a review of existing federal laws and safety norms, without compromising safety standards. This would also require a holistic effort incorporating efforts from the US public and the political class alike, setting aside individual interests to allow policies in the national interests.

### Increase Federal Spending on R&D

The US government should increase competitiveness of government institutions and research agencies vis-a vis private sector. Currently these institutions and agencies are facing tough competition from the private sector to obtain/ retain top AI talent, and information on cutting edge AI-research. Poaching AI talent from academic institutions

poses a bigger problem, stripping these institutions of top instructors that could train the next generation of AI talents. Thus, the US government should increase research funding of these institutions and agencies to help them retain AI talent and information on cutting edge research.

Sometimes, the US government is less effective in the operationalization of its technical advances. The government support for the research and startups that have less commercial viability is limited. The US X-47B combat drone project is an example where the US government invested significant time and money looking for an aircraft carrier combat drone. However, in 2015, the navy scuttled this project citing cost over-runs. China picked up the research progress by the US and developed its CH-7 combat drone, the sole aircraft carrier combat drone. Thus, federal funding is an important component to bring the research advancements out of the labs into deployable AI systems. The USG funding efforts should focus on technologies having long term implications, and countering or exploiting adversary AI capabilities.

### Developing its AI Talent Pool and Stemming Outflow of AI Talent

The requirement of AI talent will increase in future and the US must invest in building and expanding existing STEM education programs. More importantly, a more focused approach will be required to fulfill human capital requirements of DoD. There will be a requirement for a trained workforce for handling and operating the AI systems, apart from the talent requirements in DoD R&D organizations. DoD will have to expand funding to research organizations to enable recruitment and retention of AI talents. It

might also consider new human resource guidelines for the technologically skilled workforce.

Chinese AI efforts reached a competitive level due to the US trained AI talents, both of Chinese and US origin. The USG would have to take steps to stem the outflow of AI talent. As federal spending is insignificant in comparison to commercial sector spending, the USG can do very little for private companies, to incentivize the retention of AI talent by increased federal funding. The government support can take other form like policy formulation to help private companies and research organizations retain their AI talent pool.

Collaboration with the Chinese Companies

The US should take a page out of China's book and closely monitor China's AI progress. It should collaborate with China in areas other than strategic applications of AI to benefit from Chinese advantages in this AI competition. The US may benefit from China's vast qualitative data and techno-friendly population. It should try to exploit adaptability of China for the deployment and maturing of its machine learning algorithms. The US attempts to limit technology transfer or data, talent, and capital across borders, should not undermine the dynamism of its own ecosystem, and create unintended economic consequences. The USG should also be aware of the inevitable diffusion of technology and growing Chinese indigenous capacity. Thus, a complete exclusion of China will only have negative implications.

## Disrupting Chinese Progress in AI Development

### Denying Access to Technology and Resources to Chinese Companies

China's AI dream has been possible due to their economic might. China's thinkers and policy makers, consider AI as "leap-frog technology," and aim to overtake the US, piggybacking on foundational R&D carried out in the US. Various Chinese legitimate and illegitimate methods have so far been successful in overcoming China's lack of foundational research. The US will have to take steps to curtail access to technology and resources to Chinese companies. Already the USG has taken significant steps like reforming the role and jurisdiction of the Committee on Foreign Investment in the United States (CFIUS) to prevent the takeover of US companies by Chinese companies. However, it would require more such steps. This might be difficult, due to heavy economic dependency of the US on China.

The other significant area where the US must restrict Chinese access is to information on critical AI research. AI is benefitted more from exchange of information on cutting edge research. Furthermore, researchers and developers publish their research, at the earliest to claim and patent the breakthrough. This open nature of the technology makes it susceptible to exploitation from Chinese companies, with a known history of replication and reverse engineering. Hence, the US will have to devise a mechanism to restrict Chinese access to critical AI research information without harming its own AI research by choking information exchange.

### Limiting Access to Chinese Students in Study Areas in Critical Technology

The students and professionals from around the world have made a significant contribution towards the current global domination of the US in technology. A significant portion of international students consider the US as the land of opportunity, and pursued jobs in the US. Hence, this pool of international students had traditionally worked as an asset for the US. However, in recent years, Chinese economic growth is inspiring Chinese students to return to China and utilize their education to fuel Chinese technological growth. Additionally, there also have been a few incidents of Chinese students' involvement in espionage activities, or stealing intellectual property. Considering these issues, the US may have to limit access to Chinese students in study areas in critical technology.

### Reducing US Dependency on Chinese Tech Firms

To disrupt the growing entrepreneurship climate, a crucial factor in the AI race, the US needs to replace China as the global manufacturing hub. US tech giants need to shift their manufacturing bases out of China into countries like India and Bangladesh having the potential to emerge as an alternative to China for mass manufacturing. Apart from disrupting Chinese economic growth, it will also deny them access to technical know-how. Some of the efforts have already started, with big firms like Samsung and Foxconn starting to shift their operations from China to other countries.

China's emergence as an alternative supplier of high-tech weapons, is due to their lower costs and lesser employability restrictions attached to these weapons. The US needs to change this situation, either by a policy shift or by strengthening indigenous

manufacturing in countries, that can take on this role from China. However, this would require a significant investment and long-term commitment from the US government.

## Mitigating Catastrophic Risk

### Restrict Development and Proliferation of Potential Catastrophic AI Applications

The US should try to develop international consensus, to limit development of AI system, having catastrophic implications, through international treaties. However, these efforts should start early, when the US still has the edge in the AI R&D. If the US loses its leadership position it will be difficult for the US to regulate the development of AI weapons. This would need balancing of US interests in development of autonomous weapons versus limiting proliferation of AI weapons. In addition, to achieve a global commitment for limiting proliferation of AI weapons the US needs to display its individual commitment to the world. This would be establishment of a government wide policy on autonomous weapon systems that apart from harmonizing efforts across military and intelligence agencies, displays the US commitment to peaceful applications of AI.

### Establish Dedicated Safety Organizations

Employee disgruntlement with collaboration and privacy issues prevent commercial AI giants from collaborating with DoD agencies, citing moral and ethical concerns in developing AI systems. DoD may build trust with the commercial sector by creating dedicated safety organizations specializing in research, verification and, validation of AI systems. Such organizations will act as a rational voice among the competing interests of commercial viability, enhanced lethality, and safety during R&D

of AI systems. This may also act as a focal point for all safety related best practices, and latest research benefiting all other organizations engaged in AI R&D.

### Enhanced Engagement and Dialogue Between the US and China on AI and Other Disruptive Technologies

It will be imprudent to hope for an outright ban on AI weapons in the strategic competition between the US and China, considering critical role of AI in future military power. However, efforts can be made to develop a consensus on restricting possible uses of AI having catastrophic effects. Currently, nations are unsure about their adversaries' approach regarding AI applications for military use. This misconception and distrust will prompt countries to explore more devastating uses of AI, to pre-empt its adversary. There is a requirement of transparency and mutual trust between countries in developing AI weapons. Additionally, formal and informal engagements between the US and China should focus on individual countries' desire for strategic stability and risk mitigation.

## Summary

As this study suggests, the future of the AI race and the resultant Third Offset Strategy depends on various tangible and intangible factors. It is difficult to make an accurate prediction of the future of the AI race. In addition, AI is an emerging technology, and its true impact on the combat is difficult to assess, unless it is used on the battlefield. Nevertheless, given AI's disruptive potential and China's rapid strides in AI, it is essential that the US policy makers and military leaders exercise oversight on China's AI progress and its implications for the Third Offset Strategy.

The recommended US approach can be summarized along four lines of effort. The figure on next page represents these lines of effort and decisive points along these lines.

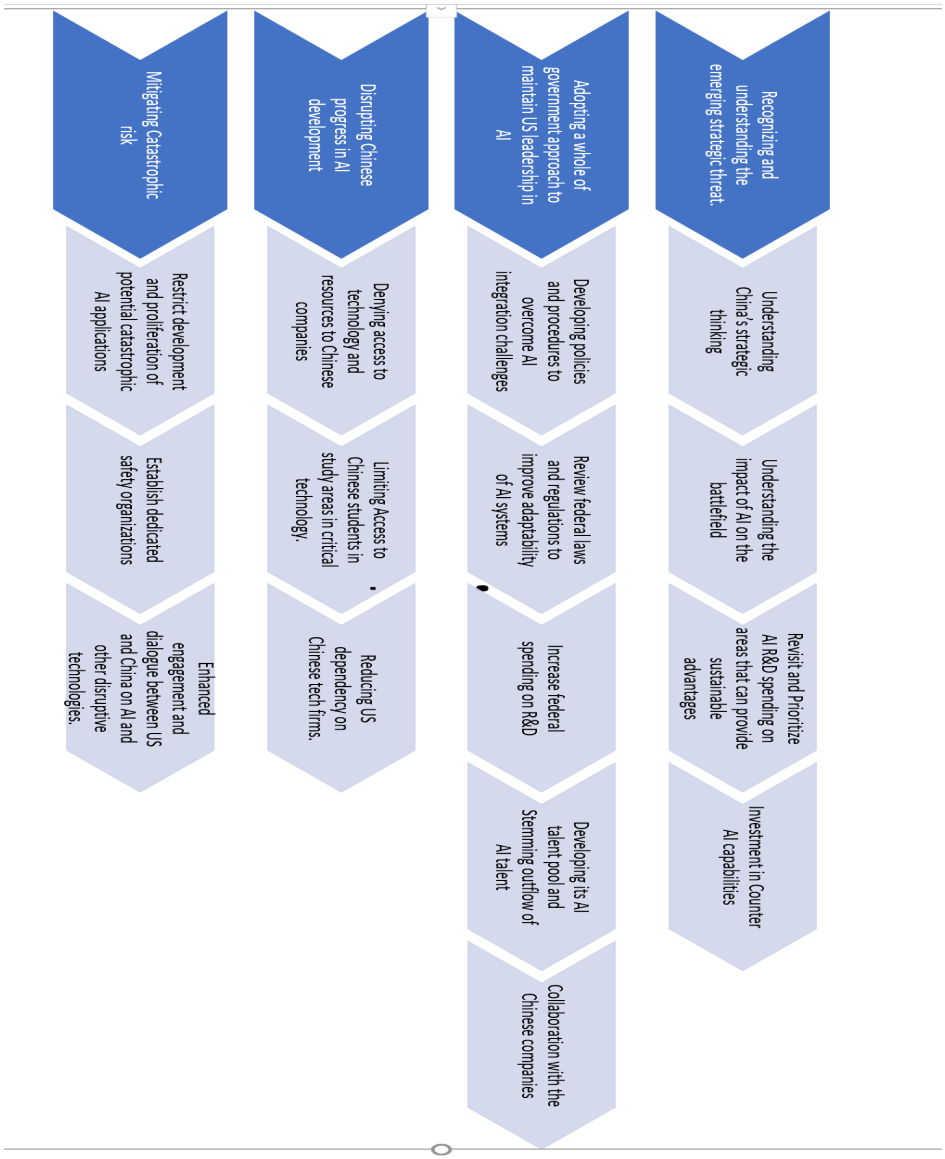


Figure 1. Recommended Lines of Effort

*Source*: Created by author.

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