Comparative Analysis of the U.S.-China Artificial Intelligence Architecture and Effects of Autonomous UAVs on the Future of the Battlefield.

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Abstract

Artificial Intelligence (AI) took the lead in the global technological market in the last decade, touching on applications in all areas of industry, from familiar examples in smart home appliances and consumer electronics to national defense. The U.S. and China represent the two largest economies in the world. Both countries are engaging in the AI tech race to implement this technology in the global markets and on the battlefield.

The U.S.-China AI tech race presents a security dilemma for the U.S. on two fronts: economic and national defense. If China successfully creates fully autonomous AI UAVs and disseminates them throughout the global market, it will have an economic and battlefield advantage. Fully autonomous AI UAVs in the People's Liberation Army (PLA) arsenal will provide a live picture of the battlespace, first-strike advantage, denial of waters and territory to the neighboring nations, control of the trade routes and contested islands, and negatively impact the U.S. global power projection in the Indo-Pacific Command (INDOPACOM), Figure 1, Appendix 1. This thesis seeks to examine how AI represents key elements in the global economy and on the battlefield, what specific function it can play in INDOPACOM, and how the U.S. is competing to win this race vis-à-vis China.

Frontispiece

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List of Acronyms

ABMS – Advanced Battle Management System

AFSOC – Air Force Special Operations Command

AGI – Artificial General Intelligence

AI – Artificial Intelligence

AMS – Academy of Military Science

AOR – Area of Responsibility

AP – Associated Press

ARTUμ – name of AI software

ASE – All Seeing Eye, hypothetical autonomous UAV

AWACS – Airborne Warning and Control System

BMDS – Ballistic Missile Defense System

BRI – Belt and Road Initiative

BRICS – Brazil, Russia, India, China, and South Africa

C3 – Command, Control, and Communication

CASPER™ – Cognitive Aids to Sensor Processing Exploitation and Response

CCP – Chinese Communist Party

CCTV – Closed Circuit Television

CENTCOM – United States Central Command

CES – Consumer Electronics Show

COVID-19 – Coronavirus Disease 2019

CPEC – China-Pakistan Economic Corridor

DARPA – Defense Advanced Research Projects Agency

DHS – Department of Homeland Security

DHSS/HSS – Department of Health and Human Services

DIU – Defense Innovation Unit

DIUx – Defense Innovation Unit Experimental

DOC – Department of Commerce

DoD – Department of Defense

DODD – Department of Defense Directive

DOE – Department of Energy

DOT – Department of Transportation

EA – Electronic Attack

EU – European Union

EV – Electronic Vehicle

FAA – Federal Aviation Administration

FBI – Federal Bureau of Investigations

FDI – Foreign Direct Investment

GDP – Gross Domestic Product

GII – Global Innovation Index

GPS – Global Positioning System

HGV – Hypersonic Glide Vehicle

IARPA – Intelligence Advanced Research Projects Activity

IBM – International Business Machines Corporation

ICBM – Intercontinental Ballistic Missile

IMF – International Monetary Fund

INDOPACOM – Indo-Pacific Command

IoE – Internet of Everything

IoT – Internet of Things

IP – Intellectual Property

ISR – Intelligence, Surveillance, and Reconnaissance

IT – Information Technology

JADC2 – Joint All-Domain Command and Control

JAIC – Joint Artificial Intelligence Center

JSTARS – Joint Surveillance and Target Attack Radar System

LAWS – Lethal Autonomous Weapon System

LiDAR – Light Detection and Ranging

LRRDPP – Long-Range Research and Development Program Plan

MCF – Military-Civil Fusion

MDO – Multidomain Operations

NAI – Narrow Artificial Intelligence

NAIIO – National Artificial Intelligence Initiative Office

NAIRR – National Artificial Intelligence Research Resource

NAOC – National Association of Ordnance Contractors

NASA – National Aeronautics and Space Administration

NATO – North Atlantic Treaty Organization

NGIA – National Geospatial-Intelligence Agency

NIH – National Institute of Health

NPC – National People’s Congress

NPR – Nuclear Posture Review

NSC – National Security Council

NSF – National Science Foundation

NSTC – National Science and Technology Council

NV – Nevada

OSTP – Office of Science and Technology Policy

PLA – People’s Liberation Army

PLAAF – People’s Liberation Army Air Force

PRC – People’s Republic of China

R&D – Research and Development

RAM – Random Access Memory

ROEs – Rules of Engagement

SCS – South China Sea

SecDef – Secretary of Defense

SOUTHCOM – United States Southern Command

SPECOPS – Special Operations

THAAD – Terminal High Altitude Area Defense

U.S. – United States

U.S.S.R. – the Union of Soviet Socialist Republics

UAE – United Arab Emirates

UAV – Unmanned Aerial Vehicle

UCP – Unified Command Plan

UDHR – Universal Declaration of Human Rights

UK – United Kingdom

UN – United Nations

UNESCO – United Nations Educational, Scientific, and Cultural Organization

USAF – U.S. Air Force

USD – United States Dollar

USINDOPACOM – United States Indo-Pacific Command

USPTO – U.S. Patent Office

VA – Veterans Affairs

VC – Venture Capital

VR – Virtual Reality

WIPO – World Intellectual Property Organization

WTO – World Trade Organization

YRD – Yangtze River Delta

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Chapter I.

Introduction

During the power struggle of competing nations in an anarchic system, the state that possessed a technological edge has historically been able to leverage that advantage, although at the cost of destabilizing international relations. This is exhibited throughout history with the invention of gunpowder, airplanes, chemical weapons, the Enigma machine, radar, nuclear weapons, and satellites. After the Cold War and the turn of the 21st century, the conventional threat has evolved into new technological domains. In addition to the recognized land, sea, and air domains by the Department of Defense (DoD), two new dimensions were added: space and cyberspace. The space domain encompasses satellites and hypersonic cruise missiles to replace old ballistic systems; the cyber domain, with the invention of the Internet of Everything (IoE), guards nation-states against hacking, theft of trade secrets and intellectual property (IP). With the cyber and space domains, the air domain now employs Remotely Piloted Aircraft (RPAs) acting as invisible proxies. In addition, the new emerging Artificial Intelligence (AI) technology, with its remarkable adaptability, is posed to thrust the air domain into more autonomy than the RPAs provide today. Although AI has theoretical underpinnings dating back to the 1950s (Anyoha, 2020), it did not become a topic of discussion until public demonstration of machines surpassing human intellect in a specific subject.[1]

[1] Notable public milestones involving NAI include International Business Machines Corporation (IBM) Watson beating the 2011 Jeopardy champion, AlphaGo defeating a 2016 'Go' strategy game champion, project Maven igniting protests among Google employees in 2017 (Wakabayashi & Shane, 2018), self-driving cars of 2018 (Marr, 2021), synchronized drone air shows at the Olympic games in

Over the centuries, computational science has evolved from the abacus to binary logic to a modern computer and continues to thrive in both the private and government sectors. The security dilemma the U.S. is facing is if China's current advancements in AI technology outpace those of the U.S. and then China militarizes it, the U.S. will be on the wrong side of the Enigma machine and Sputnik once again. It will be left in the cloak of uncertainty on capabilities and intentions of another actor, whose rationale may be to displace the U.S. from the Indo-Pacific Theater.

The AI tech race does not quite parallel the U.S. doctrine for nuclear warfare nor the Space Race. Because this technology is so broadly applied to the private sector and not exclusive to the defense industry, a narrower form is needed. Narrow Artificial Intelligence (NAI) is unique to a specific task for which it is built. Similar to the IoE, the policies for NAI are based how each country implements them. The integration of AI into military technology, nations' doctrines regarding AI, the public and government sectors' monetary investment, and domestic policies on achieving AI supremacy are particularly interesting. This technology carries an enormous power potential that nation-states can use against their adversaries. Examining its military potential and developing defensive strategies to maintain the balance of power is imperative for the U.S., especially the Indo-Pacific Theater. This thesis examines how both the U.S. and China build and sustain their respective national architecture for achieving AI dominance. This work proceeds as follows.

Chapter II introduces the concept of Artificial Intelligence and provides an overview of the current U.S. market value for consumer electronics and electronics that

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PyeongChang in 2018 (*A spectacle of light,* 2018) and in Tokyo in 2020 (*Spectacular Intel Drone,* 2021), and Shanghai's world record of a 3,000 drone formation air show in 2021 (Hambling, 2021).

use AI functions, giving the reader a monetary perspective of this emerging technology. It also defines the role of AI in national defense.

Chapter III reviews the broad concepts of technological competition in a globalized society and introduces China's position as a rising power and an international competitor. It describes why this technology is important from an individual to a state standpoint, how this technological race is different from the Space Race, and examines what kind of actor China is, in broad geopolitical aspects.

Chapter IV examines how military aviation incorporates NAI and how autonomous UAVs will transform the battlespace. This chapter focuses on specific AI advancements already under way in the U.S. and applies them to the air domain to explain how narrow AI in the sky is a key to first strike and maintaining a strategic advantage over an adversary.

Chapter V contrasts the architectural designs that the U.S. and China are pursuing to win this tech race. These contrasts include each nation's legislative and foundational organizations, intellectual property protection, and interaction of governments with private industries and the education sector in achieving AI primacy.

Chapter VI analyzes financing for Artificial Intelligence in terms of venture capital (VC) vs government spending, discusses the acquisition process of AI tech in the defense sector, and compares the available monetary data between each country.

Chapter VII examines how narrow autonomous AI UAVs present an intricate ethical dilemma in the absence of international rules of engagement (ROEs) regarding the use of full autonomy on the battlefield.

Chapter VIII sums up the contrasts between each country's approach to AI supremacy. It attempts to ascertain whether each country is at status quo or in the lead and presents topics for future research.

This thesis has some limitations that need to be addressed. The author does not speak Chinese, so the sources used to complete the research were either published or translated to English. The thesis addresses Narrow Artificial Intelligence (NAI) with specific functions, not Artificial General Intelligence (AGI) that aims to function on par with a human. Since AGI is a concept rather than reality, the thesis references NAI and AI interchangeably. Within NAI, this thesis examines conventional military advantage in a niche of UAVs or drones to present a particular scenario. This work is not a broad interpretation of the AI effect on conventional and nuclear weapons or command and control structures, but an examination of a fully autonomous UAV as a gateway to multidomain operations. This work examines the AI development in the U.S. and China exclusively. Further, China's data on monetary investments into AI is scarce in general. The Chinese Communist Party (CCP) does not have a reliable published AI budget to ascertain the actual spending on AI, much less allotted categories within NAI. Conversely, the DoD provides public information on defense spending, including NAI categories. This thesis is limited to the U.S. and Chinese domestic policies only and does not include the U.S. or Chinese foreign policies nor the collaboration between countries on AI/UAV research and development (R&D). Lastly, due to practical document limitations, this thesis omits rogue nation or terrorist group advanced AI weapon system implementation. These omitted topics can be explored extensively in future works.

Chapter II.

Background

This chapter offers a broad overview to the concept of AI and Machine Learning. It discusses integration of smart tech into societies and its impact on the current and future economic outlook for the world, and the strategic value AI brings to the defense industry.

AI and Machine Learning

Automated telephone voice menus, translation algorithms, and automated drone flight are a few examples of how AI is already used in many aspects of our lives. It is important to recognize that the AI boom happening today started with the availability of Big Data and vast computer processing power – something not available in the 1950s. Big data for AI is equivalent to textbooks or study materials humans use, and Machine Learning (ML) is how AI learns just as humans learn through reading and writing. To understand how AI is changing the future of the battlefield, it is important to understand what AI is and where it is today.

According to the Oxford Reference Publishing, artificial intelligence is "the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages" (Oxford Reference, n.d.). In simple terms, AI is a program that lives in many everyday gadgets that people use.

The consumer electronics market is full of AI today, from smart lights and security systems outside a home to smart appliances inside a home. There are familiar household appliances that use artificial intelligence such as the iRobot series of autonomous vacuum cleaners and mops that help with chores, smart refrigerators, smartphones and smart fitness watches, tablets, personal AI voice recognition assistants such as Amazon's Alexa or Google's Assistant, et cetera. On a more sophisticated level there are robots specialized for the consumer while others are specialized for the industry.[2]

How does AI work? It learns just as humans do, but instead of reading and writing it uses Big Data and Machine Learning (ML). Big Data is "the multiplication of the traces we leave of ourselves on digital media" (Schmitt, 2020).[3] Big tech aggregates this data to provide better web search results, shopping recommendations, video recommendations, or navigational route for driving, walking, biking, or public transit based on the browsing history. Data is fed into an AI with an input of a desired result, and the AI figures out an algorithm that is best suited to map the input to the results. According to IBM,

> Machine learning, deep learning, and neural networks are all sub-fields of artificial intelligence. However, deep learning is actually a sub-field of

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[2] For example, some robot dogs, such as Sony's Aibo (Aibo), are geared towards the household, whereas Boston Dynamics' Spot (Spot) is specialized for manufacturing and construction. The robotic laundry folding machine Foldimate (*Take the Work Out* 2019) can be used in a house or in a hotel. Preventive vehicle maintenance programs or self-driving algorithms, like Tesla's auto-park feature, is for personal use. TuSimple trucks' (Hou, 2021) automation programs are for shipping goods, and Robotaxis Cruise and Waymo (Hetzner, 2022) are for passengers. All the preceding automation hardware and software exist exclusively for the transportation industry. The fully robotic kitchen Moley (*The Future is Served*), was cooked up to promote a healthy diet and time optimization for busy families. Humanoid robots, Nadine of Singapore (Burns, 2016), Erica and Junko Chihira of Japan (Graham, 2018, Kelion, 2016), Jia of China (*Chinese humanoid robot,* 2017), Sophia of Hong Kong (*World's first AI robot citizen,* 2018), Ameca of the UK (Ameca 2022), are all designed for the hospitality industry. Automated drone tasks vary from taking pictures for cite surveys to delivering consumer packages (Palmer, 2020) to amusing the public with spectacular light shows. AI is everywhere!

[3] Such as internet search results, the contents of an online shopping cart, videos watched, sites visited, directions from a map application on a cell phone, etc.

> machine learning, and neural networks is a sub-filed of deep learning (*What is machine learning?,* 2020).

In simpler terms, ML works as follows: a multitude of photos of a specific animal teach AI to recognize the animal; the same can be done to recognize a face, a traffic light, a crosswalk, or any object or subject. Translation algorithms after 2016 are trained on neural networks where they translate the meaning of a sentence rather than individual words. More complex tasks, such as training AI to accomplish a drone flight may involve black box or reinforcement learning. In the process of black box ML, the operator inputs initial parameters, such as the location of a target vs a drone, and tells the software to figure out the flight path to the target. In black box ML, the machine knows the initial parameters and results but must figure out a way to get to the result. It is called a black box because the operator does not know what the machine is 'thinking' as to why it picks a specific altitude or turn to arrive at the target (Zhang et al., 2020). An everyday use of an adaptive algorithm is Google Maps, that provides the fastest or most fuel-efficient route from one location to another. The software uses satellites and the Global Positioning System (GPS) to integrate traffic accidents and route closures into navigation, as well as cell phone service to measure speeds of the cars on different routes to present the most optimal route suggestion. Reinforcement ML involves providing AI a feedback loop based on the correct result. There are many ML methods, but all of them involve feeding data to AI whether it is digital media, text, speech, etc. The main idea of ML is to evolve the NAI to the point where it is consistent, predictable, and reliable.

The Big Data can train AI algorithms for defense purposes such as rough terrain navigation in a denied environment, electromagnetic auto-jamming, surveillance, object recognition and avoidance, preventive vehicle or aircraft maintenance, live-feed data aggregation to minimize analysis time, synchronized drone flying, etc.

While the state budget supports the defense, the consumer budget supports the private industry. Large corporations aim to maximize revenues, while delivering affordable products to a consumer. Just how much revenue can smart electronics that use IoT and electronics that use AI generate that make corporate America so eager to conquer the AI market share ahead of China or other competitors?

AI in Market Values

An important aspect of AI implementation is its economic impact. Even during the ongoing COVID-19 pandemic, from January 7-10, 2022, the Consumer Electronics Show gathered 2,279 companies and over 44,000 attendees from 133 countries in Las Vegas, NV (*The Global Impact of CES,* 2022). The annual event showcases new consumer electronic products ranging from AI-controlled, smart, energy-efficient windows to flying vehicles.

The tech of "tomorrow" that utilizes AI in limited forms is a fruitful business considering the price of electronics today. Although a lot of smart electronics use IoT and not ML, an increasing trend in the usage of AI in the consumer market is evident.[4] The

[4] Samsung's "AI-powered robot vacuum" with Light Detection and Ranging (LiDAR) employs an object recognition camera trained on over a million objects, a voice assistant Bixby, and runs around $1,300 (*Bespoke Jet Bot AI+* 2021). A smart fridge with "AI image recognition technology, which automatically scans the products inside your fridge, identifies them, and sends you updates on items your family has added or depleted" is around $3,500 (*Samsung's Family Hub,* 2020). A wearable smart ring Aina is built "using behavioral AI…[it] learns how you go through your day and anticipates what you need next," with a price tag of around $300 (*Everything you want,* n.d.). A lot of smart devices such as fitness watches are connected to the IoT rather than employ many AI algorithms and run around $400-500. A smartphone may come with several AI features: unlocking the device via looking at it or AI facial recognition, speech-to-text function or AI that uses natural language processing, built-in voice assistant. All the contemporary features of single phone can add up to over $1,000 per device. A humanoid robot, with

Consumer Technology Association forecasts "the U.S. consumer technology industry is projected to generate over $505 billion in retail sales revenue for the first time ever" in 2022 with some of the following categories depicted in Figure 2 below (Fellinger, 2022).

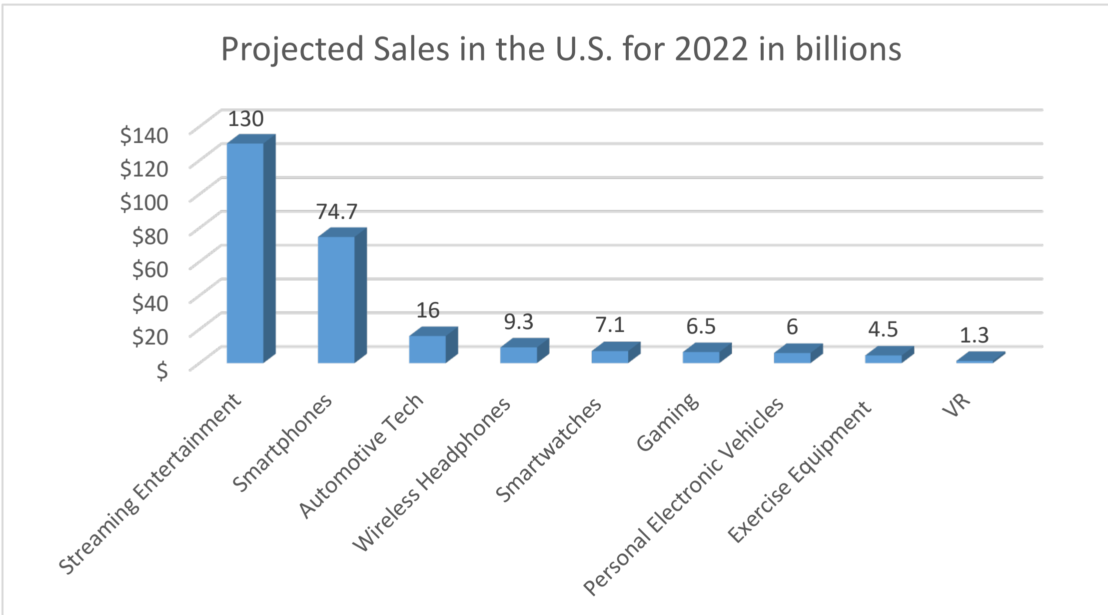

Figure 2. U.S. Consumer Electronics Market for 2022

Most of the categories utilize AI algorithms geared towards engaging a consumer, such as recommending similar videos for streaming, various smartphone and smartwatch applications, gaming, and virtual reality (VR). Numbering is in billions of dollars: Streaming Entertainment services - $130b, Smartphones - $74.7b, Automotive tech - $16b, Wireless Headphones - $9.3b, Smartwatches - $7.1b, Gaming - $6.5b, Personal Electronic Vehicles - $6b, Exercise Equipment - $4.5b, VR - $1.3b (Fellinger, 2022).

imbedded AI speech recognition and natural language processing, if it was for sale, is estimated at $200,000.

A lot of current consumer electronics simply use IoT, but newer electronics incorporate AI.[5] The global smartphone market with AI software is expected to reach $795 billion by 2027 (*Global Smartphone Market,* 2021). The global military drone spending (some high-end drones have embedded AI software) will equate to $32.14 billion by 2025 (*Military drones global market,* 2021) with a higher estimate for the end of the decade: "$96 billion will be spent on military drones between 2019 and 2029" (Frantzman, 2021). The PwC estimates a "$15.7 tr Potential contribution to the global economy by 2030 from AI", Figure 3 (Rao & Verweij, 2017).

[5] The global smart watch market that is mainly based on the IoT, is expected to bring in $165.14 billion by 2027 (*Global Smart watch Market,* 2022). The civilian IoT drone market is estimated to reach $5.4 billion by 2027 (*Drones Market Size,* 2021).

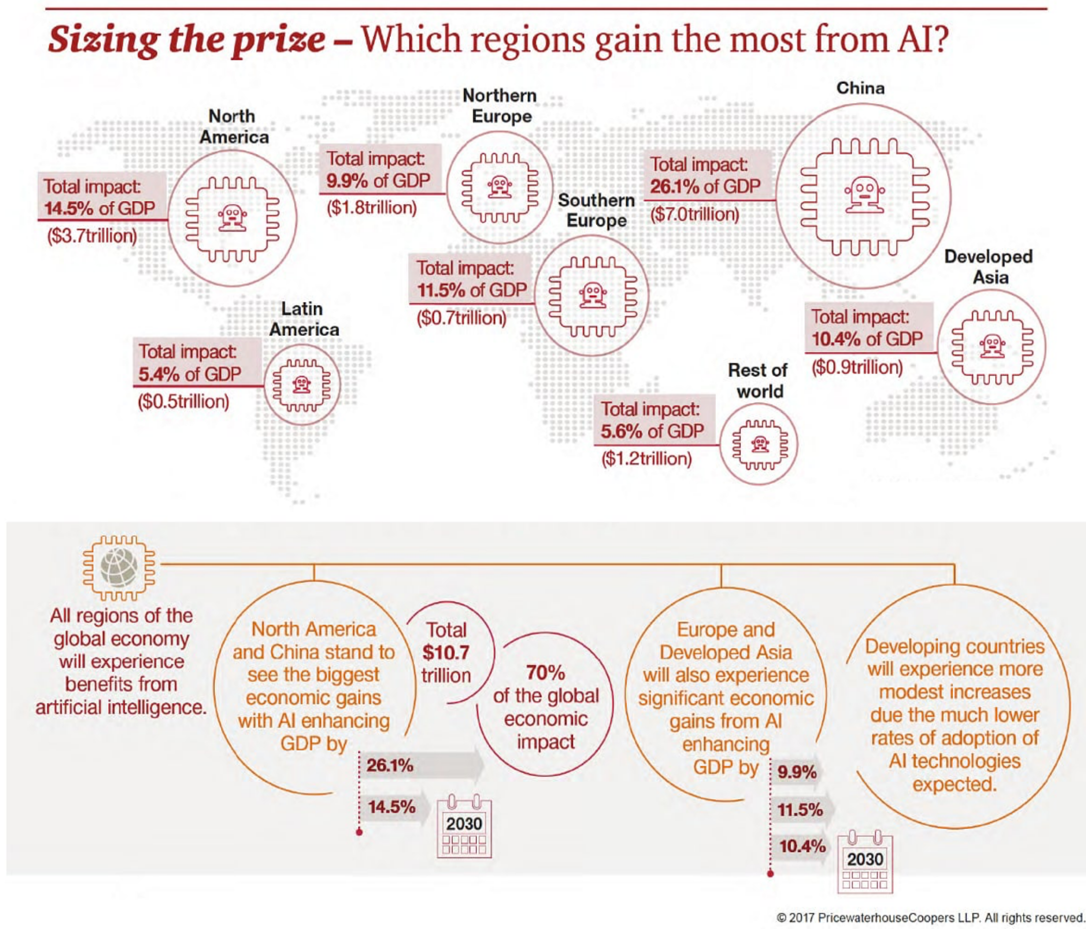

Figure 3. World Economic Benefits from AI

This Figure signifies GDP amplification by the addition of the AI sector in each country's respective economy. It is of no surprise that China and North America will be the biggest beneficiaries, thus further fueling the race to become the first AI superpower (Rao & Verweij, 2017).

In national defense revenue terms, military spending on autonomous systems for the land, sea, air, space, and cyberspace domains replace the consumer electronics market. While the civilian population buys cellphone technology, nation-states buy military technology from the top, economically feasible suppliers on the global market. Thus, the emerging AI industry is a multi-billion-dollar prize of the country that is able to dominate this field in the near future. Aside from the economic advantage, AI is the driving force behind future national defense strategies.

States, New Technology, and Military Strategy

Unilateral military strategy exists in a state with a central authority, such as a government agency, leader, or military commander. The U.S. military strategy aims to maintain its status quo as a constitutional federal republic and promotes democracy worldwide. To maintain its status quo on the international stage, the U.S. military strategy must ensure that an autocracy or dictatorship does not consume the democratic way of life. As a part of this strategy, the U.S. was in favor of the Sino-Soviet split in 1969 and acknowledged formal relations with China during Nixon's years in the 1970s, followed by economic incentives to China for decades after.

China did not become less autocratic and more democratic through the openness of the international market economy as the U.S. had hoped. Instead, the economic leverage China held for generations with the U.S. providing lower trade barriers for China's exports, fueled China's economy, and the Chinese Communist Party. Today, the U.S. must change its military strategy to offset a wealthy, technologically savvy strategic competitor with ideological values of autocracy and an ambition for expansion.

New technologies integrate into the concept of state survival by exerting technological advantages and power projection in anarchical state of the multi-polar world arrangement. A crude analogy is Darwin's theory of survival of the fittest. The U.S. is recognizing new tech, such as AI, as an emerging security dilemma and implementing domestic and foreign policies to propel its technological dexterity and counter a growing China. In essence, this tech race contrasts the arms race in terms of government versus private funding, and supply-demand audience. The only customers for the Space Race were competing governments, whereas AI tech is widely applicable to all world governments and private sectors. The existing literature is broad and does not explain how current and not too distant future specific NAI applications would provide State A an advantage over State B in state survival and the possibility of expansion.[6] What is missing is a link between AI tech and the U.S. policymaking that aims to counter-balance China.[7]

Artificial Intelligence is the strategic military technology of the next generation, just as important as the satellites were in the last generation and still are today. The U.S. has a long-standing history of unsurpassed technological talent dating back throughout most of the 20th century, effectively since the invention and testing of the first atom bomb in 1945. It was outpaced only once by the Soviet Union during the Space Race in the 1950s and early 1960s when the U.S.S.R. launched *Sputnik* satellite. An adversary's strategic advantage of satellite technology meant an imminent threat to the national security and continued way of life for the American people (i.e., if a satellite could be sent into space, then a missile capable of reaching the U.S. mainland could be sent into

[6] The current literature spans over government and private sectors, without detailed analysis of how AI fits into the governmental bureaucracy layers, DoD budgets, and in-depth study of a specific NAI UAV military applications for the U.S.'s and China's national or military strategies.

[7] The current literature has given attention to a rising China (*United States Strategic Approach,* 2020, Tellis, Szalwinski, Wills, & Grare, 2020, Roy, 2013, Jalil, 2019), global economic challenges (Dollar, Huang, & Yao, 2020), uncertainty in Asia (Mohandas, 2019, Babcock-Lumish, Chacho, Fox, & Griffiths, 2020), China's military expansion (Cordesman, 2019, Roy, 2013, Gao, 2018), and the implications of future AI advancements in the defense sector (Frantzman, 2021, Johnson, 2019, Johnson, *Artificial Intelligence & Future warfare,* 2019, Gill, 2019). China's rise is mainly portrayed from a national security perspective. The CCP's strive to become a technological hegemon is a point of contention for U.S. decisionmakers due to a potential displacement of the U.S. influence in the Pacific Theater.

space). That propelled the U.S. government to take the lead in the Space Race and became the country with the most advanced national defense technology.

Space technology revolutionized warfare.[8] The impact GPS brought to the battlefield shows in all domains of warfare – land, air, and sea. In air warfare, one bright example is the GPS enabled smart warheads instead of dumb bombs.[9] Likewise, AI has the potential to collect the information from satellites in near-real time and provide courses of action to the decision maker or control the strike-drone to the target autonomously. The speed at which warfare can be conducted is now amplified, and that is why the U.S. is apprehensive of other actors building a militarized AI first.

Artificial Intelligence carries a lot of weight in the strategic and tactical employment of military assets. AI will impact all battlespace domains – land, sea, air, space, and cyberspace – but its most illustrious imprint can already be seen in the air domain with the current drone advancements between the U.S. and China (Johnson, 2019). Both nations are capable of equipping their militaries with a mini-drone fleet or a drone that acts as an Advanced Battle Management System (ABMS) (Frantzman, 2021, *Air Force Research Laboratory*, n.d.). A flying drone capable of near real-time data analysis, instantaneous autonomous decision making, and tasking attack assets such as strike drones or hypersonic weapons presents a first-strike advantage. It is the ultimate game changer for controlling the battlespace and a gateway to multidomain operations or

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[8] One bright example is the use of satellites and GPS navigation. Aside from the obvious advantage of GPS navigation and knowing troop, vessel, or airplane locations precisely, even in a denied environment, satellites brought pictures of the battlefield to the table of military strategists. Now, the adversary's moves can be observed like a petri dish, maybe not in real-time, but throughout the week to give a more accurate representation of the ground.

[9] The difference was an array of bombs dropped on a terrorist compound vs a smart bomb with a GPS-enabled seeker head, that can guide itself to a terrorist's bunker and hit a precise target location.

mosaic warfare (Ionita, 2022). The country with the utmost control of this technology will inevitably shift tactical advantage in their favor and create asymmetric superiority in direct conflict and diplomatic negotiations (Johnson, 2021).

To understand how AI will shift the balance of the geopolitical scale in favor of the nations that will implement AI in national security, it’s important to understand the current stance of technology in terms of globalization, defense, and the current world order.

Chapter III.

Globalization, Security, and Multipolarity

How is AI different from the Space Race? What kind of actor is the U.S. facing in terms of military power, economic strategy, and state strategy? This chapter expands on Chapter II and describes the Artificial Intelligence tech race in terms of International Relations rather than the public scope.

Technological Competition and Globalization

The term Globalization[10] has gained widespread use in the last few decades, indicating integration of worldwide societies via communication, and entangled economies and banking systems, enabled by space technology, satellites, the invention of IoE and IoT, and the ability to instantaneously share information from one part of the globe to the other. On par with this new technology, the era of cybercrime has emerged, adding a new layer of threat to the security of nations. The security of nations in an anarchical world depends on the country's defenses and alliances. Alliances of small countries, such as the European nations, add up to a substantial power and balance out one big actor, shifting unipolarity to bipolarity. Since the security of the nations is tied to advancements in defense technology, and advancements of technology are tied to the computers, electronics, and data storage and are prone to cyberattacks, it is important to

[10] Globalization is defined as "the increasing worldwide integration of economic, cultural, political, religious, and social systems" (Black, Hashimzade, & Myles, 2013).

understand how Artificial Intelligence fits into the technological competition in the era of globalization and multipolar[11] state arrangement.

The enduring Artificial Intelligence competition is quite different from the former Space Race where the rival countries did not engage in extensive economic trade, student exchange programs, work visas, etc. The Soviet Union was sealed off behind the Iron Curtain, for the most part, and dictated its own economy and pricing. Today, the economies of most countries are intertwined, and any military escalation or outright conflict will bear negative consequences for all nations involved. For example, the U.S.-China Trade War resulted in higher consumer prices, bankruptcies, job losses, and stock market instability. From an eagle-eye view, it may be irrelevant to the general population but, in fact, globalization effects everyone.[12]

The AI tech race with China is not a race between exclusive military or space technologies. The previous Space Race took place before globalization, the invention of the Internet, and the collection of data in digitized form that can be hacked. Today, Artificial Intelligence is embedded in a multitude of civilian sectors, so it is not a restrictive competition between the governments aimed at military or space superiority. In today's globalized society, the U.S. and China have a significant imprint of global investments, trade, and exchange of intellectual information. Private venture capital in the

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[11] Multipolarity is defined as "an international system characterized by four or more major centers of power and influence" (Brown, McLean, & McMillan, 2018).

[12] Because most U.S. jobs do not have guaranteed pension plans and instead have market driven 401K plans, every person putting money away for a retirement is invested in and at the mercy of a stock market. If the market goes up at the right time, one can retire a millionaire. Conversely, if the stock market goes down, people may be forced to work longer and not retire or lose a huge portion of their retirement savings. Those people would be struggling to make ends meet with rising inflation. Thus, it is important for everyone to have a basic understanding of how a conflict or a competition between nations bears international effects.

U.S. predominantly carries the burden of competition, however combined private and government funding share the load in China. The addition of AI to the global markets is a multi-trillion-dollar industry that added $2 trillion to the Global GDP in 2018 with an estimated $15.7 trillion in global GDP revenue by the end of this decade (Holmes, 2019). Thus, it is of no surprise that each country aspires to be the lead in AI research, implementation, and production. The research in AI extends the capabilities of the applications that can be embedded into consumer electronics and made into products. The research is necessary for the implementation of technology into a usable product. Each country must invest into R&D to forge a usable product for the consumer to become a supplier of AI-enabled tech on the global market, subsequently collecting profits off this emerging industry. The AI market is critical not only for raising the GDP of a country, but also for its potential to augment the defense sector.

Technological Competitions and National Strategies

Nascent AI tech in military applications bears a resemblance to the incipient satellite. The launch of Sputnik by the U.S.S.R. in 1957 was seen as a thrust of warfare into a new domain – space; it threatened the U.S. national security and the security of every nation unable to keep up with this technology. The U.S.S.R. now had the basic requirements met to field and deploy untouchable surveillance assets around the globe. It also gave them a sizable developmental leap towards fielding intercontinental ballistic missiles (ICBMs) that could harness the space domain for a quick strike capability anywhere on the planet.

Shortly after losing the race to be the first in space, the U.S. shifted its deterrence strategy and technological focus to surpass the U.S.S.R. in space technology. From the first moon landing in 1969, to the successful hybridization of the private sector technology to fulfill military need, to continuously exploring Mars since the late 1990s, the U.S. has found itself ahead of its strategic competitors. Influence and recognition on the global arena are the prizes for the nation that wins the technological advancement competition.[13] As for the U.S.S.R., it found itself on the losing side of the Space Race, and suffered a crippling economic collapse, along with the demise of the union.

Space technology revolutionized military strategies by bringing the defense industry exact GPS positioning, the ability to pinpoint a hostile target, and the ability to wirelessly control a drone. Previously, wars were fought predominantly on the ground and with manned aerial combat, WWI, WWII, the Korean War, and the Vietnam War, were all traditional wars with heavy casualties and with captured American aviators serving as POWs. After the Space Race, satellite arrays, and GPS, armed conflicts shifted to less ground and more into the air domain, where the unmanned drones are remotely piloted by ground teams away from the hostile territory. The ability to fly a drone via satellite uplink for days and weeks to observe the situation on the ground and then remotely fire missiles at the target was revolutionary. UAVs were first used in Operation Desert Storm. They played a greater role in the Global War on Terror, the capture of Osama bin Laden, Operation Iraqi Freedom, and Operation Enduring Freedom, to name a few.

[13] An iconic phrase by Neil Armstrong during the Space Race as he successfully accomplished moon landing in 1969: "That's one small step for a man, one giant leap for mankind," is recognized over half a century later as America's greatest achievement in space exploration. The Space exploration brought many advancements to the public sector and the world at large: LEDs, laptops, satellite imagery, medical imagery, continuous video streaming services, location tracking for startup businesses of ride shares, grocery deliveries, and more.

Today, armed conflicts are shifting into the new expanse. In the same way that the U.S.S.R. was the first to successfully exploit the space domain, both the U.S. and China seek to be the first to operationally employ AI combat systems and dominate in AI technologies (Kania, 2019). Considering missile and air defenses, AI has the potential to change the way hostile objects could be detected, tracked, and engaged from a technological perspective down to the military's command, control, and communication (C3) structure. AI can also greatly reduce human risk in combat, assuming combat roles that traditionally required "boots on the ground." AI is a gateway to control the battlespace and the outcome of a military conflict between the nations. A country able to use AI and UAVs in tandem is able to provide decision makers the automated target identification and troop movement analysis in near-real time, without having to spend hours or days analyzing satellite imagery constrained by narrow satellite viewing windows.

The implications of China's AI superiority in the military domain and its implementation in PLAAF will result in the erosion of U.S. security in the greater Pacific area and the international community, thus weakening the global stability. The significance of China's AI superiority in the private sector will provide the CCP a net influx to China's annual GDP, leaving the U.S. economy at a slower growth rate. The economic advantage would, in turn, provide China with a perpetual loop of economic gains fueling the CCP government to allocating funds for AI research at universities to subsidizing the private sector research on AI that the CCP can use in the future.

AI in Context of Rising China

While the U.S. and the U.S.S.R. were competing in the Space Race due to potentially offensive technologies, Intercontinental Ballistic Missiles (ICMBs), AI can fill both offensive and defensive role. Will China use it as a defensive, offensive, or a combination of both technologies? To answer this question, an analysis of previous geopolitical moves by China needs to be conducted to trace which direction China's policies are leaning.

China in the World, a Rising Hegemon

The rise of the Chinese Communist Party is evident by its development of international relations with other nations based on shared interests.[14] The CCP's quest has been to expand to power projection, influence, and technological supremacy.[15] The People's Republic of China's (PRC) pursuit of military power lies in its search for modern technology. A new groundbreaking leap in AI can propel any nation's military

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[14] The CCP used liberal institutions – BRICS (Brazil, Russia, India, China, and South Africa) to mimic the Western equivalent of the World Bank and International Monetary Fund (IMF) to become the dominant player in Asia (Renard, 2010). It is a member of the World Trade Organization (WTO) with a most favored nation status and lowered trade barriers to benefit its economy (Blanchard, 2013). China has veto power in the United Nations (UN) security council, which ensures other nations cannot meddle in the CCP's internal affairs and investigate human rights violations (Kim, 2015). China is expanding the idea of globalization by building economic trade and increasing foreign direct investment (FDI) with Europe, a $7.3 billion average annual investment (Hanemann & Kratz, 2021, Speranza, 2020). In 2021, China was Europe's number one importer with €472 billion (*Significant increase in EU imports,* 2022). It is expanding its influence with the ongoing Silk Road Initiative project (Chatzky & McBride, 2020). Alarming still, it is also projecting soft power in Hollywood to influence the American culture and American perspective on China (Shi, 2013, Wong, 2016).

[15] China's self-declaration as a Near-Arctic State (Guo & Wilson, 2020), space plans (Goswami, 2021), and expansion and militarization of the South China Sea (Babcock-Lumish, Chacho, Fox, & Griffiths, 2020, Roy, 2013, Gao, 2018), evidence its appetite for power as viewed from a realism perspective. The U.S. House of Representatives views Hong Kong's new national security law (Wong & Khan, 2020, Hernández, 2020) as China's "part and parcel of a broader hegemonic vision that would see the Government of the People's Republic of China impose its will upon all free people of Asia and beyond" (Gallagher, 2020).

power, resulting in a new security dilemma. China's quest for AI superiority by 2030 (Roberts et al., 2020) fits into its pursuit for global expansion and hegemony posing as a threat to the U.S. and stability of the global order. The addition of AI technology to a few already fully militarized islands in South China Sea will undermine the stability of the Pacific theater and the neighboring U.S. allies – South Korea, Japan, Philippines, Australia, and New Zealand. The militarization of AI tech to multi-domains such as air, naval, land, space, and cyberspace will undermine the security of all the nations that do not develop defensive AI capabilities. Cyberattacks on the U.S. will rise exponentially from the present level, further endangering U.S. intellectual property. China's quest for global AI superiority goes beyond its quest to reassert dominance over Taiwan, which CCP views as a rogue Chinese province. It also includes reestablishing control over Hong Kong and its major ports; venturing to the Arctic; rejecting the International Court ruling over a dispute with Philippines (Phillips, 2016); and increasing political, economic, and military ties with the Middle East.[16]

China in the World, Enlarging Military Power

The latest destabilizing elements in China's military doctrine are the hypersonic guided and glide vehicles (HGVs) and militarization of South China Sea.[17] Potential augmentation of HGVs with AI means the creation of a "smart" weapon that is able to change direction or switch targets in flight, compared to a "dumb" ballistic missile that once fired, follows a predictable trajectory. The U.S. Missile Defense Agency utilizes

[16] The latter example is evidenced by joint military exercises and China's rising stance in arms sales to the Middle East (Lons, Fulton, Sun, & Al-Tamimi, 2019).

[17] Hypersonic missiles can travel anywhere between Mach 5-20 and are highly maneuverable.

land, sea, and space-based systems to detect and eliminate incoming threats, with the future addition of UAVs, Figure 4, Appendix 2.[18]

In March 2022, Admiral John C Aquilino, the U.S. Indo-Pacific commander, noted that China has countered its previous rhetoric. Beijing has continuously reassured the West that artificial islands in South China Sea would not be militarized, but according to an AP news interview held with Admiral Aquilino, what China says is not what China does:

> China has fully militarized at least three of several islands it built in the disputed South China Sea, arming them with anti-ship and anti-aircraft missile systems, laser and jamming equipment, and fighter jets in an increasingly aggressive move that threatens all nations operating nearby (Gomez & Favila, 2022).

On par with technological weapons development, China is augmenting its research budget with increased weapon sales to the Middle East. While Pakistan, Bangladesh, and Algeria were traditional buyers, China is expanding its sales market to wealthy gulf states such as Qatar, Saudi Arabia, and the United Arab Emirates (UAE), including contracts to develop attack UAVs. While the U.S. and Europe have been traditional suppliers of defense systems to Saudi Arabia and the UAE, China's entry into the market may be slowly displacing the U.S. with its cheaper copies of the U.S. drones. As the *Diplomat* notes, "Between 2016 and 2020, China increased its volume of arms transfers to these two countries by 386 percent and 169 percent, respectively" (Ningthoujam, 2021).

[18] However, the land-based radars are ineffective in HGV trajectory until the later stage of flight (Sayler & Woolf, 2021). America's Aegis Combat System naval-based missile defense system and Terminal High Altitude Area Defense (THAAD) land-based system (*Elements*) are designed for ballistic missiles, not hypersonic weapons, thus leaving a gap in the U.S.'s defenses. This gap further amplifies the security dilemma the U.S. is facing with China's continued HGV testing. The 11th Vice Chairman of the Joint Chiefs of Staff, U.S. Air Force General John E. Hyten, said that China's long-range hypersonic missile test conducted in the summer of 2021 "went around the world, dropped off a hypersonic glide vehicle that glided all the way back to China, that impacted a target in China" and that it "looked like a first use weapon" (Duster, 2021).

China in Tech Expansion, a Global Strategic Competitor

China's desires to become the new cutting-edge technological hegemon is evidenced by its progression in many areas including establishing economic zones, routes for future AI and other tech exports, and moving population into cities with direct access to education and consumer sectors. Cities serve as a test bed for gathering large amount of data to feed into the AI data training sets. Big megapolis and megalopolis projects employ a myriad of AI face-recognition street cameras that follow the population from the street into buildings to collect data on daily routes and shopping habits. China's domestic megaprojects include all the sectors in which AI can be implemented, such as transportation, manufacturing, energy, and engineering, already have constructive strategies for expansion into the international market.[19] Economic development zones in China shifted the rural population towards urbanization from 57% living in cities in 2017 to 61% in 2020 (Urban - China 2018).[20] [21] As more and more people move into the cities, economic and social engineering data grows tremendously. More social networks and education opportunities are presented to a younger population, allowing for a larger skilled labor force in the fields of tech, computer science, and AI. Larger data sets are available with a larger population, feeding Big Data for AI training ML algorithms with the use of apps. WeChat, Tenet, Baidou, Alibaba, and other companies, the Chinese

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[19] For instance, the Jing-Jin-Ji Megalopolis project entails integrated communication and transportation systems, taking the infrastructure concept of Beijing, Tianjin, and Hebei to the size of a state.

[20] For example, China resettled 700,000 Tibetan nomads to urban environment by 2005 (Bauer, 2015).

[21] This urbanization is going to "contribute to the growth of YRD [Yangtze River Delta] as a mega-regional economy and simultaneously enhance Shanghai's status at a multi-scalar financial network" (Li & Wang, 2019).

equivalents of the U.S. companies Amazon, Google, Uber, etc., collect Big Data for AI algorithm training in China.[22]

In parallel, China is seeking out international partners. China's Belt and Road Initiative or the Modern Silk Route, proposed in 2013, is a trading route encompassing 139 countries, as shown in Figure 5, Appendix 3 (Sacks, 2021).[23] This trade route enables China's sales of UAVs that are U.S. equivalent of an MQ-X Predator. The trade route exemplifies how China is planning to export its high-tech emerging market globally but also rings alarms of possible political influence by using this project as a soft power approach to influence decisions of states through the lever of political economy. Expanding urbanization and economic zones globally goes hand in hand with expanding the tech production.[24] China uses soft power to extend its influence with other allies, for example, the China-Pakistan Economic Corridor (CPEC) projected for 2030.[25] Since India and Pakistan are non-friendly nuclear neighbors, it is plausible to query whether China-Pakistan economic alliance will lead to a further shift in the balance of power against the U.S. and NATO alliance and influence U.S. Indo-Pacific strategy.

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[22] The 7.6 zettabytes –7.6 trillion gigabytes—of data collected in China in 2018 surpassed the U.S. by 0.7 zettabytes in the same year and is only forecasted to increase with an estimate of 48.6ZB by 2025 in China (Choundhury, 2019).

[23] "China's footprint in the entire Middle East has been widening rapidly ever since the announcement of its Belt and Road Initiative (BRI) in 2013. Since then, it has become the largest trading partner and foreign investor for several countries in the region (Ningthoujam, 2021)."

[24] The expansion of AI tech is dependent on the workforce, which causes the need to educate the workforce in AI, gather more data via surveillance of the population, and provide government reforms to make AI a national priority for the warfare of the future.

[25] "With the investment of 46 billion U.S. dollars… [that] has great geostrategic importance to Pakistan to counterbalance Indian influence in South Asia" (Ibrar, Mi, Rafiq, & Ali, 2019).

China's View on Warfare

What is China's view regarding the future of the battlefield given it has not fought a major war since the Korean War in the 1950s? After the Gulf War and the use of UAVs by the U.S. and allied forces in the 1990s, China has recognized the evolution of warfare from the military domain to all domains. In the book *Unrestricted Warfare*, published at the turn of the millennium, two colonels of the People's Liberation Army (PLA), Qiao Liang and Wang Xiangsui, describe the means of expanding the military strategy to the non-military means to achieve a victory over an adversary:

> We can point out a number of other means and methods used to fight a non-military war, some of which exist and some of which may exist in the future. Such means and methods include psychological warfare (spreading rumors to intimidate the enemy and break down his will); smuggling warfare (throwing markets into confusion and attacking economic order); media warfare (manipulating what people see and hear in order to lead public opinion along); drug warfare (obtaining sudden and huge illicit profits by spreading disaster in other countries);
>
> Network warfare (venturing out in secret and concealing one's identity in a type of warfare that is virtually impossible to guard against); technological warfare (creating monopolies by setting standards independently); fabrication warfare (presenting a counterfeit appearance of real strength before the eyes of the enemy); resources warfare (grabbing riches by plundering stores of resources);
>
> Economic aid warfare (bestowing favor in the open and contriving to control matters in secret); cultural warfare (leading cultural trends along in order to assimilate those with different views); and international law warfare (seizing the earliest opportunity to set up regulations), etc. (Liang & Xiangsui, 2021, p. 55-56).

China is already using some of the methods to achieve its objectives. They include media warfare, cultural warfare to influence public opinion into viewing China favorably, and network warfare to infiltrate U.S. universities and embassies under false identities as will be described further.

The U.S. is facing a strategic competitor with an established doctrine, geopolitical and international ambitions for widening its territory and presence in the global economy. The challenge between China and the U.S. is not only competing for market and military advantage, but also competing ideologies for building NAI. The structure of the U.S.'s and China's governments approach the AI tech race at slightly different angles with the same end goal in mind – become the winner of this new tech, set international standards, proliferate it throughout the global market, and build next generation military technologies that can shift the balance of power and military strategies.

Chapter IV.

AI on the Battlefield – Revolutionary or Evolutionary?

Does Artificial Intelligence technology create a revolutionary breakthrough in aerial warfare or is it merely another incremental advance in military science? This chapter will analyze the promise of AI for military aviation[26] and the revolutionary impacts it may have in the future.

Current Methods and Platforms of Air Warfare

As discussed previously, space technology thrusted a leap in military aircraft employment with advancements of GPS, revolutionizing positioning, navigation, timing, and coordination – the availability of navigation and communication over a globe with a computer and a cellphone made decision making faster. Availability of an AI will shift communication and decision-making to a near-instantaneous speed across the globe, making NAI UAVs an invaluable asset for an on-demand rapid deployment asset.

Several nation-states possess a contemporary arsenal of air warfighting capabilities. The 2020 China Military Power Report to the U.S. congress estimated that PLAAF possesses around 2,000 combat airframes, 2,500 in total (*Military and Security Developments,* 2020, Office of the Secretary of Defense). Due to the apparent parity between the USAF and PLAAF, this section examines U.S. airframes, but the same logic

[26] Due to the sheer complexity and volume of the manned and unmanned platforms in the U.S. and China, this section only examines a few specific projects to introduce comparison and contrast of the USAF-PLAAF designed UAVs.

can be applied to China's airframes. In a case of an armed conflict, the following manned fixed-wing platforms (the list is not exhaustive) may be utilized by the USAF:

Table 1. USAF Fixed Wing Asset Categories.

<table>
<tr><th>Function</th><th>Base Platform</th><th>Limitations</th></tr>
<tr><td>Combat Search and Rescue (CSAR)</td><td>HC-130</td><td rowspan="8">Flying duration
Fatigue
Discomfort
Air sickness
Medical/Physiological factors
Overfilled bathrooms
Manning requirements

Logistics:
Aircrew and maintenance
air transport,
lodging,
ground transportation,
provisions,
rest time</td></tr>
<tr><td>Transport/Airlift</td><td>C-17, C-5</td></tr>
<tr><td>Air Refuel</td><td>KC-135, KC-46</td></tr>
<tr><td>Intelligence, Surveillance, Reconnaissance (ISR)</td><td>RC-135 and variants, U-2</td></tr>
<tr><td>Electronic Warfare (EW)</td><td>EC-130</td></tr>
<tr><td>Combat Attack</td><td>F-15, F-22, F-35, B-1, B-2, B-52</td></tr>
<tr><td>Special Operations (SPECOPS)</td><td>AC-130, MC-12, U-28, C-145/146, MC-130</td></tr>
<tr><td>Airborne Command Center (AWACS, JSTARS, NAOC)</td><td>E-3, E-8, E-4</td></tr>
</table>

The warfighting domain can utilize a package of different combinations of the above platforms to accomplish the mission. For a full list of aircraft and designation to active, reserve, or guard component, see 2021 USAF & USSF Almanac: Equipment.

Aside from the cost of operation and fuel limitations, manned aircraft are limited to a greater extent than unmanned aircraft.[27] RPAs or UAVs still use operators on the ground, but it is less constrained than a manned platform. A fully autonomous NAI UAV would only be dependent on the maintenance personnel, operational cost, and amount of fuel.

Is it possible to transform some of the abovementioned air warfare capable manned aircraft to fully autonomous NAI UAVs? What benefit would that bring to the air warfighting domain? Using content tracing, or thorough examination of current manned platforms and functions they perform, it is possible to analyze which of them can be fitted with NAI for partial autonomy.

U.S. UAVs

The U.S. has used RPAs or UAVs, in armed conflicts extensively since the 1990s. Along with the rising popularity of the unmanned drones on the battlefield, the popularity of recreational drones increased, with many of them coming from overseas, presenting a mistrust by the U.S. government to the drones of foreign nations. The 116th United States Congress tightened the screws around foreign drone usage by the federal service:

> The bill bans the procurement or use by the federal government of commercial off-the-shelf drones or other unmanned aircraft systems manufactured or assembled by certain entities, including entities subject to influence or control by China (*American Security Drone Act*, 2019, U.S. Senate).

[27] Manned aircraft is more constricted in flying duration due to fatigue, discomfort, air sickness, and overfilled bathrooms. The manning requirements for aircrew and ground maintenance come with an array of logistics liabilities – the need for an airlift aircraft to transport personnel and maintenance equipment, human need for lodging, transportation, provisions, rest time.

The Federal Aviation Administration (FAA) reports 855,860 registered drones in the U.S (*Drones by the Numbers* 2022). However, there is no number for unregistered drones, and they are frequently involved in military airspace violations (Alvarez, 2021). There is no telling whether a drone flying over military airspace is recreational curiosity or spy activity. The FAA numbers indicated above illustrate the sheer variety of small sized drones used in the U.S. The DoD possesses a variety of drones from small miniature versions to full-scale attack drones.

The U.S. military has many current UAVs, and more are being designed. The RQ-11B Raven is a low-altitude Intelligence Surveillance and Reconnaissance (ISR) asset primarily used in the Air Force by the Security Forces. It has been deployed since 2004 and has "proven itself in combat supporting U.S. operations in Iraq and Afghanistan" with a price tag of $260,000 (*Raven B, RQ-11B Raven,* 2017, USAF). The Wasp III is a low-altitude UAV primarily used by Air Force Special Operations Command (AFSOC) that can maneuver in closed terrain and provide encrypted video to the operator.[28] Puma is a slightly larger low to medium altitude UAV able to carry more payload and has an extended loitering time of 2.5 hours compared to around 1-1.5 hours of its smaller counterparts.[29] The MQ-1B Predator was a multirole medium altitude UAV asset initially acquired by the USAF in 1995 and retired in 2018 (Knee, 2019). It gained its fame after the 9/11 attacks during Operations Enduring Freedom, 2001-2014, and Iraqi Freedom, 2003-2011, with its varied mission from ISR to combat to search and rescue. Cost per

[28] It was delivered to the Air Force in 2007 with a current price tag of about $68,000 (*WASP AE, Wasp III, USAF*).

[29] Primarily used by the Security Forces, the USAF purchased a package of Puma 3 and Ravens for $15.9 million from AeroVironment in July 2021 (*Puma 3 AE*, *AeroVironment to deliver* 2021, *AeroVironment Receives* 2021).

unit amounted to $20 million, or $26 million in 2022 dollars (*MQ-1B Predator,* 2015, USAF).

In 2016, the USAF retired the Predator in favor of its successor, the much-improved MQ-9 Reaper. The Reaper has increased size, speed, range, sensor capability, and firepower. Reaper was deployed in 2007, albeit with a steeper price tag of $56.5 million per unit or $70 million in 2022 dollars (*MQ-9 Reaper,* 2021, USAF). A high altitude ISR asset first deployed by the USAF in 2001 is the RQ-4 Global Hawk. It provides an overview of the battlespace below to the decision makers at a price of around $104-$222 million per UAV depending on configuration and outfitting (*RQ-4 Global Hawk* 2014, USAF, *Global Hawk Unmanned,* Missile Defense Advocacy*, An Air Force Drone,* MSN News). The RQ-170 is a $6 million stealth ISR platform acknowledged by the USAF during Operation Enduring Freedom in 2009, further details are unavailable as the program is classified (Tyree, 2021).

The latest UAV upgrades include software and hardware packages. For example, there is some speculation in the media about replacement of the RQ-4 Global Hawk platform to a "the jet-powered, batwing RQ-180 – in essence a weaponless, pilotless stealth" aircraft (Axe, 2021). The M2DO upgrade for MQ-9 is aimed at shifting the platform to Multidomain Operations (Tirpak, 2021). Along with that, the Skyborg UAV is being researched that is going to use

> Complex algorithms and cutting-edge sensors [to] enable the autonomy to make decisions based on established rules of engagement set by manned teammates… Autonomous systems can significantly increase capability and be a force multiplier for the U.S. Air Force. By emphasizing future scalability through a portable, modular, and adaptable autonomy system, Skyborg represents a transformational way for the U.S. to prepare for potential engagements with near peer adversaries (*Air Force Research Laboratory*).

In short, the utilization, research, and development of many kinds of drones rose drastically after the Gulf War, with the next generation of drones implementing more and more autonomous artificial intelligence functions.

Chinese UAVs

In November 2019, former Secretary of Defense Mark T. Esper addressed the National Security Commission on Artificial Intelligence. He noted that

> The Chinese government is already exporting some of the most advanced military aerial drones to the Middle East, as it prepares to export its next generation stealth UAVs when those come online. In addition, Chinese weapons manufacturers are selling drones advertised as capable of full autonomy, including the ability to conduct lethal targeted strikes (Esper & McFarland, 2019).

China's UAVs vary in shape and size as much as the U.S. drones do. The smallest category of note is swarm drones. The synchronized autonomous flight of 1,108 drones in 2017 in Guangzhou and 3,000 drones in Shanghai in 2021 illustrated the potential of autonomous system flight (Hambling, 2021).[30] The storage for releasing these drones is known as the swarm launcher. It is capable of releasing up to 40 drones simultaneously. Pre-programmed for autonomous flight with collision avoidance and altitude separation, these drones can reach a target zone independently once programmed (Hambling, 2020).

The Golden Eagle made its way onto the international stage during the 2017 and 2018 China International Aviation and Aerospace Exhibition in Zhuhai (Kay, 2020). It is a reconnaissance-attack-cargo UAV that can be equipped interchangeably with 8 missiles or a cargo payload and can be used as an assault or delivery of supplies vehicle. The

[30] The tiny drone bots have a potential of buzzing to the warzone and acting like a thousand mercenaries, however, they would have to be released in close proximity to the target due to limited flight time (Romaniuk & Burgers, 2018). Each drone is $1,500 (Lin & Singer, 2018).

Rainbow series or Cailhong (CH) UAVs started emerging in China from the early 2000s. The series have many variants to date, with a lot of them representing a clone of U.S. UAVs. The first variant, CH-1, is thought to have been copied off USAF UAVs lost in the Vietnam war, specifically, the Firebee High Performance Aerial Target System of the 1950s (Dolan, n.d.). Each of the following variants in the series, the CH-2, CH-3, CH-4, CH-5, have been augmented and improved with engine upgrades, higher cruise speed, and longer loitering time. The CH-4 is China's clone of the U.S. MQ-9 Reaper and is estimated to be built at a fraction of the U.S.'s MQ-9 price – $4 million (Brimelow, 2017, Gady, 2018). The latest addition to this series is the CH-6, armed multipurpose UAV displayed at Zhuhai Air show in 2021 (*Exclusive: CH-6 drone,* 2021, Global Times).

The CH-7 Caihong prototype displayed at the 2018 Air Show, is an equivalent copy of the RQ-170 classified drone program (*Rainbow CH-7 Stealth Drone*, Military Drones). The WZ-7, appearing at the 13th China International Aviation and Aerospace Exhibition in 2021, is a replica of USAF Global Hawk program, while the WZ-8 is an improved version of a high-altitude UAV (Huang, 2021, Tian, 2021, *China's most advanced,* 2021, Global Times). ASN-209 is a medium-range tactical ISR asset developed in 2011 (Hsu, 2013), the BZK-005 is a mid-altitude drone that carries out the ISR mission. It appeared in 2006 at an air show and in 2015 during a parade in China (Joe, 2019). GJ-1 or Wing Loong I is a combat drone also equivalent to the U.S.'s MQ-9 Reaper minus the heavy price tag. At approximately $1 million, this ISR combat drone is very appealing to the international market (Hsu, 2013, Brimelow, 2017). GJ-2 or Wing Loong II is an improved version of its predecessor that completed its first flight in 2017. It is employed by PLAAF and cost around $1-2 million (Gady, 2018). The GJ-11 Sharp

Sword is a stealth UAV capable of penetrating hostile territory, theoretically undetected, to carry out its attack mission. This secret Chinese program was unveiled at the 2019 China's National Day Parade (Sheng & Xuanzun, 2019, Joe, 2019, Joe, 2019).

China has been catching up to the U.S. on drone production, assembly, and arms sales, competing not only for next-gen drone technology, but also on luring affluent buyers in the Persian Gulf for bargain cost on similar weapon systems of the U.S. The military UAV market is "forecast to reach roughly 4.7 billion U.S. dollars by 2031," (Laricchia, 2022) and drone production makes it an important revenue addition for China. At the start of 2022, China added North Africa as its customer for UAV sales (Chan, 2022). The difference between China's and the U.S.'s drones is that the U.S.'s drones have been used in combat since the 1990s while China has not been in major combat since the Korean War. What happens when these drones are fused with AI?

NAI and UAVs

According to the 2020 Congressional Research Service report,

> AI is being incorporated into a number of other intelligence, surveillance, and reconnaissance applications, as well as logistics, cyberspace operations, information operations, command and control, semiautonomous and autonomous vehicles, and lethal autonomous weapon systems (Hoadley & Sayler, 2020).

Such an array of military applications will inevitably bring battlefield advantage to the country incorporating AI into their armies.

> AI holds the prospect of augmenting conventional, nuclear, and cyber capabilities in ways that make security relationships among rivals more challenging to predict and maintain and conflicts more difficult to limit (Kissinger, Schmidt, Huttenlocher, & Schouten, 2021, p.135-177).

The above definitions are very broad in scope and do not offer a specific answer on what capabilities NAI can bring to air warfare specifically. Content tracing of each of the USAF packages for warfighting capabilities should shed some light on the answer to this question.

Capabilities of CSAR NAI – Replacing HC-130

The Combat Search and Rescue role in a scenario of a downed aircraft during armed conflict is primarily accomplished by HC-130 airframe. The plane's mission is to

> Rapidly deploy to austere airfields and denied territory in order to execute, all weather personnel recovery operations anytime…anywhere
>
> Crews routinely perform high and low altitude personnel & equipment airdrops, infiltration/exfiltration of personnel (HC-130P/N King, n.d., USAF).

Every military aircraft is equipped with an Emergency Locator Transmitter (ELT) device that automatically sends a distress signal on Guard Frequencies, 121.5 MHz Very High Frequency (VHF) and 243.0 MHz Ultra High Frequency (UHF) bands. The newer digital, as opposed to older analog ELTs, operate on 406 MHz. In the event that an airplane is shot down or crashes, the ELT transmitter automatically sends the distress signal on its designated frequency. Civilian and military aircraft and associated aviation management bodies monitor these established distress VHF or UHF Guard frequencies around the clock and will know if the aircraft is in distress. Additionally, with the use of a newer digital ELT transmitter operating on 406 MHz, the ELT distress signal is picked up by an international satellite group dedicated to search and rescue missions. The satellite downlinks the nearest ground station a distress signal, which is then sent to the nearest air control center, as depicted in Figure 6 below (*Cospas-Sarsat System Overview,* n.d.).

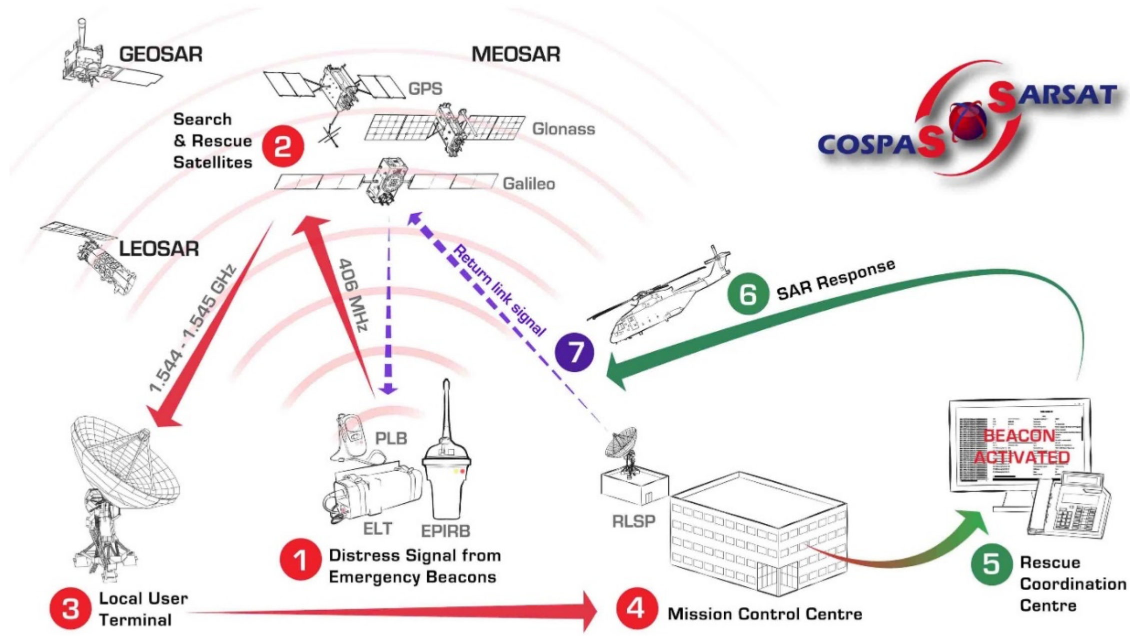

Figure 6. Satellite Search and Rescue system

The Cospas-Sarsat is an international search and rescue system consisting of satellites from lower to mid to geostationary Earth orbits provided by different countries. When an auto-distress signal is transmitted by newer digital ELT, the satellites pick it up and send it to the ground terminal, which forwards it to the air control center, who will then call in a rescue team (*Cospas-Sarsat System Overview,* n.d.)

If an aircraft loses communication and does not land at the specific destination listed on its flight plan, or goes missing in action (MIA), the ground station closest to the operational area will start looking for the missing aircraft. However, due to many false alerts with the older ELTs, the process to verify an actual emergency can take hours according to the FAA (*GEN 3.6 Search and Rescue,* n.d., FAA). Following, a civilian or military search and rescue team must be alerted to initiate the search, which subsequently adds time to the search and rescue process.

AI can serve to narrow down the search process timeline. It does not need to be built with cognitive abilities or decision-making skills. It can be a combination of separate programs responsible for one simple function.[31] In this matter, a ‘search’ and ‘verify’ NAI can be programmed to monitor the three frequencies of older and newer versions of ELTs, 121.5 MHz, 243.0 MHz, and 406 MHz, just as the autonomous satellites already monitor 406 MHz. In case of any of the three frequencies becoming active (meaning that the ELT is transmitting), the ‘scan’ NAI can use simple ‘if-then’ command to pass the next step to another NAI, whose function will be to verify whether the signal represents an emergency. The ‘verify’ NAI program does the verification portion of the signal. It can initiate an automated call to the owner of a downed aircraft (if civilian) or the unit (military) to see if the ELT signal represents a false alert. The automated calls are already a reality today with AI bots calling for advertisement.

If the detected ELT signal is a downed aircraft and constitutes an emergency, the ‘verify’ NAI can be programmed to pass that information to an NAI UAV sitting on the ramp whose sole function is to loiter in orbit for surveillance, just as the RQ-4 already does. An NAI search drone that is parked on the runway, fully serviced, and operationally ready 24/7 represents a huge advantage in CSAR operations. In the instance of a denied environment and rough terrain or the need for descent, another drone can be modified from already existing varieties of USAF arsenal as described above. A connected NAI system to identify an ELT distress signal, verify the emergency, and alert the NAI UAV to search the last known area is a huge timely advantage. The NAI UAV of RQ-4 variety would have been an integral part in CSAR for the U.S. Navy fighter pilot Scott Speicher that went MIA in Iraq during Operation Desert Storm. It took 18 years to find his remains with the help of the local population (Gibbons, 2009).

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[31] As the IBM Watson and Alpha Go were programmed for one function, or one specific game.

The NAI can function without rest or the need for alert and getting a manned crew together. In essence, the process of verifying an ELT in distress would only be limited in time by a unit human operator confirming whether an aircraft is missing or not. Otherwise, the search process cuts hours of man labor down to get a NAI UAV asset to look for survivors, while the manned rescue team is getting ready. The only thing remaining for that NAI UAV is to pass information of the crash site and survivors in the area.

Is NAI revolutionary in the case of CSAR? No. The NAI can only serve a narrow function of identifying distress frequencies, verifying actual emergencies, alerting a search NAI UAV, and scanning the area closer to the ground than satellites in search of survivors. A drone equivalent to a Global Hawk has the advantage of taking photos and videos of the area and loiter in orbit for an extended duration of up to 34 hours (*RQ-4 Global Hawk,* 2014, USAF). This can provide continuous real-time data of a broad search area, and using ML, identify objects that pertain to the aircraft crash and pinpoint its location without a sensor operator having to monitor the screen for countless hours. In a search and rescue scenario, the time becomes the limiting factor for survival, as the injured personnel in distress may be in a hostile environment during an armed conflict. NAI can expedite the rescue mission. What NAI cannot do is the rescue function of the task. That is left for the special operations and PJ teams until AGI becomes a reality. Thus, the NAI UAVs are unlikely to replace the military aviation search and rescue function but are likely to augment the search function of the process.

Capabilities of Transport/Airlift NAI – Replacing C-17, C-5

The function of the airlift is to transport personnel and equipment. The amount of cargo that needs to be transported determines whether a C17 or a C-5, a larger aircraft, is used. The mission of C-5 and C-17 is similar. It is to provide

> Rapid strategic delivery of troops and all types of cargo to main operating bases or directly to forward bases in the deployment area (*C-17 Globemaster III*, n.d., USAF, *C-5M Super Galaxy*, n.d., USAF).
>
> The aircraft can perform tactical airlift and airdrop missions and can transport litters and ambulatory patients during aeromedical evacuations. Crew: Three (two pilots and one loadmaster). Aeromedical Evacuation Crew: A basic crew of five (two flight nurses and three medical technicians) … medical crew may be altered as required by the needs of patients (*C-17 Globemaster III*, n.d., USAF).

A C17 can carry 170,900 lbs versus a C-5 up to 281,000 lbs, and both aircraft are only limited in range by crew fatigue as they have an air-refueling function (*C-17 Globemaster III*, n.d., USAF, *C-5M Super Galaxy*, n.d., USAF). Can NAI replace either of the airlift aircraft? As discussed earlier, the Consumer Electronics Show introduced a flying vehicle at the 2022 expo. Following, a civilian cargo delivery corporation FedEx, announced a partnership with Elroy Air startup that designed a drone for delivering packages up to 500lbs with a 300-mile range (Garsten, 2022). The mission of the U.S. drone startup, Elroy Air, aims at

> Developing autonomous cargo aircraft systems to massively expand the reach of express shipping, provide humanitarian aid in regions with challenging infrastructure, immediate relief in disaster situations, and enable rapid autonomous aerial resupply to troops in the field (*Elroy Air*, n.d.).

The U.S. Air Force is already teamed up with Elroy Air through the Agility Prime program (*Agility Prime*, n.d.), but that only involves electric vertical takeoff and land (eVTOL) drones. The electric drones, compared to a jet engine drone such as an RQ-4

Global Hawk, are limited by the battery range. To replace the C-17 and C-5 cargo missions, the USAF would need to keep the size of the airframes and the jet engines for long range and heavy cargo loads. That would not be feasible with the commercial start-ups geared towards a consumer. The DoD would have to build a different airframe with three different NAIs. The first NAI would need to replace a pilot (autopilot already performs a lot of the functions the pilot does). The second NAI needs to be capable of accessing, tracking, and modifying inventory. A third NAI needs to have a function equivalent to Amazon warehouse machines – capable of loading and unloading equipment. Current humanoid AIs that were discussed earlier are only geared towards the hospitality industry. It doesn't seem to be too far-fetched to build a humanoid machine whose narrow function is to load and unload the aircraft. Given the price tag of hospitality robots of around $200,000, the Air Force would have to build an NAI loadmaster. A better alternative is an NAI similar to the robots used in the warehouses in industry for a specific repetitive task, and a human loadmaster for safety checks and non-standard missions. Rapid mobility requirements that may alter the plan to adjust 'on the go,' also require a human, same for the medical mission.

Thus, the airlift/transport function can be augmented by NAI, but not fully replaced by NAI. The aeromedical evacuation function cannot be replaced. Does NAI represent a revolutionary shift for airlift/transport/medevac? Again, the answer is not complete revolutionary advancement, but narrow augmentation of the mission.

Capabilities of AR NAI– Replacing KC-135, KC-46

Former Deputy Commander of the 621st Air Mobility Operations Group wrote while in the USAF Air War College: "Air refueling serves as a force multiplier, increasing the speed, range, lethality, flexibility, and versatility of combat aircraft" (Dougherty, 1996). The extension of range signifies that an aircraft capable of air refueling can conduct operations anywhere on the globe. A KC-135 tanker that can transfer up to 200,000lbs of fuel has been executing air refueling missions since 1956; its upgrade version, KC-46, can carry 10% more fuel and was first fielded in 2019 (*KC-135 Stratotanker*, n.d., USAF, *KC-46A Pegasus*, n.d., USAF,). Both aircraft are versatile and used for personnel, cargo transport, and medical evacuation missions. Can NAI replace the missions of KC-135 and KC-46?

On June 4, 2021, the Boeing-made MQ-25 UAV successfully demonstrated its air refueling capability to a Navy fighter asset, F-18 (Erwin & Gibson, 2021). This capability implies that an NAI UAV can fulfill the mission of air refueling to the fighter community, including USAF fighter platforms, such as F-35. The first difference between the MQ-25 UAV and KC-135/KC-46 is the fuel load capacity. While MQ-25 is projected to hold 15,000lbs of fuel, that is only 7.5% of what KC-135 can carry (*MQ-25 Stingray* 2021, Naval-Technology). MQ-25 is limited in refueling operations, since it is geared towards smaller airframes. The second difference is the methods of air refueling: drogue vs boom.

The hose-and-drogue is far easier for NAI to learn than the boom. The flexible hose can be extended from the UAV aircraft that is flying ahead of an asset needing refueling. The tanker NAI UAV is separated from that asset by a short distance during the refueling process. In case of an emergency, the NAI can simply be programmed to disconnect and speed up, there is less potential for an air collision. The flying boom, on the other hand, is rigid and is often extended from a tanker that flies above the asset that needs refueling, such as another large aircraft – a bomber, ISR or AFSOC asset. Due to a narrow altitude separation, a human operator is needed to operate the boom both for proper and safe alignment and for human cognitive abilities. In case of an unforeseen circumstance, such as updrafts, downdrafts, turbulence, or air intercept, an NAI asset would fall short today due to substantially higher number of variables needed for stable boom operation. The boom can damage the skin of the aircraft, or worse puncture a hole in the skin of the aircraft, followed by rapid decompression and physiological effects for the crew that would then need to execute an immediate descent and emergency landing, thus aborting the mission. An NAI capable of multifunction, in-real time analysis of combat air refueling with a boom would have to be trained extensively longer than NAI for hose-and-drogue operations. Since the boom transfers 6,000lbs vs a drogue about 2,000 per minute, the boom method is preferable for a larger aircraft flying longer duration missions (Bolkcom, 2006).

The tanker NAI UAV then becomes a matter of scalability for the hose-and-drogue refueling methods, and a matter of Machine Learning and Big Data for the boom method. Can NAI replace the full mission of KC-135 and KC-46 in the near future? Not for the boom refueling method for a large aircraft nor for the medical evacuation missions as discussed earlier. Is the tanker NAI a revolutionary invention? Again, the answer is no. It is evolutionary, but does not alter the air domain military strategy.

Capabilities of ISR NAI – Replacing RC-135, U-2

Intelligence, Surveillance, and Reconnaissance is an integral function of modern air warfare. The U-2 and RC-135 are examples of two fixed-wing assets that execute this mission. Specifically,

> The U-2 is capable of gathering a variety of imagery, including multi-spectral electro-optic, infrared, and synthetic aperture radar products which can be stored or sent to ground exploitation centers. The U-2 also carries a signals intelligence payload All intelligence products except for wet film can be transmitted in near real-time anywhere in the world via air-to-ground or air-to-satellite data links, rapidly providing critical information to combatant commanders. MASINT provides indications of recent activity in areas of interest and reveals efforts to conceal the placement of true nature of man-made objects (*U-2S/TU-2S,* 2015, USAF).

> RC-135V/W Rivet Joint reconnaissance aircraft supports theater and national level consumers with near real time on-scene intelligence collection, analysis and dissemination capabilities. The Rivet Joint's modifications are primarily related to its on-board sensor suite, which allows the mission crew to detect, identify and geolocate signals throughout the electromagnetic spectrum. (*RC-135V/W Rivet Joint*, n.d., USAF).

The two planes differ in the equipment used and the crew complement. While the U-2 flies with a single pilot, the RC-135 can have a crew of around 30 people based on mission requirements. Can NAI replace either of these platforms? As discussed earlier, the RQ-4 Global Hawk already performs aspects of that mission. Similar to a U-2, it is a high-altitude ISR asset

> With an integrated sensor suite that provides global all-weather, day or night intelligence, surveillance, and reconnaissance (ISR) capability. The Global Hawk provides persistent near-real-time coverage using imagery intelligence (IMINT), signals intelligence (SIGINT) and moving target indicator (MTI) sensors…electro-optical, infrared, synthetic aperture radar (SAR) (*RQ-4 Global Hawk*, 2014, USAF).

The advantage of an RQ-4 over a U-2 is that it is a remotely piloted asset, allowing long loitering time of up to 34 hours unrefueled. The only aspect that separates a U-2 from a fully autonomous UAV is an autopilot function. This, however, is already in the works. ARTUμ AI software acted as a co-pilot on a U-2 plane during a test flight on December 15, 2020,

> ARTUμ was responsible for sensor employment and tactical navigation, while the pilot flew the aircraft and coordinated with AI on sensor operation. Together, they flew a reconnaissance mission during a simulated missile strike. ARTUμ's primary responsibility was finding the enemy launchers while the pilot was on the lookout for threatening aircraft, both sharing the U-2's radar (*AI copilot,* 2020, USAF).

Can the same be done with the RC-135? Since the RC-135 employs an array of crewmembers, the NAI would have to take over the specific function of a crewmember. For example, the difference between an RQ-4 and an RC-135 is that the RQ-4 mission is primarily imagery where the RC-135 is primarily SIGINT. Since the RQ-4 already has a sensor suite, this or another drone platform can be modified to provide a specific function. For example, if an RC-135 identifies and geolocates signals, it is not hard to make NAI that scans the spectrum for a specific signal, just as discussed above with the CSAR mission of homing on the ELT emergency distress frequency. The NAI can be made to provide this specific function and pass it on to another NAI program to geolocate the signal, which can be passed down in real-time to the ground station, as the U-2 already does with air-to-satellite datalinks. The NAI on the ground can then analyze the SIGINT findings in near real-time to provide almost a live picture to the decision-makers. This is possible with Raytheon's CASPER™ software – Cognitive Aids to Sensor Processing Exploitation and Response. This Artificial Intelligence software is able to remove the warfighter from the hostile territory and save lives, reduce the workload for personnel on the ground by analyzing ISR imagery quicker, identify any hostile actions in near real-time, and continuously update the battlespace picture. For example,

> Much like talking to Alexa or Siri, an operator tells CASPER to scan for fast boats and prioritize by threat to the carrier… CASPER then takes control of sensor functions, rapidly identifies which boats are threats based on things like their appearance and behavior over space and time, and provides the operator with the threat list and recommended courses of

> action. This enables the operator to focus attention on ensuring recommendations are correct and consistent with policy, making the whole process shorter and safer (*How artificial intelligence,* 2020).

A strategic advantage AI image analysis software presents can be understood by quantifying how much data intel analysts have to sift through. As a former director of National Geospatial-Intelligence Agency (NGIA) described in 2017,

> If we were to attempt to manually exploit the commercial satellite imagery we expect to have over the next 20 years, we would need eight million imagery analysts. Even now, every day in just one combat theater with a single sensor, we collect the data equivalent of three NFL [National Football League] seasons – every game. In high definition! (Gonzalez, 2017).

A strategic advantage of SIGINT ISR is the ability of NAI UAV to collect information on adversaries' defense systems and give decision makers an idea of how to come up with countermeasures. In the instance of replacing a manned ISR aircraft by an unmanned, the limiting factor is the design and scalability of the aircraft. If the equipment associated with ISR missions is bulky and must be airborne for ISR, that presents a weight problem. One solution to the weight problem could be to design NAI on board to collect and pass the information to the ground via satellite links. The ground station would then have the necessary equipment and computer processing centers to analyze the data. If the heavy equipment on board the aircraft is necessary, then NAI UAV must be scaled up to carry the weight and gas that the manned platforms already do. Thus, NAI is not revolutionary in a sense of ISR, it does not change the military strategy, but it can aid in a near-instantaneous specific ISR functions.

Capabilities of EW NAI – Replacing EC-130

The EC-130 Compass Call is an electronic warfare system that

> Disrupts enemy command and control communications and limits adversary coordination essential for enemy force management.
>
> The Compass Call system employs offensive counter-information and electronic attack (or EA) capabilities in support of U.S. and Coalition tactical air, surface, and special operations forces (*EC-130H Compass Call,* 2015, USAF).

Compared to the RQ-4, U-2, or RC-135 assets that gather intelligence, this asset employs non-kinetic methods to combat the enemy. Can the RQ-4 be modified to become a fully autonomous NAI UAV asset capable of executing EA on its own? Only in a narrow scope. If the function of one NAI program integrated in a UAV was to employ jamming against ground radars, another program to employ spoofing, another to scramble enemy's hand-held radios, and another to use the earlier described neural network ML to translate adversary's conversations in near-real time, it could be accomplished. The pre-programmed NAI can be automatically employed to jam or scramble enemy's communications systems while in a desired position or be at the standoff range to auto-record and translate conversations held on the ground by the adversary forces.

However, the fully autonomous EA UAV of today would fall short due to the size of EA equipment and the need for NAI to have decision-making skills. First, electronic countermeasure equipment is bulky. It is not just a computer program written to translate human speech. The equipment must output power to jam a signal on the ground, scramble radios, fool the ground radar, etc. Similar to a scalability problem of MQ-25-like drone needing carry 200,000lbs to replace the current USAF tanker fleet when it only holds 15,000, an electronic attack UAV must not only have NAI performing the desired functions, but also the equipment associated with it. The weight of the equipment does not matter on the ground. For example, the ground vehicle IED-jammer "draws up to 30 amps of vehicle power, weighs approximately 69lbs, and measures 13"H x14"W x19"D" (*Crew Vehicle Receiver/Jammer*, n.d., L3Harris). The weight matters in the UAV design.

In terms of an armed conflict, the Electronic Attack NAI UAV must be powerful, large, and smart. It must provide sufficient power output to radiate the signal air to ground or air to air; fit in all the equipment and fuel for a long loitering time whether it is to provide ground support, air escort duty, standoff range, or special operations; and be able to make rational decisions. Since the ground forces may relay information to the NAI, the NAI of today would lack the cognitive ability to adapt to evolving situations – that would be a task for an AGI. The procurement of an NAI EA asset does not represent a revolutionary shift in military strategy.

Capabilities of Attack NAI – Replacing F-15/22/35, B-1/2/52

Fighters are used for the close combat role in a situation of an armed conflict, or as escorts to a high value asset. The U.S. is already experimenting with AI software fused with aircraft systems. After the Air Force called for Autonomous Horizons (Zacharias, 2019), and DARPA advertised $2 billion campaign for Next Wave of AI Technologies (*DARPA Announces,* 2018, DARPA), RAND corporation published a study on AI-assisted mission planning involving algorithms learning how to maneuver a jet in a hostile environment to the target (Zhang et al., 2020). The research for AI that is able to think as a pilot in the cockpit has begun. The AlphaDogfight and ARTUμ are examples of AI performing human functions in flight. The AlphaDogfight competition, held in August 2020, was used "to demonstrate advanced algorithms capable of performing simulated, within-visual-range air combat maneuvering," with the software beating an F-16 pilot five to zero (*AlphaDogfight Trials*, 2020, DARPA).

The bomber NAI UAV is simpler since it flies in a straight line. Equipped with a camera pod and IR capability, it can be pre-programmed to meet specified mission parameters, such as collateral damage minimization. Since both bombers and fighters represent close combat roles and ground troop support, they would fall short in terms of non-standard operations, such as the need for decision-making while talking with the ground troops. Further, an NAI bomber would need Big Data and ML for obstacle avoidance (mountains, terrain, towers, power lines) and enemy attack avoidance. A state may have separate (Army, Air Force) or joint (combined between ground and air) air defenses.[32] A bomber of State A cannot simply fly into the territory of State B and hit the target without encountering State B's defenses – artillery fire, Surface to Air Missiles (SAMs), etc. Thus, an NAI UAV involves a myriad of constantly interchanging variables a program has to account for and come up with a solution to. It is more suitable for an AGI.

While the fighter or a bomber does not shift the air warfare military strategy, a miniaturized version of them can, as will be discussed further. Fighter and bomber NAI UAVs create less risk due to a loss of life in an armed conflict. However, they do present an ethical dilemma of liability and accountability. Ethical dilemmas will be addressed in a future chapter, but it suffices to say that an autonomous weapon not producing a desired outcome due to an unforeseen circumstance must be considered during the design rather

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[32] For example, NATO uses IAMD, or Integrated Air and Missile Defenses, China uses IADS, or Integrated Air Defense System.

than implementation phase of NAI. The responsibility for NAI must be assigned prior to its deployment.

Capabilities of Drone Swarm NAI – Inventing LAWS

The U.S. Congress defines the integration of special autonomous weapons systems into the military, such as drones fused with AI capable to execute lethal force, as LAWS,

> Lethal autonomous weapon systems (LAWS) are a special class of weapon systems that use sensor suites and computer algorithms to independently identify a target and employ an onboard weapon system to engage and destroy the target without manual human control of the system (Sayler, 2021).

Drone swarms during the airshows in 2017, 2018, 2020, and 2021 represent a potential lethal autonomous weapon system. The 3,000 drones used in Shanghai for the air show likewise could have been programmed to execute a precision air to surface strike. Drone swarms or smaller Unmanned Aerial Systems (UASs) represent decreased production cost and increased quantity and maneuverability over a larger fighter or bomber manned system. A UAS fleet allows for a more persistent, survivable, and effective ISR collection and strike capability over a target area.

The power source is the limiting factor for the swarm drones, not the NAI but. Due to the small size, these drones cannot carry a fuel load substantial for a long-range attack unless an airlift is used to deliver the drones to a specified location and air drop them. The drone swarms are not very useful for a long-term loitering ISR function but can provide on scene intelligence if used for a short time. They are useful for clandestine operations such as infiltration, exfiltration and locating terrorist hide-outs, especially if they have a compact design and minimum noise output to lurk in the shadows and collect intel. They can be programmed with NAI for electronic attack functions or carry a small explosive payload for a strike capability. The drone swarms have a capacity to shift the air warfare strategy and air defenses to some degree. As an example, eighteen drones hit the Abqaiq oil facility in South Arabia and destroyed 5% of global stockpile in 2019 is an example of coordinated drone attack (Frantzman, 2021).

Capabilities of SPECOPS NAI – Replacing AC-130, MC-12, U-28, C-145/146, MC-130

Special Operation Forces include a variety of platforms to execute functions of ISR, attack aircraft, and integrate them with insurgency and exfiltration operations. Due to an intertwined nature of missions between the air and ground, NAI is only likely to be useful at a very specific mission set. As discussed in previous sections, ISR, search function for exfiltration, precision attack, translation, and electronic attack are the only feasible useful components. The ability of NAI to replace SPECOPS air warfare as a whole is not feasible due to limited ability of NAI to have cognitive functions as the humans do. That would be a task for an AGI, and thus NAI does not represent a revolutionary shift in the air domain.

Capabilities of Airborne Command Center NAI – Replacing JSTARS, AWACS, NAOC

The speed of the decision-making is of the essence in today's operating environment. A conflict involving the use of nuclear arms or hypersonic weapons is especially austere.[33] It is imperative that the U.S. develop a defensive strategy with the

[33] A hypersonic weapons test carried out by China in the summer of 2021 went around the globe before striking its target. The test demonstrated China's first-strike capability anywhere around the globe. Hypersonic missiles reduce the decision-making time to a few minutes compared to traditional ICBMs of around 15-30 minutes.

help of AI. Such defense is already under works and is called Joint All-Domain Command and Control; JADC2 is aimed at connecting all the sensors from land, water, air, space, and cyberspace, a broader concept of MDO – Multidomain Operations (Nettis, 2020), Figure 7 below.

Figure 7. Lockheed Martin Conceptual Representation of MDO

MDO is a working implementation of DoD decision makers to unite the battlefield into one comprehensive domain where information can be available from every service in a database that can be accessed by any service that needs that information. In short, all services working in unison instead of separate (Kahn & Thatcher, 2020).

The idea for MDO and JADC2 as its implementation is to eliminate fractures and barriers between the branches of the Department of Defense in such a way that a warfighter can have the most up-to date information of the battlespace from any of the branches that collect that information. That is, a footage collected by the Air Force UAV is instantly accessible to the Army, Navy, and Marines, and ground footage collected by the Army or Marines instantly accessible to the Air Force and intelligence is shared between the branches without barriers or time lapses.

> JADC2 envisions providing a cloud-like environment for the Joint force to share intelligence, surveillance, and reconnaissance data, transmitting across many communications networks, to enable faster decision making. JADC2 intends to enable commanders to make better decisions by collecting data from numerous sensors, processing the data using artificial intelligence algorithms to identify targets, then recommending the optimal weapon – both kinetic and nonkinetic (e.g., cyber or electronic weapons) – to engage target (Hoehn, 2022).

Thus, Artificial Intelligence fused with a drone flying in a contested environment presents a decisive first-mover advantage over an adversary. A drone fused with AI can paint the battlespace in near real-time, signal the intentions of adversaries instantaneously, eliminate friendly fire or fire at will, deny airspace, and act as a brain of MDO. However, it is important to differentiate between full autonomy and augmentation. The NAI cannot replace the JSTARS, AWACS, NAOC military strategists aboard the aircraft. To ascertain the advantage in each category that NAI can augment, it is best to analyze it using an example, such as the contested islands in the South China Sea.

NAI UAV Scenario

China claims The Nine-Dash line that fuels the security dilemma for the neighboring states Vietnam, Taiwan, Philippines, Malaysia, Brunei, and for the U.S. freedom of navigation, Figure 8 below.

Figure 8. Contested islands in South China Sea

China's claim on South China Sea and the contested islands expands way beyond the country's borders. The area includes fishing and trade routes and is strategically important for China in terms of military bases. While China claimed to only do scientific research, it has fully militarized at least 3 of the islands. (Phillips, 2016).

Given the advanced drones China already possesses as described in the previous section, and its intent to become the dominant country for Artificial Intelligence, it is feasible to assume that China does the same research as the U.S. on advanced UAV systems such as Skyborg and AI algorithms for Multi Domain Operations such as CASPER or JADC2. Fusing the GJ-2 Wing Loong II drone or GJ-11 Sharp Sword with an AI package would result in a smart drone, call it All Seeing Eye 1 or ASE-1, which can act as a flying command center. This AI drone could act as a central hub for collecting, analyzing, and disseminating information and act as a decision-maker.

Painting Battlespace. In this scenario, China utilizes ASE-1 to control the airspace over Paracel Island, Scarborough Shoal, and Spratly Islands, Figure 8. ASE-1 acts as an air battle manager. It tasks two drones, such as RQ-4s, per each island, to gain situational awareness on the area. The job of those drones is to act as the eyes in the sky and continuously take photos or video of the area to monitor any friendly or hostile airborne or naval assets in the area. Over the course of a few hours, the drones collect an enormous amount of imagery that would take a human operator hours to analyze and exploit.[34] AI can process enormous amount of data in near real time that is impossible for a human. Thus, China's equivalents of Skyborg and JADC2 would analyze imagery, identify friend or foe, and paint and updated picture of the battlespace around the perimeter in near-real time by the data feeds coming off the drones that were tasked with the perimeter patrol mission. Any vessel in the area can be tracked in near real-time, identified and tagged as a friend or foe, civilian or military, and presented to a general or

[34] Project Maven that was in the works by Google in the U.S. utilized AI to do just this – analyze imagery. Google employees in the U.S. refused to work on DoD projects and Google did not renew its contract for project Maven. It is feasible to assume that China's government has a similar research project.

a politician on the ground.[35] Thus, the Skyborg equivalent, ASE-1, can paint the battlespace in real time, identify any incoming threats, increase situational awareness, warn decision makers of changing environment, and eliminate friendly fire or fire at will.

Elimination of Friendly Fire or Fire at Will. In the presented scenario, a Filipino fishing vessel enters the perimeter around Scarborough Shoal (Figure 8) that is claimed by China. One of the drones tasked with the perimeter patrol mission zooms in on the vessel, takes a picture of it, and passes this information to ASE-1 in real time. ASE-1 uses algorithms to identify the vessel, and the information is visible on the ground within the matter of seconds. Military personnel on the ground identify the vessel within China's claimed waters as an unfriendly but non-threatening and proceed with the decision making, whether it is to let the fishing vessel continue or intercept it with a navy asset to turn the fishing vessel around.

The downside of this scenario, or fire at will, is if ASE-1 is given full autonomy to make decisions if the perimeter of the nine-dash line gets breached. If the ASE-1 is programmed as a LAWS with the clause of protecting the nine-dash line at any costs and deny entry to any non-Chinese assets in the area, the same Filipino fishing vessel may have been another story. ASE-1 command center in the sky calls on an attack drone, such as Wing Loong I, or Reaper equivalent, to destroy the ship violating the naval space.

This scenario is highly unlikely to happen with a civilian vessel, but highly probable with a hostile asset, such as a U.S. vessel or drone flying in the area. The incident of the downed EP-3 Navy ISR aircraft in 2001 due to an unsafe intercept by an F-8 PLA fighter and the detention of the American crew by the Chinese authorities

[35] This tracking is similar to how the Air Traffic Controller at any point has a computer screen with each airplane identified and tracked for collision avoidance.

signals China's intent to remove the U.S. from SCS while pushing rhetoric beneficial to the image of China on the international stage (Kan et al., 2001). It is unknown whether the CCP has approved the PLA to execute air intercepts of U.S. aircraft closer than the international regulations require or if it was an individual decision of the fighter pilot.

Denying Airspace. Continuing the scenario, the ASE-1 drone acting as an air battle manager is flying an orbit in the South China Sea. It collects the ISR information from the drones it tasked to fly the perimeter of the islands to protect its strategic interests and paints the near real-time imagery on the computer screen on the ground.

Beijing states that the nine-dash line is now all Chinese-controlled airspace and waterways and warns the international community that no foreign military airborne, naval, or other assets are allowed within the perimeter of the nine-dash line. Any non-compliance will not be tolerated, and China will protect what it now claims as its national waters. The U.S. tries to conduct a freedom of aviation or navigation exercise in the area and sends one of the U.S. drones to collect ISR imagery within the nine-dash line. Before the U.S. drone can get to the area, it is spotted by a Chinese perimeter drone. The information is passed to the ASE-1 battle manager, which identifies U.S. UAV as a hostile, and implements an autonomous program to alert attack drones or navy vessels to any hostile asset. Since time is of the essence, the ASE-1 tasks the Chinese navy in the area to shoot down the U.S. drone overflying Chinese airspace.

All this decision-making is autonomous, presenting a decisive first-mover advantage. If a hostile can be identified, deterred, and/or shot down within minutes, the airspace is effectively denied to any assets not welcomed in this new Chinese nine-dash airspace. Area denial can quickly trickle down to airspace, waterway/trade route, and land grabbing once ASE-1 is implemented in multi-domain operations.

Multidomain Operations. All-domain means ASE-1 AI drone can analyze the battlespace picture, provide a course of action to the decision-maker based on how the battleground below unravels in near real-time, task any of the multidomain assets with objectives, all while deconflicting friendly aircraft, denying airspace, and do this continuously without fatigue.

Unmanned aircraft designs are more efficient, allowing them to stay on their missions for longer loitering times than traditional manned platforms. This can grant continuous NAI UAV/UAS ISR coverage without needing tanker support. Since the near real-time data would transmit over a network, there is no loss of data, which provides the generals and politicians with a 24/7 real-world view of the battlespace and all MDO operations within. The cyber-attacks within Multi Domain Operations can be used to hinder enemy communications or send deceptive messages with misinformation and deep fake campaigns (Kissinger, Schmidt, Huttenlocher, & Schouten, 2021). The use of AI in cyber-attacks are wide and unpredictable. In short, AI implemented into the military technology with an example of Skyborg equivalent in China, ASE-1, presents a radical shift for the future of military tactics and diplomacy.

Shift to Asymmetric Deterrence

With China's militarization of at least three contested islands in the South China Sea, it is only a matter of time before China will implement MDO JADC2-like system or Skyborg-like drone to oversee the perimeter of those islands to protect its claimed territory. Using Jack Snyder's terms to differentiate the stems of the emerging conflict, China's AI ambitions represent structural, perceptual, and imperialist security dilemmas for the U.S (Tang, 2009).

Strategic Stability in South China Sea

Both structural and perceptual security dilemmas begin from China's rise and its destabilizing policy of military expansion.[36,37] China's development of the militarized islands in the contested territory is a source of quarrel between China, Vietnam, the Philippines, Taiwan, Malaysia, and Brunei. Reconstructing the reefs into a military base with landing strips where the NAI UAVs can be launched creates a perception of hostile stance since China's policy nulled troop footprint or nuclear weapons outside of China. Now, arguably, Beijing can claim the SCS islands as part of China.[38]

Global strategic security rests on the balance of power and resolution of the conflict on the rules-based approach through international legislation. China does not follow a rules-based approach when the ruling does not fit its agenda.[39] The eternal

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[36] After 1998, the "Chinese military spending has increased, on average, 15 percent per year" to catch up with the West (Twomey, 2008).

[37] China's striving for the "Underwater Great Wall Project" and underwater drones poses a direct threat to the international waters, the U.S. Pacific fleet, and its allies, and alarm regional powers such as India (Bana, 2016).

[38] China pursued minimal nuclear deterrence, no first strike, and no nuclear umbrellas policies (Yunzhu, 2008). With the turn to a new millennium, things began to shift. China's nuclear force modernization, on par with the U.S. 2018 NPR, seeks to "deploy new delivery systems" (Lewis, 2009). "In late June 2021, satellite images revealed that China was building 120 intercontinental ballistic missile (ICBM) silos on the edge of the Gobi Desert. This was followed by the revelation a few weeks later than another 110 missile silos were under construction in Hami, in Xinjiang Province. Together with other planned expansions, these sites amount to a dramatic shift in the country's approach to nuclear weapons… according to current U.S. intelligence estimates, that [nuclear] arsenal is now on track to nearly quadruple, to 1,000 weapons by 2030" (Krepinevich, 2022).

[39] It is evidenced in Philippines v. China international court case. China has denounced the court's ruling in favor of Philippines and threatened military escalation if the nine-dash line will not be in their favor (Phillips, 2016).

debate over China's expansionist tendencies besides the contested islands continues today with the Japan-Taiwan-U.S. interests involved. The Diaoyu/Senkaku contested islands, Taiwan and the One China Policy are continuing contemporary conflicts.[40]

Adding AI to an already deadly force only escalates tensions in the Indo-Pacific Theater.[41] The implications of State A having AI superiority that is implemented into military technology means State A possessing a technological edge that can be used for disrupting and undermining current global policies and partnerships. For example, if NAI algorithms are implemented into the defense sectors of China with the intention of hacking the U.S. government's secrets, trade secrets, and intellectual property, then cyber warfare and security are at stake. The military applications range from exact tracking and targeting of the stealth aircraft of the U.S. and allies to beyond visual range ballistic and hypersonic missile systems. China's implementation of AI into the PLA could enable jamming of the U.S.'s present tech, thus eliminating the effectiveness of the ISR aircraft, manned and unmanned, ships, early-warning satellites, and ground radars.

How do the U.S. and China ensure they have defensive AI capabilities to avoid erosion in national defense in case of an offensive AI? This is where the government implements the policies for continuous technological innovation.

[40] Interestingly, with a chip shortage during the COVID -19 pandemic, Taiwan Semiconductor Manufacturing Company produces chips that can run AI. If China was to take the microchip production industry from Taiwan as part of the One-China policy, that would reinforce its strive to become the AI leader by 2030.

[41] Militarizing SCS and using AI-enabled drones along with or augmenting "hypersonic aircraft that could fire nuclear missiles at up to six times the speed of sound" (Yan, 2018) will produce a nuclear umbrella security dilemma for the members and other U.S. allies such as Australia, New Zealand, Japan, South Korea, Philippines, and Thailand comparable to that of Europe's security dilemma during the Cold War.

Chapter V.

Architectural Design Amidst AI Superpowers

How do states organize governmental structure in their pursuit of becoming an AI superpower? The architectural design in the context of AI superpowers is how each country builds up its forces, policies, infrastructure, and education sector to ensure continued progression in this technology.

Organizational Structure of AI in the U.S.

Currently, the U.S. is pursuing a vertical or top-down but decentralized decision-making approach in domestic policies regarding AI implementation in the defense sector. The government directs national policies and executive orders but does not mandate the public institutions, universities, or private corporations to research AI in the military domain. This task is achieved by incentivizing the education and private sector with a plethora of funded projects anyone can apply to. The lateral proliferation of funds across the country comes back to the U.S. government through the new institutions put in place to connect academia and industry with the defense sector.

AI in the U.S. Government, Private and Education Sectors

A part of the executive branch, the Office of Science and Technology Council, and the Office of Management and Budget work with the National Science and Technology Council (NSTC) to outline a course of action. In turn, the NSTC determines which committee the task falls under. The recognition of the artificial intelligence threat to the U.S. national security and ongoing cyber-attacks on intellectual property drove the executive branch of the government to publish "The National Artificial Intelligence Research and Development Strategic Plan" in 2016 under the Obama administration (Biegel & Kurose, 2016). On May 6, 2016, the National Science and Technology Council established a Subcommittee on machine learning and artificial intelligence under the Committee on Technology (Kalil, 2016). The AI subcommittee assesses the demand for AI technology to provide the executive branch the national strategic overview of AI.[42]

On Feb 11, 2019, the Trump administration released an executive order on *Maintaining American Leadership in Artificial Intelligence*, which was followed by the *National Artificial Intelligence Initiative Act* in 2020 (Exec, order 13859).[43] The presidential order went into law in 2021 and led to the establishment of the National AI Initiative Office (NAIIO) on Jan 12, 2021.[44] Aiming to advance and oversee the national AI research from public and private sectors, the NAIIO launched the AI Researchers

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[42] In particular, it "Advises The White House on interagency AI R&D priorities and improving the coordination of Federal AI efforts to ensure continued U.S. leadership in this field…[it implements] policies to prioritize and promote AI R&D, leverage Federal data and computing resources for the AI community, and train the AI-ready workforce" (Select Committee on Artificial Intelligence 2022).

[43] The key agencies supporting this initiative are:

- Defense Advanced Research Projects Agency (DARPA)
- Intelligence Advanced Research Projects Activity (IARPA)
- National Aeronautics and Space Administration (NASA)
- National Science Foundation (NSF)
- Department of Defense (DoD)
- National Security Council (NSC)
- Office of Science and Technology Policy (OSTP)

[44] This office is tasked to "Provide technical and administrative support to the Select Committee on AI, serve as the central point of contact… across Federal departments and agencies, industry, academia, nonprofit organizations, professional societies, State and tribal governments… conduct regular public outreach to diverse stakeholders… promote access to technologies, innovations… and expertise derived from Initiative activities to agency missions and systems across the Federal government" (NAIIO – National Artificial Intelligence Initiative Office 2022).

Portal on December 17, 2021. This allows the general public to connect to the Federal funding on AI, Figure 9 below.[45]

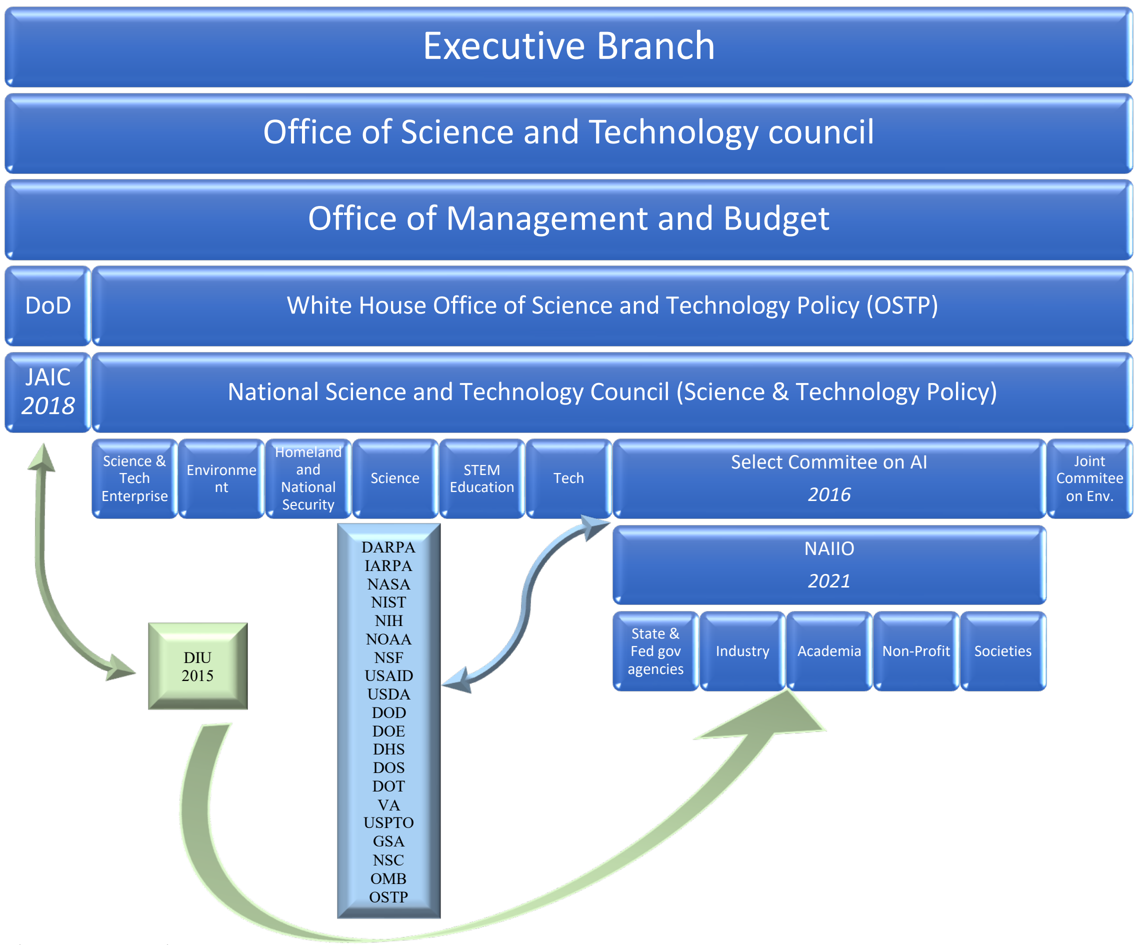

Figure 9. AI in U.S. Government

This figure represents a visual depiction of how the U.S. government is utilizing the executive branch to build up the foundation for Artificial Intelligence. By incentivizing both the academia and the industry with funded projects and research topics, the government is encouraging civilian population to progress in the field of AI. DIU acts as a mediator between public or industry research and the DoD for supply-demand projects on militarized AI.

[45] General public can browse through current 140 funded research projects (AI researchers portal 2021) from Department of Commerce (DOC), Department of Energy (DOE), Department of Health and Human Services (HSS), Department of Transportation (DOT), VA, NASA, NSF, and the DoD.

The DoD has recognized the importance of policy implementations aimed at AI technology even before Obama's AI R&D plan. In 2014, former Secretary of Defense Chuck Hagel announced a new Defense Innovation Initiative aimed at sustaining U.S. military advantage in terms of developing and integrating new cutting-edge technologies (Pellerin, 2014). This initiative was fulfilled via open forum to the general population. Shrewdly, the DoD realized leading experts in cutting-edge technology would reside in the industry.[46]

Former Secretary of Defense Ash Carter, recognized that private corporations, such as the Silicon Valley startups, were more ahead on technology than the military. In 2015, he established a Defense Innovation Unit Experimental (DIUx) to acquire tech on the market relevant to the military while reducing the acquisition process timeline. In 2018, DIUx became DIU by losing its "x" suffix, and officially became part of the DoD after proving its value as a technological facilitator (Bertuca, 2015, Carter & Rhodes, 2018). In 2016, DIU incorporated Shield AI to bridge the latest AI tech to the DoD's needs (Defense Innovation Unit). The DIU has streamlined the DoD's original acquisition process from 91 months in 2017 to just 12-24 months in 2022 but still lags the private industry's AI development cycle and implementation of 6-9 months' timeframe (Hoadley & Sayler, 2020).

Much like the National AI Strategic Plan, the DoD released its own AI Strategy in 2018. The DoD objective to maintain America's defense via technological edge became

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[46] The DoD created a Long-Range Research and Development Program Plan (LRRDPP), which was an innovative way of enabling anyone from public businesses to private citizens submit ideas for next-gen emerging tech and its integration in the U.S. military to make sure U.S. forces did not become outdated. The responses were compiled to the Secretary of Defense (SecDef) in 2015 to decide on funding for the programs (Pellerin, 2015, *Identifying capabilities for the future*, n.d.).

known as the Third Offset Strategy (Work, 2015, Pellerin, 2016) and culminated in the creation of the Joint Artificial Intelligence Center (JAIC) in 2018. The JAIC has its own independent structure including a budget directorate as shown in Figure 10, Appendix 4. Given that the U.S. government has implemented structural integrity for achieving its goal for AI, how does it protect trade secrets and intellectual property with such high stakes as the next gen AI weaponry?

AI in the U.S. Intellectual Property Protection

Intellectual property has been protected in the U.S. since the *Copyright Act of 1790* (Fisher, 1999). A company willing to innovate has different paths to safeguarding its inventions. One way is to keep a trade secret and not disclose the details of how the invention was made, another way is to patent it. In either case, the U.S. government provides protection with the *Economic Espionage Act of 1996* and the *Defend Trade Secrets Act of 2016.*[47] Private companies making the latest research in artificial intelligence and UAVs may elect to keep their developments as trade secrets at the expense of independent discovery by another company. Unlike patenting it and providing details of the invention out in the open, where a foreign entity may copy the design, as China has done over generations, a company will keep it a secret.

The U.S. government utilizes a vertical approach to protect its national security, a crisp example of realism or self-help system in anarchy and emerging security dilemma.

[47] According to the U.S. Patent Office (USPTO), "Economic espionage refers to the theft of a trade secret intending or knowing that the offense will benefit any foreign government, foreign instrumentality, or foreign agent… theft of trade secrets… is related to a product or service used in or intended for use in interstate or foreign commerce, to the economic benefit of anyone other than the owner of thereof" (Trade Secrets/Regulatory Data Protection, 2021).

The U.S. is implementing a vertical domestic policy in the Justice Department on par with the Executive branch. A top-down approach to tighten the screws around potential leaks of information to China is depicted in Figure 11 below.

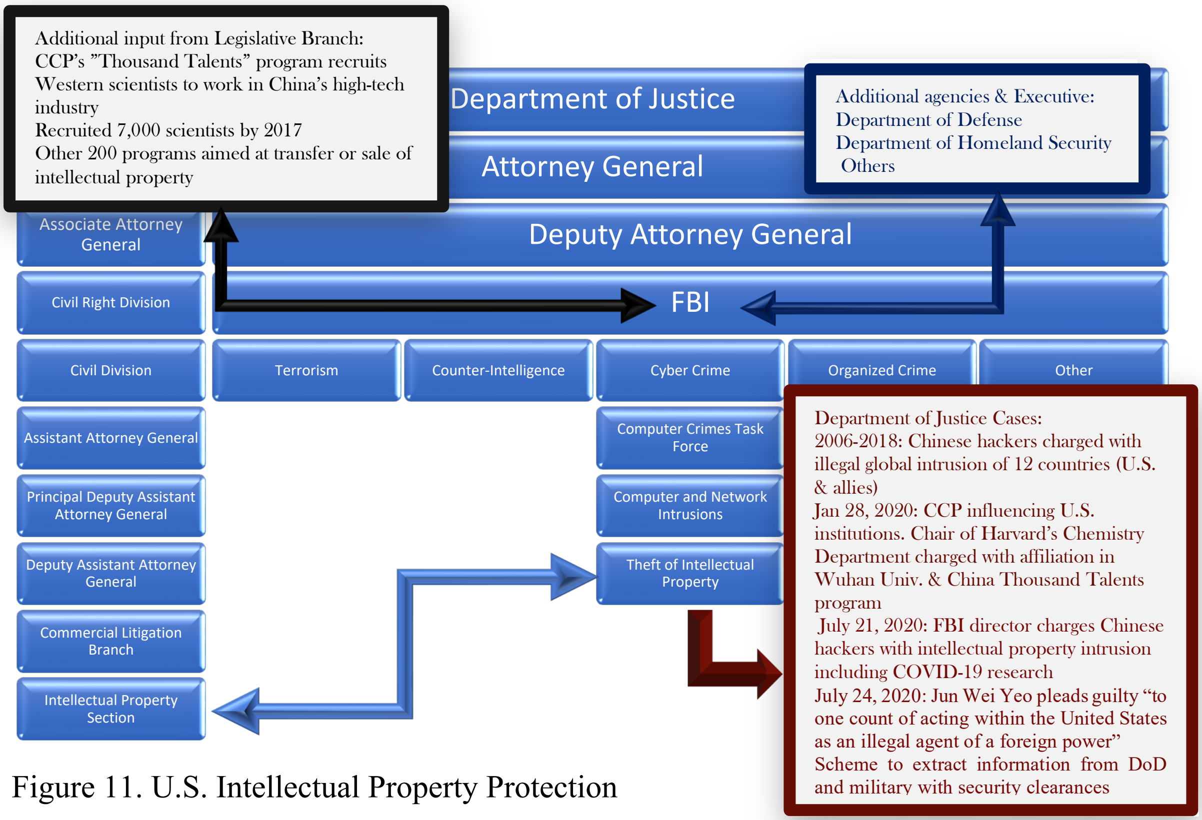

Figure 11. U.S. Intellectual Property Protection

U.S. implements the Department of Justice to protect its intellectual property, including new emerging technologies.

The Justice Department's Commercial Litigation Section employs the Federal Bureau of Investigations (FBI) to hunt potential violators in issues of patents, copyrights, and sophisticated high technologies. The Justice Department uses experts with science and engineering degrees and utilizes the Intellectual Property Section to collaborate with the FBI. The FBI, in turn, collaborates with the DoD, the Department of Homeland Security, and others, which fall under the Executive Branch. The threats established both by the executive and the legislative branches are categorized as cyber-crimes under the FBI. The Computer Crimes Task Force is employed to look for computer and network intrusions and theft of intellectual property. Once the suspects are identified, they are apprehended by a ground team. The U.S. has employed this vertical structure both in the apprehension of cyber and non-cyber threats to information leaks to China.

The FBI also works on the tasks of the Legislative Branch. The Senate has identified China's "Thousand Talents" program that recruits Western scientists to work in China and groom China's students in the high-tech industry as a threat to the U.S. research enterprise. This plan is only one of the 200 Chinese talents plans and has recruited 7,000 scientists and researchers in just three years (Portman & Carper, 2019, Congress/Securing the U.S. 2019). This plan targets the U.S. and Western scientists to advance China's plan "to become the world's only superpower by any means necessary," as the director of the FBI Christopher Wray noted in Washington D.C. on 7 July 2020 (Wray, 2020). Because this plan percolates down to civil society and the scientific community, the FBI warns that China is trying to influence U.S. institutions.[48] The vertical domestic policy in protecting national interests is then implemented through the FBI to eliminate foreign influence in academia.

The Assistant Attorney General reports that "From 2011-2018, more than 90 percent of the Departments' cases alleging economic espionage by or to benefit a state

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[48] On January 28, 2020, the U.S. Department of Justice charged Dr. Charles Lieber, the chair of Harvard University's Chemistry Department with making false statements about his affiliation with the Wuhan University of Technology and involvement in China's Thousand Talents Program; the $15 million grant he received from DoD and National Institute of Health (NIH) "required the disclosure of all sources of research support, potential financial conflicts of interest and all foreign collaboration" (*Harvard University professor,* 2020, DoJ).

involve China, and more than two-thirds of the Departments' theft of trade secrets cases have had a nexus to China" (Demers, 2018).[49]

There have been many other examples of Chinese espionage in the U.S.[50] This trend in the data culminates with the closure of a Chinese consulate in Texas on July 24, 2020, as the FBI announced criminal spy and covert activity by the Chinese Communist Party (*Briefing with senior U.S. government officials,* 2020, Strohm, 2020). It is highly unusual for the U.S. to close a foreign consulate. This political move serves as a signal to China that the U.S. is willing to protect intellectual property even if the cost will incite heightened tensions between the two governments.

The picture outside of the U.S. is different. If a U.S. company wants to establish a business in China, such as the latest research on artificial intelligence imagery recognition and analysis, it will have to partner up with a Chinese national and disclose all its business details, giving China an inside on how the American companies work. This, in turn, gives an advantage of copying the business model and having access to the research (Bradsher, 2020). Whether joint ventures represent forced technology transfer from the west is hard to say. Western companies gain access to the rising middle-class

[49] The U.S. Department of Justice charged two Chinese hackers in 2018 in illegal "global computer intrusion campaigns targeting intellectual property (including satellite, aviation, computing, science, etc.) and confidential business information. The attacks span for over a decade from 2006-2018 and targeted 12 countries: Brazil, Canada, Finland, France, Germany, India, Japan, Sweden, Switzerland, the United Arab Emirates, the United Kingdom, and the United States" (*Two Chinese hackers,* 2019, DoJ).

[50] In 2020, the FBI arrested three Chinese nationals conducting research in the U.S. on visa fraud charges and concealment of their employment for China's People's Liberation Army (*Information about the Department of Justice's China initiative,* 2021). On July 21, 2020, the FBI Deputy Director announced another two charges of Chinese hackers to the Department of Justice, indicating intellectual property intrusion including COVID-19 research (Bowdich, 2020). On July 24, 2020, Jun Wei Yeo entered a plea of guilty to "one count of acting within the United States as an illegal agent of a foreign power," the U.S. Attorney's Office of District of Columbia learned that the individual was exploiting unsuspected Americans via internet to recruit military and DoD officials with security clearances and access to sensitive information (*Singaporean national pleads guilty to acting in the United States as an illegal agent of Chinese intelligence*, 2020, DoJ).

population of China, who are ready to spend money on the latest consumer electronic gadgets, whether it's a new phone or a recreational drone. As discussed in the previous section, China's urbanization drives the demand for consumer electronics. According to Brookings, "by 2027, we estimate that 1.2 billion Chinese will be in the middle class, making up one quarter of the world total" (Kharas & Dooley, 2020). Thus, companies trade their technological advancement and business models for access to a higher population and broader economic market.

The U.S. government is taking intellectual property protection seriously because the U.S. does not want China to have the latest techniques to analyze the data, allowing the adversary has the potential to use it to their advantage.

Organizational Structure of AI in China

The organizational structure of AI in China differs from that of the U.S. because the Chinese Communist Party owns both the government and the private sectors. According to the U.S. Congressional Research Service, "In general, few boundaries exist between Chinese commercial companies, university research laboratories, the military, and the central government" (Hoadley & Sayler, 2020). There is no clear division as there is in the U.S. between the lawmaking on AI and how it is acquired and implemented. Thus, China's AI architecture has a centralized vs the U.S. decentralized approach.

AI in China's Government, Private, and Education Sectors

Akin to the U.S. Executive branch, China has made AI top-down policies to strive for technological hegemon recognition. As shown in Figure 12 below, Chinese President Xi Jinping oversees the National People's Congress (NPC), which consists of elected officials to oversee the affairs of government, military, and civilian sectors. The State Council falls under the NPC. It "executes laws and supervises the government bureaucracy and thus carries out the administrative functions of the Chinese government" (Albert, Maizland, & Xu, 2021).

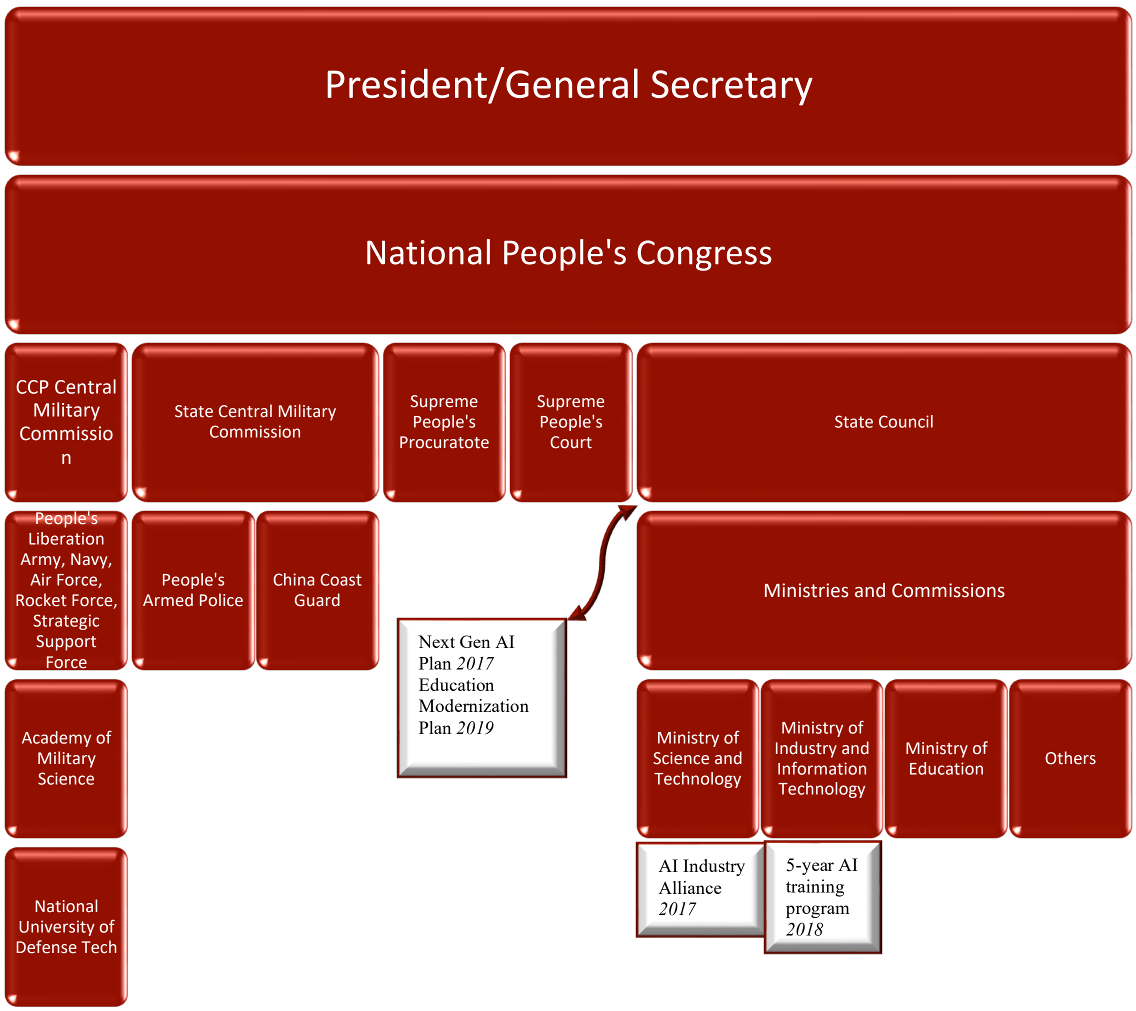

Figure 12. Artificial Intelligence in relation to China's politics

China's government arrangement allows for a swift implementation of the Artificial Intelligence plan by all sectors simultaneously, military, education, and private companies.

The direction in which China moves can be understood by its 5-year plans.[51] The 5-year plans are passed by the NPC and written to law by the State Council. The 12th 5-year plan of 2011-2015 asserts a focus on scientific development but does not mention artificial intelligence (Casey & Koleski, 2011).[52] Next, the 13th 5-year plan ratified by the NPC for 2016-2020 focused on development of emerging technologies including artificial intelligence (Murphy, 2016). Further, the CCP Central Committee, using China's State Council, unveiled the *Next Generation Artificial Intelligence Plan* in 2017, by which China plans to position the country as the leader in AI innovation, a projected $150 billion revenue industry in China by the end of the decade (Kharpal, 2017, *In Their Own Words,* 2017). The CCP wants "to emerge as the driving force in defining ethical norms and standards for AI" (Roberts et al., 2020, Wu et al., 2020).

The State Council is further subdivided into the Ministries. The Ministry of Science and Technology and the Ministry of Industry and Information Technology collaborated to create the AI Industry Alliance in 2017 (Luong & Arnold, 2021). The goal of this alliance is to incorporate industry, universities, and private sector under one comprehensive information-sharing system that can be accessible to the government. China's 14th 5-year plan for 2021-2025 details specific scientific objectives, plans for AI, and strives to push China to achieve a "major progress in the construction of a science

[51] Since the creation of the PRC in 1949, its first leader, Mao Zedong, the head of the CCP, started implementing 5-year plans to give economic direction and progression of the country.

[52] The U.S.-China tech race may not have even developed if China's plans did not go public and broad. Li Keqiang, the premier, or prime minister and highest official within China's State Council, revealed a "Made in China 2025" plan in 2015 that "aims to shift China's economy into higher value-added manufacturing sectors, such as robotics, aerospace and energy-saving vehicles" (Hopewell, 2018, 'Made in China 2025' plan unveiled 2015).

and technology (S&T) innovation center with global influence" (*Shanghai Municipal "14th Five-Year,"* 2021).

On the national defense side, Xi Jinping has been implementing military reforms and modernization.[53] The 2010, 2013, and 2015 White Papers address how to handle growing military competition, organize the forces, and gain strategic influence in INDOPACOM (Cordesman, Colley, & Wang, 2015, *Military and Security Developments Involving the People's Republic of China,* 2021).[54]

With the restructuring of the commands and consolidation of forces, Xi Jinping made substantial emphasis on modernization and empowerment of the military with addition of technology.[55] The integration of AI technology into China's military is done with involvement of the State Council, the Central Military Commission, and different ministries. The Ministry of Science and Technology working with the Ministry of Education has organized the integration of tech from private sector into the military.[56] The 2017 Military-Civil Fusion (MCF) Development Commission is aimed at acquiring

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[53] Just as China uses the 5-year plans to construct the direction of economy and emphasis items for the country, China uses the Defense White Papers to outline the direction of its military and its defense strategy.

[54] Since 2015, Xi Jinping has reorganized the military structure from a larger land footprint to a more condensed but structured military. The military regions were reorganized from land-based specific regions to a broader geographical theater commands. Just as the U.S. has CENTCOM, INDOPACOM, SOUTHCOM that are global commands, China now has the Eastern, Western, Northern, Southern, and Central Theater Commands that are unified under one commander. Although they are dividing landmass of China to different areas of responsibility, it is not hard to envision the expansion of Southern Command to South China Sea.

[55] The Academy of Military Science under PLA (*The Academy of Military Science (AMS)* 2016) restructured its organization under the same Xi Jinping reforms and centralized the specific research under rebuild National University of Defense Technology in 2017 (*National University of Defense Technology*). The two new laboratories of note are Artificial Intelligence Research Center and the Unmanned Systems Research Center (*Academy of Military Science – Chinese Defence Universities* ... 2019).

[56] Tsinghua University has eight laboratories for civil-military fusion, one of the newest of which is High-End Laboratory for Military Intelligence, which focuses on implementing AI into China's defense forces (Kania, 2019).

new emerging technologies such as "quantum computing, big data, semiconductors, 5G, advanced nuclear technology, aerospace technology, and AI" (*The Chinese Communist Party's military-civil fusion policy,* 2021). It is equivalent to the DIU in the U.S., that is aimed at decreasing acquisition timelines between civilian and military sectors. The U.S. government is very concerned about China's MCF approach. The U.S. Department of State reports:

> In a clandestine and non-transparent manner, the CCP is acquiring the intellectual property, key research, and technological advancements… Joint research institutions, academia, and private firms are all being exploited to build the PLA's future military systems – often without their knowledge or consent. (U.S. Department of State, 2021).

The Ministry of Education implements the State Council's agenda by its Education Modernization plan and 5-year AI education programs. In 2018, China's Ministry of Education released the *AI Innovation Action Plan* for Institutions of Higher Education.[57,58] This centralized approach of installing AI curriculum and connecting universities and industry is driven by the central government.[59] It is different from the

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[57] "By 2030, colleges and universities will become the main force behind building the world's main AI innovation centers and will lead the development of a new generation AI talent pool to provide China with the scientific and technological support and guaranteed talent to put it at the forefront of innovation-oriented countries" (Murphy, 2019).

[58] In 2019, China's Ministry of Education received 180 applications from universities to implement AI as a major, with AI being the most rapidly expanding discipline across the country (Dai, 2020). China took the world lead on the number of peer reviewed AI papers and AI journal publications in 2017, and on AI journal citations in 2020.

[59] The World Intellectual Property Organization (WIPO) and the Global Innovation Index (GII) report that "China has made remarkable achievements in the AI-related IP protection. In the past decade, China has filed 389,571 patents in the area of AI, accounting for 74.7 percent of the global total and ranking the first in the world. China ranked 12th in the GII, moving up two places since 2020, and has moved steadily up the ranking for nine consecutive years. China is the only upper-middle income economies breaking into the top 15" (*China Leads the World in AI Related Patent Filing,* 2021). However, the number of filed patents may not accurately represent the global AI landscape. Companies that want to keep their latest AI invention from the public eye keep it as a trade secret rather than file patents. The WIPO reported patent numbers, do render China's focus and continued aggregation of research in the area of AI.

decentralized approach in the U.S., where education system and partnership with the industry through the DIU and JAIC is driven by universities rather than the government.

Given that the architectural designs of the U.S.-China AI strategies differ, how does the Intellectual Property Protection work in China?

China Intellectual Property Protection

China's Intellectual Property (IP) protection and organizational structure greatly lags the U.S. and did not start until the late 20th century.[60] Realizing that the country was behind others in terms of intellectual property prestige, the CCP started rapidly developing laws to catch up with the rest of the world. In 1980, China joined the World Intellectual Property Organization.[61] The Trademark Law was passed in 1982 "marking the beginning of the systematic establishment of China's modern legal system for the protection of intellectual property rights" (*Intellectual Property Protection in China, 1994*).[62] The 1980s Patent Office of the People's Republic of China is now China National Intellectual Property Administration falling under State Administration for Market Regulation of China under State Council, which implements policies of the Central Committee of Chinese Communist Party (*About China National Intellectual*, n.d.).

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[60] While the U.S. has established its intellectual property protection over 200 years ago with its first federal copyright law (*Copyright act of 1790*), China only came around this subject when the country started opening up to the world in the late 1900s.

[61] The World Intellectual Property Organization, established in 1967, defines the IP as: "Creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used commerce. IP is protected by law, for example, patents, copyright and trademark, which enable people to earn recognition or financial benefit from what they invent or create" (*What is intellectual property?*, n.d.)

[62] Following, Patent Law came into effect in 1985, Copyright Law in 1986 that became active in 1991, and Law on Combating Unfair Competition enacted in 1993.

China's government structure uses an organ equivalent to the FBI to look over IP theft: that organ is the Ministry of State Security under the State Council (*Ministry of Public Security*, n.d.). The People's Court is responsible for mitigating any offences in IP violations. As in the case of foreigners working in China, there seems to be some ambivalence. According to China's Ministry of Foreign Affairs, if an American or other foreigner experiences infringement on their owned trademarks and files a case with the court in China,

> China's intellectual property rights administrative offices are impartial, and firmly safeguard the lawful rights and interests of those who hold such rights. This has earned them praises from many foreign enterprises and joint ventures (*Intellectual Property Protection in China, 1994*).

Contrary to this statement, the Office of the U.S. Trade Representative finds that

> China effectuates forced technology transfer and theft including via industrial espionage, conditioning market access on technology transfer, tactical employment of vague regulations and laws to pressure U.S. forms into transferring their IP to avoid litigation, and localization requirements that force U.S. firms to house sensitive data on the Chinese mainland… Chinese theft of American IP currently costs between $225 billion and $600 billion annually (*Findings Of The Investigation Into China's Acts,* 2018).

While China has put some thought in its IP protection, it does not have a regard for intellectual property of others. According to the FBI, the CCP's government publications for the international community are just tinsel, behind which China performs IP transfer by hacking, deceiving, and buying up IP with talent plans recruiting projects (Lewis, 2021, *The China Threat 2020, Portman & Carper, 2019, Ten thousand talents 2018*). According to the former U.S. Assistant Attorney General, John C. Demers, China's strategy for acquisition of IP is to "Rob the American company of its intellectual property, replicate the technology, and replace the American company in the Chinese market and, one day, the global market" (Demers, 2018).

Since the CCP is looking to find expertise outside its borders and "given its extensive history of industrial espionage and cyber theft" (Hoadley & Sayler, 2020), it is indicative that the CCP is uncertain in winning the AI tech race from within their borders, contrary to their public statements of superiority in the field. In sum, the contrast between the U.S.'s and China's government implementation of AI is decentralized vs centralized. Can the same be said about both governments' financing of the AI tech race?

Chapter VI.

AI Funding and Defense Acquisition: U.S. vis-à-vis China

Since the world is interdependent on mutual economic ligatures, it is hard to discern U.S. investments in China and vice versa in terms of AI research and how it affects the AI race. The most direct way to compare financial investments of the AI tech race between the U.S. and China is the examination of the figures that each government and private sector invests, excluding the effects of foreign investment capital. Government funding differs from venture capital[63] funding in terms of spending on new technology advancements in that the government will fund research for national defense, but not for national leisure.

According to the World Bank Report of 2020, the three largest prevailing economies are the U.S. - $20.9 trillion, the EU - $15.3 trillion, and China – $14.7 trillion (*GDP*). However, the COVID-19 pandemic put a stall to the world's economies with negative growth of 3.2% in 2020 (Jackson et al., 2021).[64] The U.S. Congressional service report notes that

> China emerged in June 2020 as the first major country to announce a return to economic growth since the outbreak of COVID-19 pandemic… [with] 3.2% GDP growth in second quarter and 4.9% GDP growth in the

[63] Venture capital is "capital whose owners are willing to invest in new or small businesses, where the risk of losing it is high" (Hashimzade, Myles, & Black, 2017).

[64] In 2018, China's economy threatened to pass the economy of the U.S. by 2024 with its predicted 5.5% GDP growth annually from 2018-2024; the U.S. economic growth was around 3% annually (Morrison, 2019, *U.S. Economy at a Glance* 2021). The global pandemic had other plans for those forecasts. The U.S. economy dipped by 3.4% in 2020 while China's economy slowed to a positive 2.3% growth (Barrett et al., 2021).

third quarter of 2020. The International Monetary Fund (IMF) projects China's economy to grow by 1.9% in 2020 (Sutter & Sutherland, 2022).

In comparison, the U.S. economy showed a 2% recovery growth a year later in 2021 (Jackson, 2022). Although both countries had plans for technological innovation, the COVID-19 pandemic and its economic consequences leveled out the playing field, but is it possible to discern who is in the lead of financing AI?

AI Venture Capital and Government Funding in the U.S.

The investments into AI vary tremendously across countries based on which areas the AI tech is associated with.[65] For example, the DoD has granted lump-sum budgetary funding for multiple areas of R&D that overlap on the MQ-9 Reapers' hardware-software interface. Further, the AI algorithm by itself does not do the DoD any good. For instance, if Project Maven was aimed at developing AI to discern intelligence, surveillance, and reconnaissance imagery of the drone, what good is this algorithm if there are no UAVs to fly ISR missions? Thus, in a lot of instances, the AI and autonomous flight go hand in hand. To make matters even more complex, while the DoD spending is transparent to the American taxpayer, China's defense spending is grossly underestimated in figures as reported by the CCP according to independent research from international sources.

Further, the government spending is allocated to the DoD on defense projects for the military, and to other government organizations such as the NSF, NIH, DOE, and DHS to non-military and non-defense spending. The non-defense sector agency spread was $560 million in 2018, $1.1 billion in 2019, $1.4 billion in 2020, $1.5 billion in 2021,

[65] Some areas are intermingled and intertwined on AI and autonomous drone flight, so it is hard to say how much money went to autonomy and classified as such, and how much money went to the construction of the algorithms.

and $1.7 billion requested for 2022 (*Artificial Intelligence R&D investments,* 2021, NITRD). The DoD budgets for 2018-2022 were $670.6 billion, $687.8 billion, $723.2 billion, $703.7 billion, and $715.0 billion, respectively – a steady 3.0-3.5% annual GDP (*Defense Budget Overview,* 2018, *Defense Budget Overview,* 2019, *Defense Budget Overview,* 2020, *Defense Budget Overview,* 2021).

The DoD budgets did not have a separate enclave for AI until after the 2018 DoD AI Strategy went into effect. Thus, the DoD research in that area was grouped under the general Science and Technology (S&T) basic research area. The DoD basic R&D S&T budget was $2.3 billion in 2018 (*Defense Budget Overview,* 2018), and $2.5 billion in 2019 (*Defense Budget Overview,* 2019). Following this, the 2020 DoD budget differentiated between AI, including JAIC – $0.927 billion, and autonomous funding – $3.7 billion (*DoD Releases Fiscal,* 2019, Defense). The 2021 budget put the 5G and AI budget together to raise the ceiling for this area – $1.5 billion, AI and JAIC – $0.841 billion, and lowered the budget for autonomy by more than half – $1.7 billion (*DoD Releases Fiscal,* 2020, Defense, *Defense Budget Overview,* 2020). The 2022 budget further separated funding for AI – $0.874 billion, 5G – $0.398 billion, with no specific figures for autonomous funding, but rather, that funding was spread out within other areas (*Defense Budget Overview,* 2021, *The Department of Defense Releases,* 2021).

On average, the DoD allocates around 0.2-0.6% of the DoD budget on AI and autonomous research, which is well below the goal of 3.4%, as the director of the JAIC notes (Vergun, 2021). If the AI tech program is calculated as percentage of GDP, the government funding ranges from 0.01% in 2018 to 0.02% in 2021. Although it is much cheaper to build an AI program, it is not cheap to build an AI hypersonic weapon or an

AI drone that is capable of performing air battle management functions and even pricier to build a drone that is capable of fully autonomous multidomain operations, not to mention that a fleet of these drones would be necessary for worldwide deployment.

For example, the Global Hawk that performs ISR functions is around $130 million per UAV, on par with the high-end F-35 fighter (Roblin, 2021). A fleet of 2,500 Global Hawk Type AI UAVs then will be around $325 billion. In comparison, the U.S. spent a total of $482 billion in 2020 U.S. dollars on the Apollo Program (*How much did the Apollo program cost?*, n.d., Planetary). The JAIC director and leading DoD experts advocate for higher funding as they perceive AI tech as imperative for the defense of America. The 2021 spending on AI pales in comparison to what the U.S. spent to fund the Space Race. Since NASA's inception in 1958, its funding increased every year until tapering off in late 1960s. Peak spending during the Space Race was during the Apollo program in 1960s with the highest budget of 0.4% of the GDP (Stine, 2009). Given this historical perspective, the U.S. has the latitude to boost the government AI program.

The private venture capital on AI investments is published in the U.S. and can be easily found on the IoE. Prior to COVID-19, the U.S. investment in AI grew every year since 2011 (*The Economic Landscape,* 2019, OECD). Forbes reports 2018 venture capital investments in the U.S. at $9.33 billion (Su, 2019). According to Brookings, the disclosed investment in the U.S. into AI in 2019 was $25.2 billion, or "64% of the global total," funding in 2020 during the COVID-19 pandemic was $23.6 billion (*Artificial Intelligence Index Report,* 2021, Stanford), shifting into medical AI sector (Petrara, 2020, Kahn, 2021).

AI Venture Capital and Government Funding in China

Statistics on China's military AI spending are more clouded in comparison to the United States due to a lack of relative transparency. While the private spending or venture capital on AI can be gathered from the world AI spending, the Chinese government withholds data about government spending on a multitude of things, to include AI and its defense budget. Therefore, estimates about Chinese governmental spending are grossly underestimated at best. The comparison between the DoD budget and the CCP budget is not as clean-cut as it appears, because the two countries have different salaries and cost of living expenses.[66] Georgetown University estimates China's defense spending on AI to be between $2.7 billion and $4.8 billion per year. The CCP's defense spending seems to be higher than the U.S. DoD figures; China "spent between $800 million and $1.3 billion on AI in 2020, with an additional $1.7 billion to $3.5 billion for unmanned and autonomous systems" (Fedasiuk, Melot, & Murphy, 2021).

According to the U.S. congressionally mandated biannual report, the National Science Board estimated that China's investment in R&D has been steadily increasing by 20.5% per year since the turn of the millennium and slowed to 10.6% since 2010, still doubling the U.S. R&D performance of 4.3% per year after 2000 and a 5.6% increase per year after 2010, Figure 13 (Boroush & Guci, 2022). Xi Jinping wants China to become the leading technological country by 2030. A $150 billion dollar fund has been allocated to R&D in China (Herman, 2018). However, Georgetown University reports, "China's AI market roughly quintupled between 2015 and 2017, then fell back to near-2015 levels" (Arnold, Rahkovsky, & Huang, 2020).

[66] For example, the U.S. salary to a service member will be much higher than China's salary to a service member, thus stretching their dollar farther in R&D and other areas.

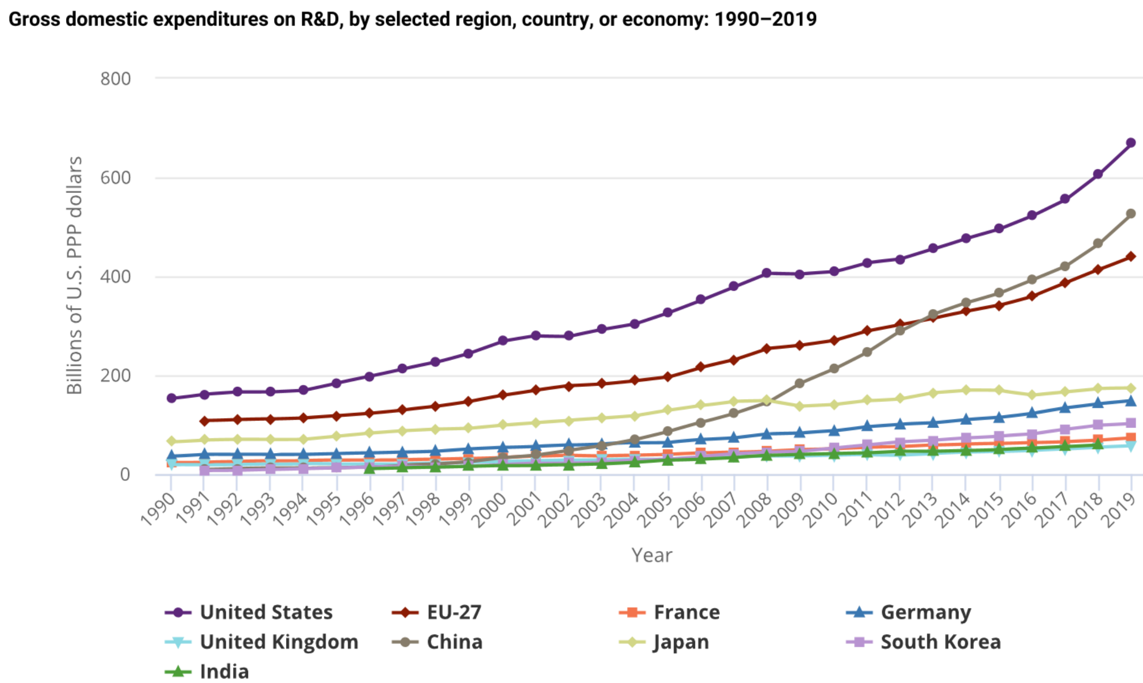

Figure 13. R&D Expenditures by country

China's R&D didn't take off until after 2000s, but since then China has been increasingly investing into new technological development, in line with its 12th, 13th, and 14th 5-year plans (Boroush & Guci, 2022).

China's AI investment was around $1.8 billion in 2018 (Acharya & Arnold, 2019), $5.4 billion in 2019 (Arnold, 2020), and $9.9 billion in 2020 (*Private investments in AI,* 2022, Statista). Additionally, the Chinese Communist Party injected money into AI for specific projects, such as Beijing's $2.1 billion AI-park (Kharpal, 2018, Jingxi, 2021) and Tianjin's $16 billion AI fund (Jing, 2018).

Even though the investments into AI in China from the party vs venture capital vs the PLA aren't as discernable, it is still feasible to pay attention to the headlines to get a glimpse into how much China values AI research. The comparison between the U.S.'s versus China's defense spending versus venture capital is depicted in Figure 14 below:

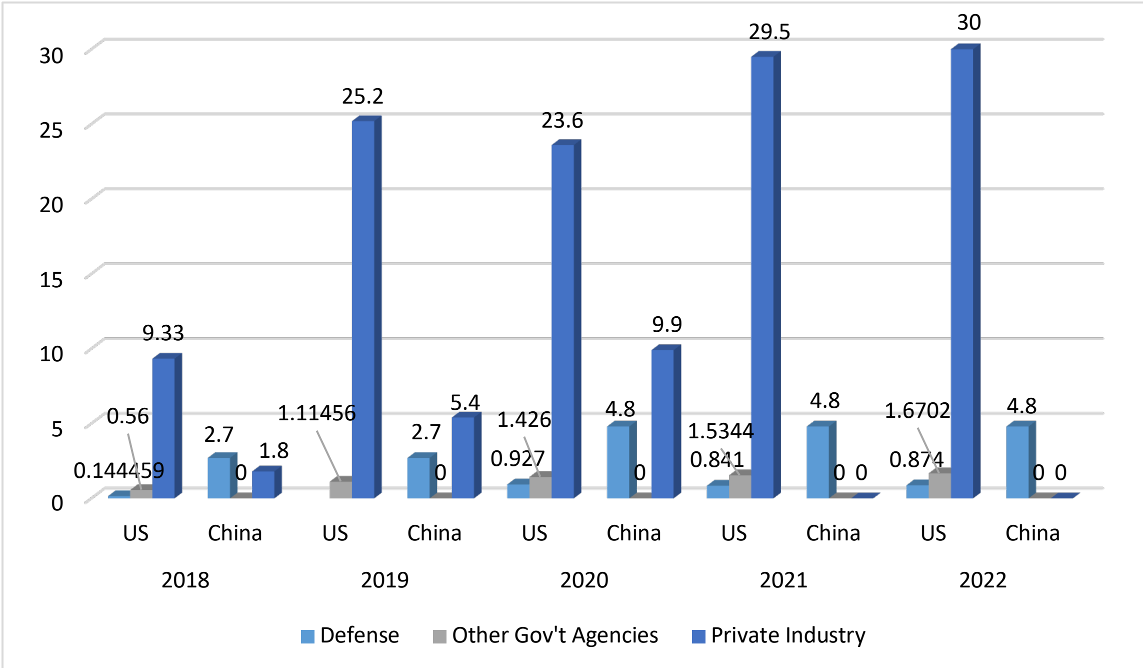

Figure 14. U.S. vs China AI spending 2018-2022

Spending on AI can be seen as rapidly increasing after 2018. Most of the funding comes from venture capital, indicated by the dark blue. The defense spending is indicated by the light blue, and non-defense spending on AI is designated by grey. China's AI spending is approximated by the average of $4.8 billion per year, although there are no concise reports with the data on how much China is spending on defense AI for the military vs non-defense AI vs private AI funding. FY 2022 figures are estimates extrapolated from the previous year. All values are in billions of U.S. dollars.

The funding for 2022 is extrapolated from the previous year due to strong AI venture capital funding on the market, although no reports with real data are yet available. The overall trend for the U.S. venture capital in AI is increasing. What can be concluded from this data is that the U.S. overwhelmingly outspent China in venture capital for the last four years, and this trend is likely to continue. For China to catch up, it will have to at least double its spending on AI. Will this spending include considerations for AI ethics?

Chapter VII.

Doctrine of AI and Ethical Dilemmas

Doctrine is rooted in fundamental beliefs of a particular system.[67] The new technology or weaponry built by a State will fall under the doctrine of that system.[68].

U.S. AI Doctrine

The bedrock of the American belief system was entrenched by the Declaration of Independence from Britain in 1776 that stated

> … all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the Pursuit of Happiness… (Hancock & Thomson, 1776).

Given this foundation, the U.S. is pursuing an AI ethical foundation based on those beliefs.[69]

AI is a set of algorithms that uses machine learning to evolve. This doesn't mean that AI training on real data in the U.S. is free of biases. Every set of data demands a set

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[67] Doctrine is a set of principles set by a certain system, whether by a nation state or a government entity, such as the military of a specific country. The military doctrine is a subset of a nation-state's beliefs, and it is a set of rules by which the uniformed members are obliged to conduct to achieve national security goals.

[68] What the U.S. does not want to happen is an autocratic nation dictating the principles and ethics of an emerging technology that is proliferated around the world. In the best-case scenario, the emerging AI tech and its ethics would be comparable to how the Internet ethics works today. Both the U.S.'s constitutional federal republic and China's autocracy exist on the internet, and the ethics of each country live alongside each other but within virtual Internet Protocol borders.

[69] The U.S. private and military sectors have been exploring the ethics of IoE since the case of United States v. Warshak where the court found electronic communication, or e-mails, a privacy content of the user (Moore, 2007). For the U.S. citizen, it is important that government foes not infringe on an individual person's rights without their consent.

of parameters, always an agitator. There are many instances of AI discriminating against people based on race, socioeconomic status, gender, etc. (Makhortykh, Urman, & Ulloa, 2021, Hale, 2021, Chin & Robison, 2020, Walsh, 2020). Fortunately, the U.S. recognizes these issues and discloses them to the public. The U.S., as part of its doctrine, strives to reach maximum transparency in hopes of improving AI and eliminating any biases.[70]

In the government sector, the White House initiated the National Artificial Intelligence Research Resource (NAIRR) Task Force in 2021

> For establishing and sustaining the NAIRR, including technical capabilities, governance, administration, and assessment, as well as requirements for security, privacy, civil rights, and civil liberties (*The Biden Administration,* 2021, White House).

The AI ethics of the U.S. military is equally transparent. The U.S. does not prohibit Lethal Autonomous Weapon Systems (LAWS), nor does it have them in the inventory but rather regulates their future appearance through government publications (Sayler, 2021). The DoD preemptively published directive DODD 300.09 ahead of proliferation and employment of these weapons:

> Autonomous and semi-autonomous weapon systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgement over the use of force (Carter, 2017).

In 2020, the DoD published AI ethical guidelines that further emphasize the use of human oversight in autonomous weapon systems (*DoD Adopts Ethical,* 2020, Defense). These directives identify the potential of future technology and try to preemptively avoid unforeseen circumstances in the decision making with AI available to the troops. Troops deployed on the battlefield follow the doctrine and rules of engagement (ROEs) of their

[70] One innovative solution in the private sector is the use of synthetic AI training data (Strickland, 2022).

respective nation. If a troop is replaced by AI, a fully autonomous drone, for example, the military faces an ethical dilemma of its own. The U.S. is pursuing to avoid this situation by having a human in control of AI, but that could not be assumed for all countries developing AI. The ethical dilemma of AI as a decision-maker feeds into the philosophy of utilitarianism, or "the doctrine that actions are right if they are useful or for the benefit of a majority" (Oxford). A famous thought experiment of this doctrine is a trolley problem.[71] For AI, that same trolley problem may be merely an optimization or a minimax mathematical computation. The problem set would not consist of people, but rather input variables x_1, x_2, x_3 and the outcome, f(x), void of human emotion.

In summary, the U.S. is pursuing AI ethical guidelines based on the Constitution with an emphasis of keeping the human in the loop on the oversight of any future autonomous AI weapon systems.

China AI Doctrine

The Chinese Communist Party released ethical norms for the *New Generation of Artificial Intelligence* in September 2021. The articles of these norms put forth privacy, protection, human rights, and support for vulnerable groups (Murphy, 2021). The reality is quite different. The CCP does not ask for people's permission nor consent to collect information and digitize it to create a database to feed into AI (Mozur, 2019).[72]

[71] A trolley that malfunctioned is going to kill two people if the driver does not pull the lever to divert the trolley to another set of tracks. However, if the driver pulls a lever, he will kill a person who is not expecting the trolley to change tracks. In this instance, does the driver pull the lever and kill one person, saving the lives of two people, or he does nothing and kills two people, but the other person is saved?

[72] "From 2010 to 2019, [Chinese] government procurement orders for equipment like facial recognition cameras and maintenance services related to surveillance increased nearly 1,900%" (McGregor, 2020). "54 percent of the world's 770 million surveillance cameras are situated in China" (Bischoff, 2021).

The AI software behind Closed Circuit Television, CCTV, aids China's Social Credit system deployed by the government to observe the civilian population and assign a rating.[73] The government can blacklist an individual or company that is non-compliant. This lowers their Social Credit Score, limits their personal growth opportunities within the country, effectively limits their freedom of movement[74] and singles out minority groups.[75]

In November 2021, the United Nations Educational, Scientific, and Cultural Organization, UNESCO, published its recommendation on the ethics of AI with member countries. As a member state, China supports UNESCO's declaration on protection of human rights and freedoms with the use of AI systems, but the CCTV, Social Credit Score system, and reports of racial discrimination did not come to an end with China's joining of UNESCO (*Recommendation on the Ethics,* 2021, UNESCO). The CCP proposed global rules for AI usage on the battlefield in December 2021 that further emphasized international human rights, ethical norms, humanitarian law, and international laws (*Position Paper,* 2021, FMPRC). Whether China will move towards

[73] The Social Credit Score in China is based on CCTV AI facial recognition to survey the behavior of individuals and combines them with other metrics such as social media monitoring, digital data, mobile, financial data, health data. For further details see Boroush & Guci, 2022.

[74] In 2018, "About 17.46 million 'discredited' people were restricted from buying plane tickets and 5.47 million were restricted from purchasing high-speed train tickets" (Huifeng, 2019), violating Article 13 of Universal Human Rights.

[75] In 2018, the United Nations Committee on Racial Discrimination noted mass detentions were conducted against the Muslim groups and Xinjiang Uyghur minorities in China. "Upwards of a million people were being held in so-called counter-extremism centers and another two million had been forced into so-called 're-education camps' for political and cultural indoctrination. All detainees had their due process rights violated, while most had never been charged with an offense, tried in a court of law, or afforded an opportunity to challenge the legality of their detention… were being treated as the enemies of the State based on nothing more than their ethno-religious identity" (Committee on the Elimination of Racial Discrimination 2018).

extending civil liberties and human rights or retracting them with the use of AI in domestic policies is yet to be determined.[76]

[76] At the onset of 2022, the CCP developed a new AI system to aid the court with prosecuting minor crimes, including “fraud, gambling, dangerous driving, and ‘picking quarrels’” (Chen, 2021). The AI prosecutor trained on 17,000 cases in 5 years is a concern for error and bias from the training set of cases. With a conviction “accuracy” of 97% and identification of “dissent against the state,” it has been a subject for much discussion of ethics and morals in the west (Newman, 2021).

Chapter VIII.

Summary

Chapters I and II introduced Artificial Intelligence as an economic and military lever in terms of wealth accumulation and power projection. It further contrasted the evolution of technology in terms of military strategy and how states view their survival in terms of power projection, which is fueled by the advancements of new technology. Chapter III built on and simultaneously discerned AI advantage from the consumer market and general population to the state level, national security concerns, and international relations. Following, this chapter gave a broad overview on China's rise into a multipolar world arrangement, its territorial expansion, and its military theory regarding unrestricted warfare. Chapter IV narrowed down to specific NAI applications that can or cannot replace defensive and offensive military air domain platforms. It presented a hypothetical case study with the use of an air battle management system NAI UAV. Chapter V and VI looked at the organizational structure of the governments and their funding in terms of AI allocation. Chapter VII presented ethical dilemmas associated with AI of the U.S. vs China.

The first part of the thesis was an investigation of NAI military functions, and the second part analyzed whether the U.S. and China are following similar governmental policies and funding towards the AI tech race to find out whether the two countries are on par with each other, or if one is lagging.

Conclusions

This research was conducted to ascertain the value that AI can bring to a nation-state in the defense sector. This work sought to find whether an AI would present a revolutionary technology in air warfare and how it would impact INDOPACOM. Findings revealed that NAI, as opposed to AGI will not be revolutionary in military air domain if partial individual functions of the manned platforms are substituted and no current manned platform could be fully substituted at this time. For the AI technology to be revolutionary to the air warfare, the NAI would have to be extensively trained and it is hard to say whether it could really fulfill a broad function of a combatant commander. NAI must be closer to an AGI to control a package of diverse aircraft for a particular mission, much less perform multidomain operations without human input that would involve all five domains – land, air, sea, space, and cyberspace. The findings showed that NAI capabilities are limited in CSAR operations, airlift, air refueling, ISR, attack/swarm, and some multidomain operations. The swarm drone technology has the potential of changing some military tactics, but not the whole air warfare domain. The multidomain operations involving an AI UAV such as Skyborg in the current state are promising, but full autonomy is unrealistic – mission planning cells must oversee the NAI.

The secondary objective of the thesis analyzed the strategic level of the U.S. – China AI governments' structure, intellectual property protections, financing, and ethics. The results showed similarity in government structure but differed in financing and law legislating.

The U.S. government is utilizing a decentralized approach to build up its AI foundation. The DoD is harvesting private sector AI research for specific needs using the

DIU as a liaison between the private and defense sectors. This approach is a prime example of a democratic government – allows free markets to invent, create, and innovate, then reel in and modify those ideas for specific defense applications. As opposed to the U.S. free market economic model, China is using the Party to direct and implement specific policies catering to the government's need to acquire AI from universities and the industry. It utilizes Civil-Military fusion in the same way as the U.S. uses the DIU.

U.S. intellectual property protection finds China as the main cyber threat to the U.S. research enterprise and joint venture. China's intellectual property protections are contradictory in laws compared to in practice in regard to foreign and American firms. China's recruitment strategies of the Western scientists and continued cyber-attacks (*The United States, joined by allies,* 2021, White House) indicate that China is not as close to becoming a leader in AI tech as it claims.

The AI budget of the U.S. is higher than China's from what could be found in public figures. Both countries utilize different approaches to economic stimulation of the AI sector: decentralized for the U.S. and centralized for China. Both approaches work at incentivizing businesses and higher education sectors. The difference lies in the number of private investments in the U.S. vs China in the AI sector. The U.S. outspent China almost threefold in 2021 in the private sector and the trend is likely to continue. Due to the lack of accurate defense spending figures of the CCP, China's government funding into AI cannot be fully determined.

Both nations have an approach to ethical AI implementation. The U.S. is transparent in AI shortfalls and addresses the population to take part in the development of ethical norms. China is appeasing the international community in forums by supporting universal human rights in discussion with the UN. Domestically, China uses AI as a tool for surveillance, suppression, and re-education of minority groups and implements the Social Credit Score System to ensure the general population is in line with the state's agenda.

To conclude, the NAI UAV presents an augmentation to current USAF and PLAAF inventories but does not revolutionize the military strategy. The U.S. and China are at status quo with each other on the strategic level of AI development. The U.S. is ahead of China on AI financing and addressing ethical dilemmas of this new tech.

Future Research

Further studies can explore drone swarms and AI-aided HGVs, the impact of AI tech in the nuclear domain, and proliferation of this tech to terrorist organizations. Alternatively, an offensive (drone swarms) vs defensive (radars, lasers) AI applications need to be explored.

Appendix 1.

U.S. Indo-Pacific Command

"United States Indo-Pacific Command (USINDOPACOM) is one of six geographic combatant commands defined by the Department of Defense's Unified Command Plan (UCP). As a geographic combatant command, USINDOPACOM is in charge of using and integrating United States Army, Navy, Air Force and Marine Corps forces within the USINDOPACOM area of responsibility (AOR) to achieve U.S. national security objectives while protecting national interests" (*USINDOPACOM Area of Responsibility*, 2022).

Figure 1. United States Indo-Pacific Command

This figure depicts the area of responsibility of the U.S. Indo-Pacific Command. It encompasses the Indian, North Pacific, South Pacific Oceans, including the contested South China Sea where China has built and militarized the islands to expand its influence in the area.

Appendix 2.

UAV Development in Missile Defense

The U.S. Missile Defense Agency has multiple anti-missile defenses. However, they are geared towards a predictable and unchangeable parabolic path of a ballistic missile system and not the HGVs. A new defensive development is a UAV which can detect the launch or boost phase of the missile launch.

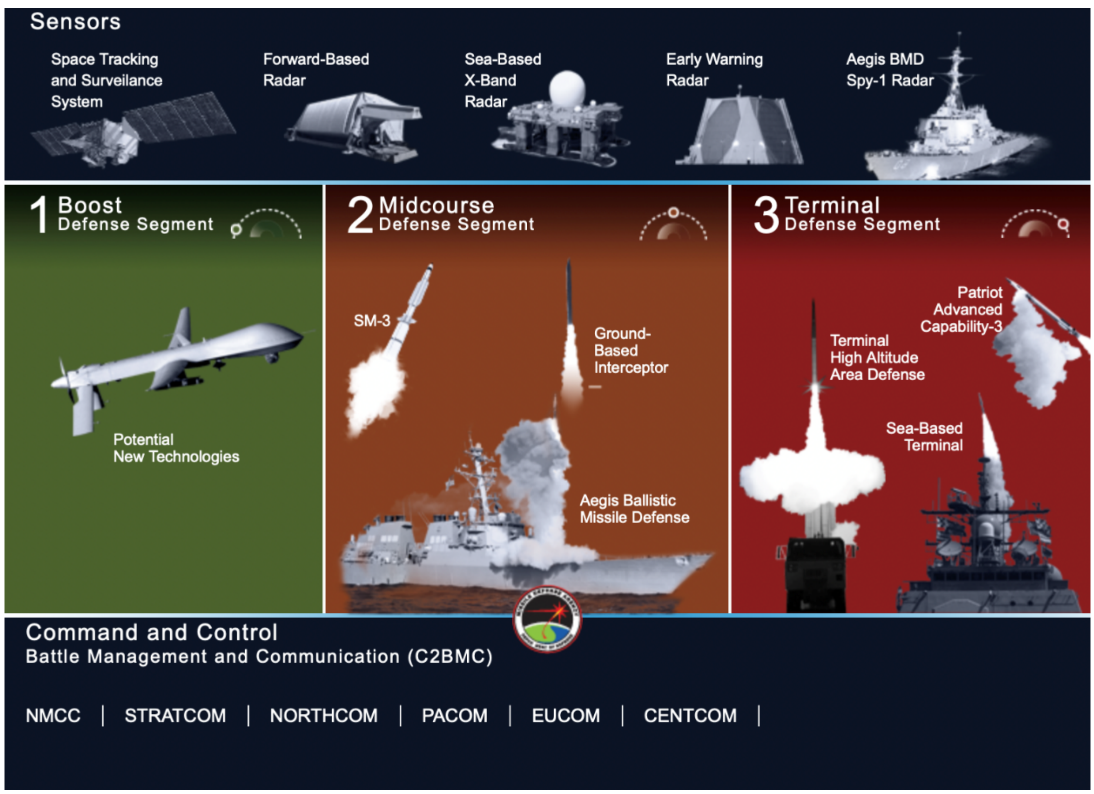

Figure 4. U.S. Ballistic Missile Defense System

This figure depicts U.S. defenses against ballistic missiles. The key takeaway is that the system is designed for the ballistic missiles and not the new HGV developments (*The Ballistic Missile Defense System (BMDS)*, n.d.).

Appendix 3.

Belt and Road Initiative Participants

Increased number of participants of the Belt and Road Initiative over the years indicate that China is able to establish economic trade with more partners, including arm sales and UAVs.

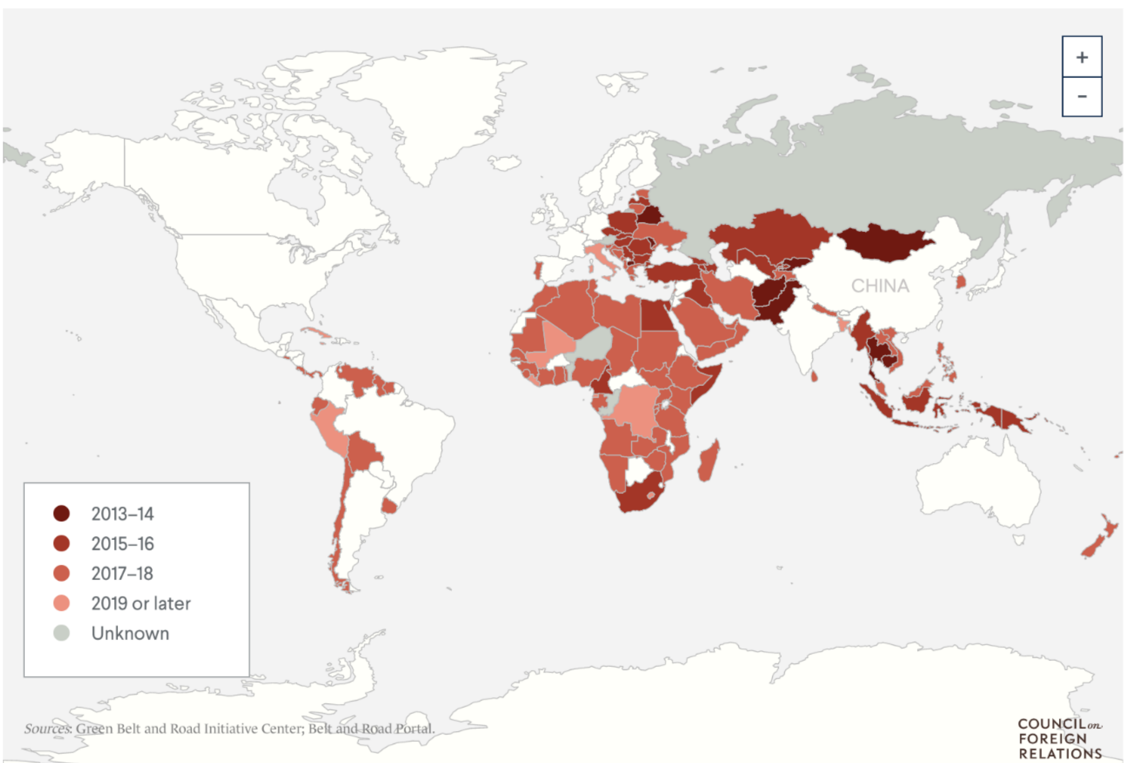

Figure 5. China's Belt and Road Initiative participants

This figure depicts 139 nations that have joined China's Belt and Road initiative (Sacks, 2021).

Appendix 4.

JAIC

The Joint Artificial Intelligence Center Organization Chart.

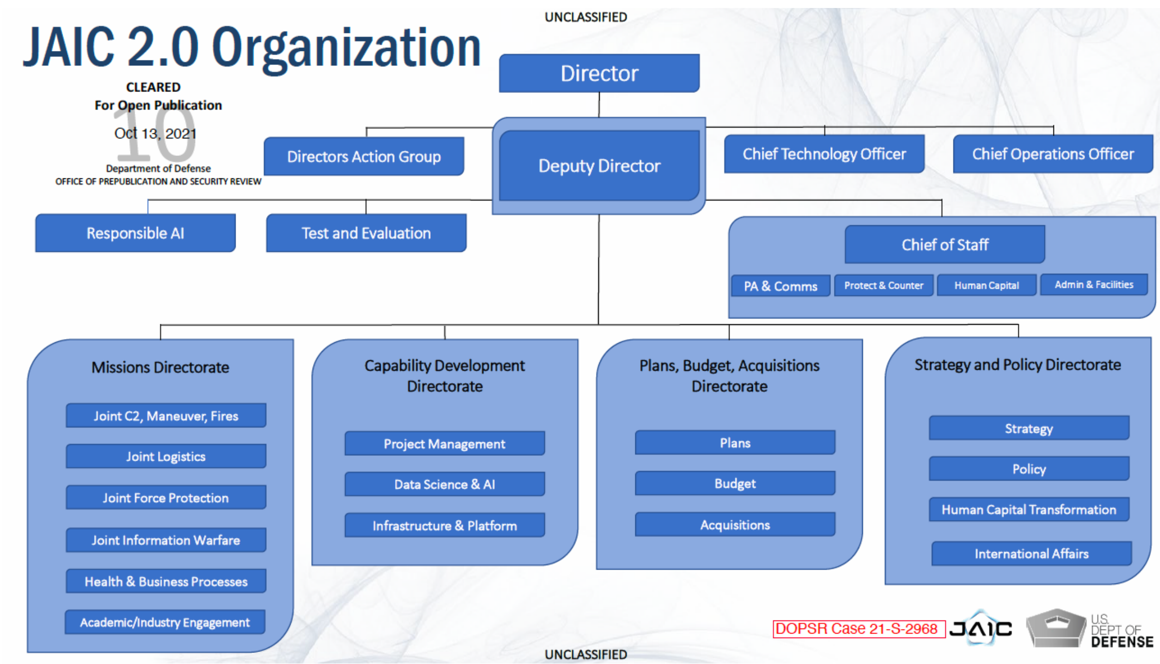

Figure 10. JAIC

This figure depicts U.S. commitment to promoting Artificial Intelligence. The Department of Defense has created a sub-organization to track the budget, research, development, and acquisition process for implementing AI on the battlefield (https://www.ai.mil/docs/JAIC_2.0_org_chart_09_2021.pdf).

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