STRATEGIC TRENDS RESEARCH INITIATIVE

IMAGINING ARMAGEDDON: A FICINT APPROACH TO CHINA-US NUCLEAR COMPETITION

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INTRODUCTION

According to the current National Defense Indo-Pacific Strategy Report, tensions over territorial disputes and sovereignty are high in the Indo-Pacific Command (INDOPACOM) area of operations, and over the past ten years there has been a rapid proliferation of key technologies which have the potential to upend the balance of power in the region. These include precision-guided weapons that can strike targets at longer ranges, and with the deployment of hypersonic weaponry, faster than ever before. This increase in range, speed, and accuracy is further complicated by these missiles' potential deployment on common platforms for both conventional and nuclear weapons, leading to increased ambiguity in an area where strategic clarity is critical. Similarly, cyber-attacks have the potential to cripple networks by offering a high degree of anonymity and deniability to the states behind them while making attribution difficult. And the growing competition in space means that the United States may not always enjoy the same advantages it does now. The implications are clear: China's potential for technological surprise due to emerging capabilities poses a bigger threat than ever before. Whether by deliberate strike or as the result of misinterpreted data, the potential for rapid escalation in the Indo-Pacific has never been higher.

Preparing for great power confrontations (and specifically confrontations with China) in the 2026–2031 timeframe has become increasingly important while simultaneously becoming increasingly difficult and complex. However, with so much noise and competition for leadership's attention, traditional studies may have trouble influencing key stakeholders. Current governments exist in a time of rapid technological change which often outpaces conventional forecasting or analysis. So, just as Human Intelligence (HUMINT) was soon joined by Signals Intelligence (SIGINT) when communications technologies progressed, "Fictional Intelligence" (FICINT) presents another tool to analyze advances in technology among revisionist powers, including China. FICINT is also uniquely suited to explore human social dynamics, a factor that can lead to potentially disastrous miscalculations. Thus, this project is based upon three fictional narratives (Appendix 1) prepared by FICINT experts and best-selling authors P.W. Singer & August Cole and backed by real-world research from the Chinese military subject matter experts at BluePath Labs. The first fictional narrative, "No Good Options," discusses hypersonic missiles and nuclear-conventional ambiguity. The second, "Contested Heavens," discusses China's growing space capabilities and their implications for the U.S. and its allies in the region, and the third, "A Matter of Evidence," discusses the human side of the People's Liberation Army (PLA) by touching on China's culture of bureaucratic secrecy while also asking whether the PLA's technological ambitions have run ahead of its human talent pool. All three present plausible, research-based scenarios which the U.S. and its allies may face in the 2026–2031 timeframe.

The following technical report presents the real-world grounding for these FICINT narratives. It includes an analysis of the current capabilities and future direction of the PLA Rocket Force (PLARF), the subject of two of the three narratives, and discusses some of the larger technological trends and challenges faced by China in the coming decade. It makes clear that while China has made significant leaps in its technology and military capabilities, it also faces daunting challenges, both within its military and larger society. While the scenarios presented in the narratives may appear dire, it is important to remember that they represent only possible futures should the U.S. and its allies be caught unprepared. It is our hope that this report will, by presenting these scenarios, lead to greater preparedness on the part of the U.S. and its allies, and (perhaps paradoxically) render these scenarios less realistic.

FINDINGS SUMMARY

Our research finds that the PLARF has grown significantly in size in the past decade, and particularly between 2017 and 2019, when it added ten new brigades (a more than 33% increase in size) in only three years. The PLARF continued to grow in 2021, apparently constructing at least two large silo fields which will

increase its silo-based intercontinental ballistic count by more than ten. Even as much of the PLA was reducing its physical size to better focus on quality rather than quantity, the PLARF was simultaneously increasing its size while also receiving an array of advanced new weapons systems, including the DF-17 hypersonic medium-range ballistic missile and DF-26 intermediate-range ballistic missile. The PLARF has also reformed its force structure by streamlining its support force and built out the industrial infrastructure needed to manufacture more ballistic missiles.

In the coming decade, we assess that the PLARF will continue to grow, filling out its two newly constructed silo fields. Given current estimates of around 110–120 new silos for each new field and 6–12 silos per brigade, BluePath assesses this will result in the creation of 4–6 brigades per silo field, even if only a fraction of silos are filled. As they grow in strength, the PLARF's nuclear forces are also likely grow in importance relative to its conventional forces. This would be a reversal of trends having favored conventional forces over the past three decades, with direct implications for personnel promotions, funding, and possibly a more aggressive nuclear posture. Such a posture could involve moving toward launch-on-warning and away from a policy of minimum deterrence and possibly even no first use. Further, the PLARF will continue to integrate with the other services to allow for joint campaigns as part of the PLA's larger drive to improve joint operations, although its nuclear forces will presumably remain under direct Central Military Commission (CMC) control. It will also continue its risky policy of "strategic ambiguity" with the co-mingling of nuclear and conventional weapons systems on the premise that its advantages outweigh the risks even while increasing the chances of inadvertent escalation. The sum of these changes will be a significantly more complex and difficult adversary for the United States to counter, although given current stockpiles of fissile material it is highly unlikely that the PLARF will reach, or even approach, nuclear parity with the United States within the 2026–2031 timeframe.

Finally, the PLA's continued reliance on conscription of personnel, many of whom have low levels of education and technical training, will continue to be a bottleneck to the PLA and PLARF's ability to integrate high-tech equipment and complex joint operations into its battle plans. The PLARF will increasingly emphasize the recruitment and training of quality personnel with higher educational backgrounds, and emphasize improved technical education for current personnel, as a way of mitigating these deficiencies. However, while some progress has been made in both recruitment and technical education opportunities, and the PLARF will be a more educated force by 2026, personnel quality will be a generational issue which will continue to negatively impact the PLARF for the foreseeable future. Further, larger societal issues, including unfavorable demographic trends and poor levels of rural education and social development, will continue to be a drag on the PLA and PLARF, with negative impacts on funding, research and innovation, and recruitment pool quality.

METHODOLOGY

This report utilized primarily Mandarin Chinese language primary open-sources supported by English language material. This overview report informed the FICINT narratives. BluePath Labs specializes in using PLA primary sources ("in their own words") to research the PLA Rocket Force as well as on emerging technologies of strategic significance and potential stumbling blocks to China's continued rise. Finally, it utilized topic clustering algorithms on English text open-source documentation, such as publications and patents, with Chinese authorship, to dig deeper into two of the key technologies and the nature of China's research into these technologies.

INTRODUCTION TO THE PLA ROCKET FORCE

PLA ROCKET FORCE HISTORY

The PLA Rocket Force (PLARF), formerly known as the PLA 2nd Artillery Force (PLASAF) until 2016, is responsible for the PLA's land-based nuclear and conventional ballistic missiles. The Second Artillery Force was officially established in 1966 and given command of China's small inventory of land-based, regional nuclear missiles. These first-generation missiles were largely categorized as unsophisticated and of limited range and capability. The story of the PLARF/PLASAF, however, has been one of steady and progressive growth in both size and capability, beginning with the development of increasingly long-range systems through the 1960s and 1970s, and with the introduction of the DF-5 in the early 1980s, the first intercontinental ballistic missile capable of striking the United States.

Key Events in the Development of Chinese Missile Forces	
1966	Founding of PLA 2nd Artillery Force
c. 1975	PLASAF deploys first ICBM
1981	PLASAF deploys first ICBM capable of striking CONUS
Early 1990s	PLASAF deploys first road-mobile ballistic missile system
1993	PLASAF deploys first conventional ballistic missile system
2006	PLASAF deploys first cruise missile system
2006	PLASAF deploys first road-mobile ICBM
c. 2012	PLASAF deploys first ASBM
2015	PLASAF becomes PLARF, upgraded to PLA service, as part of sweeping PLA reforms
2017–2019	PLARF increases number of operational brigades by over 33%
c. 2020	PLARF deploys first hypersonic glide vehicle

The 1980s were a seminal decade for the PLASAF in two other ways: first, through its development of the DF-21, the PLA's first road-mobile ballistic missile system, and second, through its decision to field conventional as well as nuclear missiles, leading to the introduction of the DF-11 and DF-15 short range ballistic missiles in the early 1990s. The steady diversification of platforms and improvement in capabilities assigned to the PLASAF was matched by its equally steady growth in size. Four new brigades were stood up between 1980 and 2000, three of which were equipped with these latest weapons systems.

This expansion accelerated in the 2000s: between 2000 and 2010, the PLASAF stood up as many as eleven new brigades equipped with its growing array of weapons systems, including its first ground-launched CJ-10 cruise missile and its first road-mobile intercontinental ballistic missile (ICBM), the DF-31. The pace of growth continued to intensify between 2010 and 2020, as the PLASAF (and, following its name change in 2016, the PLA Rocket Force) added 13 new brigades, as well as more important weapons systems such as the DF-21D anti-ship ballistic missile, the longer range and more capable DF-41 road-mobile ICBM, the dual nuclear-conventional DF-26 intermediate-range ballistic missile (IRBM), and the DF-17 hypersonic glide vehicle (HGV). Incredibly, between 2017 and late 2019 the PLARF added at least ten new missile brigades. This unprecedented expansion from 29 to 39 brigades represented a more than 33% increase in size in only three years. Thus, the PLARF has evolved from a small, unsophisticated force of short-ranged and vulnerable ballistic missiles to an increasingly large, modern, and formidable force with a wide array of both nuclear and conventional weapons platforms.[1]

CURRENT MISSION

The PLARF is responsible for two primary missions: the first is nuclear deterrence and counterattack, overseeing the PLA's stockpile of land-based nuclear missiles and guaranteeing China's minimum deterrence against foreign nuclear attack. The second mission is conventional strike, overseeing the launch of land-based ballistic and cruise missiles in support of PLA military operations.

According to China's most recent 2019 Defense White Paper, the role of the PLARF is to guarantee China's sovereignty and security via its conventional and nuclear missile capabilities. It is tasked with deterring wars in all battlespaces through credible and reliable nuclear deterrence and counterattack capabilities, as well as building its long-range precision strike forces and enhancing its strategic counter-balance capabilities.[2]

SIZE AND STRUCTURE

The PLARF controls nine Bases, all of which are either Corps or Corps Deputy Leader grade. Six of these Bases, Bases 61-66, are responsible for missile operations with its own discrete geographical area, while the other three, Bases 67-69, conduct support missions. Each operations Base currently oversees six to seven missile brigades and a variety of support regiments.

There are currently believed to be 39 missile brigades spread out geographically across China. The exact breakdown between nuclear and conventional forces is unknown for a variety of reasons, including the intermingling between nuclear and conventional roles for certain missile types and the naturally secretive nature of the PLA. However, BluePath estimates the PLARF has at least 13 conventional missile brigades, 5 dual nuclear-conventional brigades, and between 17 and 21 nuclear brigades. For a comprehensive list of brigades and their equipment, see Appendix 2.

Each missile brigade oversees six launch battalions. This seems to be true regardless of missile type and whether the brigade is nuclear or conventional. The PLARF has made efforts to ensure that each battalion is now able to operate and launch independently. The number of launchers per battalion is still poorly understood, but is likely in the range of 6-12 launchers per brigade for certain ICBMs, 12-24 for medium-range ballistic missiles (MRBMs), 18-36 for intermedia-range ballistic missiles (IRBMs), and as many as 36-48 launchers per brigade for short-range ballistic missiles (SRBMs) and ground-launched cruise missiles (GLCMs). This is based on a combination of observations of PLARF drills and dividing the estimated number of missiles of each type[3] with the number of known brigades equipped with that missile.[4]

SUPPORT STRUCTURE

While often overlooked, the PLARF would be unable to carry out its central mission of launching missiles without an effective and well-organized support force working behind the scenes. In recent years, there has been a clear trend toward streamlining and centralization of support operations. First, several entities have been combined to put missile and equipment repair, maintenance, storage, and transport under a single regiment responsible for all these tasks, improving logistical efficiency and coordination. Second, a range of previously independent operations support duties, including meteorology, survey and mapping, Nuclear, Biological, and Chemical (NBC) defense, physical security, and engineering, were all placed under a single operations support regiment. While seemingly mundane, these reforms have streamlined the process of getting missiles to where they need to be and ensuring they are able to both successfully fire and hit their targets. These changes were reflected not just at the Base level but at the brigade level as well, with each brigade getting its own support battalions for these functions.

Each Base also includes a dedicated regiment for communications between the Base HQ and its subordinate elements, as well as a dedicated training regiment. Interestingly, training remains one area which is still very much decentralized and handled by each individual Base rather than by a centralized training institution.

Finally, each Base has what is euphemistically called an "equipment inspection regiment." These regiments are tasked with storing each Base's complement of nuclear warheads and transporting these warheads to nuclear brigades. Most of the PLARF's nuclear warheads are kept at a central repository deep in the mountains

near the city of Taibai, but a small number are forward deployed to these regiments for rapid transport to missile brigades in the event of a crisis.

THE PLARF IN 2026

As recent events have indicated, the PLARF is evolving at such a rapid pace that making predictions out to even one year from now seems a daunting task. Indeed, analysts were reasonably comfortable in their assessments of the PLARF's trajectory in June 2021, only to have to wildly revise their projections twice in only four weeks following reports that it was building two large silo fields which will significantly increase its silo count (see below). Likewise, there will no doubt be many more surprises in store over the next five years which could at any point render today's assessments moot. With that in mind, there are a number of general trends which are already underway and which we can comfortably assess will continue into the foreseeable future. These trends can be roughly divided into two groups: the first three are trends of *quality*, and will directly lead to a more capable PLARF, with larger size, more advanced weaponry, higher quality personnel, and an improved ability to work in concert with the other PLA services as part of a larger operation. The last three are trends of *strategy*. As the PLARF becomes larger and more capable, it will also become more focused on its nuclear role, and possibly bolder in its nuclear posture, while also eschewing strategic clarity. Taken as a whole, these changes will lead to the PLARF becoming a significantly more complex and difficult adversary to counter than the small, minimum-deterrence force it was only a few years earlier.

1. **Continued growth in size and capabilities:** Perhaps the most striking trend in recent years has been the explosive growth in the physical size of the PLARF. Even as the rest of the PLA moved from a force based on quantitative superiority to one based on qualitative superiority, downsizing its number of personnel in the process, the PLARF has moved in the opposite direction, growing in both size and technological capability simultaneously. Between 2017 and 2019, the PLARF added ten new missile brigades, a more than 33% increase in only three years. This was followed in 2021 by the construction of two large silo fields which when completed will add approximately 230 new silos to the PLARF's inventory, a more than ten-fold increase over its current inventory of approximately 20 silos. These silos will almost certainly require the creation of still more brigades to man them in the coming years, and possibly even the creation of the first new operations Bases in over 50 years. Assuming around 6–12 silos per brigade, this could easily lead to the creation of 4–6 brigades per silo field, even if only a fraction of the silos are eventually filled. This is in addition to any other nuclear and conventional brigades which may emerge in the coming years, which is likely, given recent trends. For a short period in 2020, it appeared as if the PLARF, having experienced rapid growth in the previous three years, may enter a period of "digestion" where it worked to grow into its new capabilities, but it now seems that its growth spurt is far from finished.

   The PLARF's growth in size has been accompanied by a parallel growth in capabilities. At one time limited to a small number of primitive and relatively short-ranged nuclear missiles, in only the last six years the PLARF has added its first hypersonic glide vehicle, a new mobile ICBM with longer range and Multiple Independent Reentry Vehicle (MIRV) capability, an improved variant of another mobile ICBM, an IRBM with nuclear, conventional, and anti-ship strike capabilities as well as greatly improved range and accuracy over its predecessor, and a new ground-launched cruise missile with improved speed and survivability over its predecessor. Beyond missiles, the PLARF has continued to improve its entire Intelligence, Surveillance, Reconnaissance (ISR) kill chain, particularly in the maritime realm.[5]

   This growth has also been accompanied by an apparent growth in the infrastructure needed to increase production of ballistic missiles. A recent report uncovered evidence that several key

factories involved in missile manufacturing have been expanding in size. These include new production facilities for the Chinese Academy of Launch Vehicle Technology (CALT) in Beijing and Tianjin, the CASIC 4th Academy (creator of the DF-21), and Tai'an Aerospace Special Vehicle Company, which is partly responsible for production of many of the PLARF's transporter-erector-launcher (TEL) vehicles.[6]

Such orders-of-magnitude growth will certainly place much greater demands on the planning of DoD policymakers, who previously had to deal with a much smaller force.[7] However, it is still worth keeping some perspective: this growth, while striking, will not fundamentally change the nuclear balance of power between the United States and China. Unless it restarts production of fissile material, China will be limited by its current supply, which is probably sufficient for approximately 450–840 warheads, per one estimate.[8] It is thus likely that the United States, with 3,750 warheads,[9] will continue to enjoy a substantial advantage in number of warheads for the foreseeable future.

2. **Emphasis on quality personnel:** The PLARF, as with the rest of the PLA, has traditionally suffered from a relative dearth of highly educated personnel, especially in its enlisted ranks. A querying of primary source news articles between 2015 and 2018 reveals that a significant proportion of the PLARF's senior non-commissioned officer (NCO) force have, at most, a middle school education. These personnel are often placed into technically demanding billets which they struggle to grasp, up to and including billets which involve working with delicate explosive or nuclear materials. One oft-repeated example of this has been lower-educated PLARF personnel being unable to read the English-language instructions that come with some of their high-tech equipment.[10] As the PLARF (and the PLA in general) incorporates increasingly high-tech equipment into its force, it will need personnel who are able to quickly grasp new equipment and concepts. The PLARF is committed to increasing the average education levels and technical knowledge of its enlisted, NCO, and officer ranks and has had some success recruiting more educated and technically proficient personnel such as experimenting with pilot programs in which units partner with local colleges, state-owned enterprises (SOEs), and factories where personnel can take classes or learn useful technical skills.[11] It is thus very likely that the PLARF will be a more educated, more skilled force in five years. With that said, changing the personnel makeup of the PLARF is a generational issue which will not be solved in five years, and the PLARF will continue to feature many senior enlisted personnel with low levels of education for the foreseeable future.

3. **Increased joint operations:** In recent years, the PLA has emphasized the importance of joint operations to its future force and in 2016 reorganized its force structure into five joint theater commands. The PLARF has also increasingly emphasized joint operations and has increasingly trained alongside its counterparts in the other services and provided staff personnel to the local theater command to improve coordination. There is also evidence that the PLARF has begun integrating its conventional missile forces into the joint command system to better support its land, air, and sea counterparts in wartime.[12] Given the opacity of the PLA, the exact nature of this integration, and how exactly it is being implemented, is as yet unclear, but it is increasingly likely that the joint theater command will exercise some degree of operational control over, or at least have close cooperation with, local PLARF conventional missile forces.[13] This process of increased integration and coordination will continue for the foreseeable future. The PLARF and its theater command counterparts will become increasingly comfortable working alongside one another to facilitate streamlined missile operations as part of a larger campaign, increasing the overall effectiveness of its missile strikes. What still remains to be seen is whether local PLARF Bases are officially brought under the administrative control of the theater command system, or if they will continue to maintain a certain degree of administrative independence.

4. **Growing importance of nuclear forces:** To this point, conventional wisdom within the community of researchers watching the PLARF was the greater emphasis on its conventional forces. This is based on a number of factors including a much higher inventory of conventional missiles,[14] the fact that conventional force officers are more likely to be promoted into senior positions,[15] and China's relatively limited and nonaggressive nuclear stance. However, there is evidence that this could be changing. Of the ten most recent brigades added to the PLARF since 2017, as many as seven could be either nuclear or dual nuclear-conventional. Even more critically, however, the recent silo field revelations suggest a dramatic expansion of the PLARF's nuclear mission, and are a possible indicator of how it sees its future priorities. While it remains to be seen whether this indicates a fundamental shift in the PLARF's priorities, recent evidence suggests that nuclear forces are having its moment in the PLARF. This will likely have a number of implications: First, it may lead to changes in the composition of the PLARF's senior leadership, with more senior billets being given to commanders from the PLARF's nuclear forces (and thus further tipping the balance of influence toward nuclear forces over conventional). It also logically follows that such emphasis will lead to the growth of the PLARF's nuclear inventory. While the PLARF's nuclear inventory will be limited by its supply of fissile materials, and it is thus unlikely to reach parity with the United States (see Point 1 above), an increasingly robust nuclear capability beyond minimal deterrence will change the calculus for decisionmakers in the Chinese government and military, leading to a higher likelihood of a more aggressive nuclear posture (described below).
5. **A more aggressive nuclear posture:** As a corollary to the above, the PLARF's increasingly robust nuclear force has led to the possibility that this could be a precursor to a more aggressive nuclear posture. It is possible that China is moving away from its policy of minimum deterrence (that is, a small nuclear force meant only to deter attack and survive to counterattack), or at least warily observing U.S. trends (including nuclear modernization, Prompt Global Strike, and ballistic missile defenses) and taking a more muscular view of what minimum deterrence will mean in practice. More far-reaching changes, such as a move toward a launch on warning posture with a higher level of alert and permanently mated warheads, or even the scrapping of its no first use policy (or at least adopting a more *flexible* definition of "no first use"), are also possibilities. Such moves would of course increase the risk of an accidental nuclear exchange of the type that was narrowly avoided in 1962[16] or 1995.[17] Any future moves may be contingent to some extent upon U.S. actions in the nuclear realm, with China predicating its policies on U.S. investments in nuclear modernization and missile defense.[18]
6. **Continued nuclear-conventional strategic ambiguity:** The PLARF has invested heavily in missiles which are able to carry both conventional and nuclear warheads. The purposeful strategic ambiguity surrounding such missiles presents a perplexing dilemma for the PLA's adversaries, who may not know if they are facing a nuclear or conventional attack that could, a situation which could easily lead to a potentially disastrous escalation. Similarly, such a policy may make an adversary less likely to strike the PLARF's ballistic missiles, fearing that they may accidentally strike China's nuclear assets, which could inadvertently lead China to believe its nuclear deterrent is under attack and again sparking an unwanted escalation. The latter scenario, in which an adversary is potentially reluctant to strike at the PLARF's ballistic missiles due to strategic ambiguity, may in fact be one reason the PLARF has pursued this strategy. To date, the most prominent example of this has been the DF-26 IRBM, which is currently deployed to at least five brigades. The DF-26 is described in PLA media as "dual nuclear-conventional" and it appears that brigades do train for both missions.[19] The DF-26 warhead is likely designed to be "hot-swappable" meaning the warhead type can be rapidly switched between conventional and nuclear in the field, which only compounds its ambiguity.[20] Other missiles beyond the DF-26 have also been theorized as being dual nuclear-conventional, including the DF-17 hypersonic MRBM and CJ-100 GLCM, although this remains unconfirmed until more is known about

these new systems. The PLARF has also periodically expressed some interest in even longer-range conventional fires, leading to some speculation about a dual nuclear-conventional silo-based ICBM.[21] Such a development would significantly compound the nuclear-conventional ambiguity dilemma.

TECHNICAL EDUCATION IN THE PLA

The PLA has focused on improving the quality of its personnel at the enlisted, NCO, and officer levels through a variety of innovative programs. These programs include agreements with local civilian academic institutions, factories, and companies to provide education, certifications, and skills training, as well as individual and group learning initiatives such as the "Shuangxue" (Double Learning) program of the PLA Air Force (PLAAF). It is also working to recruit personnel at all levels from civilian academic institutions.

However, the PLA has been attempting significant reform of its personnel system toward one which relies on a professional, well trained NCO backbone force for decades with only limited success. Despite recognizing the problems with a poorly educated, short-term enlisted force model, the PLA remains dependent on conscription, with over half of PLA units made up primarily of two-year conscripts. The PLA has attempted to address this shortcoming by targeting personnel with high school or college education for recruitment via incentives like financial compensation, future employment assistance, and future educational assistance, but it remains to be seen whether it will be more successful than it has in the past. Further, the PLAAF's recent creation of the Shuangxue program, in which individuals and units attempt to diagnose and address shortcomings in their technical skills, education, and training, attests to the PLA's recognition of technical deficiencies in its personnel, but essentially leaves it up to individual initiative within grassroots units to recognize and solve these problems rather than implementing systemic reforms.

The PLA has also sought to implement the "Triad" military education and training reform concept for its officer corps with the intention of creating more capable commanders who are comfortable with the complexities of joint and system-of-system operations. The Triad system consists of military academies, unit training and exercises for practical experience, military professional education (including online learning and certificates from civilian universities), and ensuring that education and operational training are integrated and informing one another. However, PLA military education is still marred by outdated faculty and courses, poor coordination between institutions and operational units, and corruption. The PLA has set the goal of achieving these reforms by 2035. Such a goal is possible if the PLA is able to control corruption and ensure quality faculty and curricula, however the PLA's historic track record in addressing these problems makes success in this current endeavor a dubious prospect.[22]

EMERGING TECHNOLOGIES

Understanding the future development path of emerging technologies is critical to understanding how a near-future crisis between the United States, China, and its neighbors proceeds. China, applying its whole of government approach, continues to make headway in particular areas of interest that could significantly blunt U.S. capabilities and allow the PLA to develop into a world-class military force. The FICINT narratives explored several of these technologies. Further, the development path and implications of the first two emerging technologies (hypersonics and AI/ML) are further explored in Appendix 3, China R&D Trends: Hypersonic Weapons Development and Military Applications for Artificial Intelligence and Machine Learning.

- **Hypersonic Weapons:** China is actively pursuing hypersonic delivery systems due to their advantages in speed and maneuverability compared with traditional ballistic missiles.[23] Utilizing these advantages, hypersonic missiles have the potential to defeat current U.S. missile defenses and significantly reduce reaction times for U.S. decision-makers and warfighters. China began testing hypersonic delivery systems in 2014 and since then has deployed possibly dual nuclear-conventional

DF-17 hypersonic missiles.[24] Most recently, China conducted two hypersonic missile tests in October 2021 which demonstrated significant progress by circling the Earth at rapid speeds before eventually missing a target.[25] Since then, Chinese scientists have announced heat-seeking capabilities, presumably to ameliorate this problem.[26] Reportedly, Chinese entities including the National University of Defense Technology, Nanjing University of Aeronautics and Astronautics, the AVIC Aerodynamics Research Institute, and the China Aerodynamics Research and Development Center are developing hypersonics technologies.[27] We expect China to continue to make progress in the delivery systems' speed, maneuverability, and sophistication, while the United States is not expected to develop similar capabilities until at least 2024.[28] The U.S. program is expected to cost around $28.5 billion.[29]

- **Artificial Intelligence and Machine Learning (AI/ML):** AI/ML will revolutionize a wide range of PLA capabilities including but not limited to unmanned systems, intelligence collection, and defense research. To give one important example, AI/ML will be critical to the PLA's ability to carry out "multi-domain integrated joint operations." While the PLA has long struggled to create an effective joint force and only established joint theater commands in late 2015, AI-assisted MDIJO, if successfully implemented, will allow the PLA to closely coordinate land, sea, air, space, and cyber operations in a way that was unthinkable only a few years ago. Thus, AI/ML presents a lucrative direction for Chinese research and development capabilities. Current research shows strong potential in speech recognition, facial recognition, and imaging and target recognition, as well as in developing unmanned autonomous systems.[30] Some estimates suggest that the PLA is spending $1.6 billion per year to fund research into AI development, roughly equal to the DoD's budget for similar capabilities.[31] According to estimates based on date from China's Ministry of Finance, China's civilian government is presumed to be spending around $2 billion per year on various aspects of AI research.[32] On a macro-scale, the Chinese government implemented programs such as Made in China 2025, Action Outline for Promoting the Development of Big Data, the Next Generation Artificial Intelligence Development Plan, and others to boost its AI capabilities.[33] Guidance funds are also used to provide contracts and funding methods for private sector entities who are providing AI-related research and development. It is estimated that by 2018 there were more than two thousand guidance funds in China with a total capital investment of $584 billion, and with eventual targets of $1.7 trillion.[34] Chinese public entities with a significant investment in AI/ML include Huawei Technologies Company Limited, Baidu Incorporated, and SenseTime.[35] China has made significant progress in the field of AI, surpassing the United in States in term of total published research in 2017 and surpassing the United States in academic journal citations in 2020,[36] though as of March 2021 the United States still leads China in the number of AI-related conference papers.[37] In general, China is more focused on AI technology with applications in surveillance and automated image recognition and is expected to remain dominant in this domain in the near future.[38]
- **Satellite Technology:** Continued development of advanced satellite technologies will improve a range of PLA capabilities, allowing it to more effectively communicate, navigate, and conduct surveillance and remote sensing. By developing their own satellite networks and constellations, China can reduce its reliance on foreign systems and enter this lucrative market by providing internet, communications, and global positioning services.[39] In 2020, China completed its Beidou navigation system, offering world-wide coverage and competing against U.S. GPS offerings.[40] China initially invested $810 million into starting Beidou in 2013, and by its completion in 2020 the cost had increased to at least $10 billion.[41] However, in 2020, China's satellite navigation industry reportedly exceeded $60 billion in value supporting $156 billion worth of related businesses.[42]

  Major entities related to China's satellite industry include the China Aerospace Science and Technology Corporation (CASC) and the China Aerospace Science and Industry Corporation's (CASIC),

China Great Wall Industry Corporation Limited, LandSpace Technology Corporation, Charming Globe Satellite Technology Limited, and Zhuhai Satellite, among others.[43] Another impressive but less heralded achievement is the 2019 launch of the Queqiao communications relay satellite, which allows for communications with the far side of the moon and is an important component in China's ground segment communications with lunar rovers.[44] By 2026, China is expected to begin construction on a 13,000 satellite mega-constellation called Guowang to provide global communications and satellite internet access.[45] The Chinese government has also announced its intention to complete a communications, navigation, and remote sensing space infrastructure system capable of global coverage and highly efficient operations by 2035.[46]

- **Anti-Satellite Technology:** China has been pursuing anti-satellite (ASAT) capabilities due to the growing importance of communications technology in modern conflicts. Just as satellite research will improve PLA abilities in communication, navigation, surveillance, remote sensing, etc., its research into ASAT technologies can blunt and degrade current U.S. advantages in these areas. This is particularly worrisome, given the U.S. military's reliance on satellites to conduct normal operations. China first tested its ASAT capabilities in 2007 by destroying a weather satellite with an SC-19 missile.[47] Recently, China launched the Shijian-21 Satellite. Ostensibly for space debris clean-up, this satellite is capable of "grappling" other satellites and destroying them with far less collateral damage that is typically associated with ASAT weapons.[48] China is also believed to be capable of fielding directed-energy countermeasures, satellite jammers, and ground-based anti-satellite missiles.[49] Many of these capabilities were developed by the PLA's Strategic Support Force, which is responsible for PLA space operations, while the Shijian-21 was developed by the Shanghai Academy of Spaceflight Technology, a subsidiary of CASC.[50] The Anhui Institute for Optics and Fine Mechanics' Center for Atmospheric Optics and the Chinese Academy of Engineering Physics are both strongly suspected to be developing directed-energy weapons for the PLA.[51] China's most likely avenue for development of ASAT capabilities appears to be in electronic and directed-energy weapons, as they are less likely to produce destructive space debris. China is likely pursuing neutral particle beams, radio frequency weapons, and is expected to be able to field ground-based laser weapons by 2030.[52]

NONTRADITIONAL CHALLENGES FOR CHINA IN 2026

While this report has to this point mostly discussed China's growing capabilities, it is also important to note that China will also face growing challenges by 2026. Both of the challenges described below will negatively impact China's continued ability to grow as a world power. More narrowly, both will negatively impact the PLA and PLARF's ability to continue to transform itself into a world-class military force. First, an increasingly aged population will have a range of negative effects, from lower economic growth leading to less funding available for other priorities (including, presumably, national defense and associated S&T research), growing pension and medical burdens taking money away from defense priorities, and a reduced rate of S&T innovation. Likewise, an education system beset with problems could negatively affect the quality of the PLA's recruitment pool, as well as the wider defense industry's ability to maintain the necessary pace of breakthroughs. Even more worryingly, the continued low level of educational and intellectual development amongst China's rural poor will have a direct impact on the PLA's enlisted and conscripted talent pool, potentially leaving a significant percentage of low-level personnel without the necessary education to sustain an increasingly complicated and high-tech force.

DEMOGRAPHICS

Since the introduction of the One Child Policy in 1979 to address its burgeoning population, China's birthrates have fallen significantly. It reached a historic low in 2021 with official births outpacing deaths by

just .034%.[53] In 2016 the One Child Policy was increased to a Two Child Policy, followed by a Three Child Policy announced in 2021. However this has had little effect on China's overall demographic trend.[54] According to official statistics, China's population is expected to peak in 2025, but a leaked version of China's 2020 census showed that the population may have already started to fall.[55] Analysts predict that China's population will not bounce back without radical social changes. Studies have cited low marriage rates, gender imbalances, long work hours, high cost of child rearing, high costs of housing, and the financial burden of caring for aging parents as possible social factors influencing China's declining birth rate.[56]

To counteract the low birth rate, the Chinese government has considered numerous incentives and punishments. To reduce costs associated with child rearing, the Chinese government has focused on increasing paid maternity leave, increasing the number of nursery schools, and clamping down on after-school tutoring businesses.[57] In September of 2021 Chinese leadership also announced plans to limit abortion access for non-medical reasons.[58] Further, to reduce the burden on businesses and younger workers supporting pensions, the Chinese government has announced its intent to raise the retirement age for men, which is currently set at 60.[59] This may also help to keep China's workforce relatively large as the percentage of the population over 60 years of age continues to grow.

If China cannot stabilize its birth rate, it is expected to encounter growing difficulties. Foremost, lower birthrates and an aging population typically result in decreased productivity as a larger percentage of the population has aged out of the workforce, and more resources are diverted to assisting with issues that develop with age.[60] China is also facing a full depletion of its state pension fund by 2035 as more people retire and place greater financial burdens on younger workers.[61] Further, innovation has also been tied with the average age of a country's citizens, as older societies tend to provide fewer breakthroughs and cutting-edge inventions.[62] These numerous issues are expected to lead to a decline in China's overall competitiveness in the coming decades.

EDUCATION

The number of overall graduates from Chinese higher education institutions has increased steadily over time. 8.74 million students graduated from Chinese higher education institutions in 2020, and 9.09 million graduated in 2021, a record high number.[63] By 2030, China is expected to have approximately 80 million 25–34 year-olds with tertiary education, as opposed to the roughly 23 million it had in 2013.[64]

While the number of graduates continues to rise, a slowing Chinese economy has, for at least the past decade, produced insufficient white collar job openings to absorb these graduates. This has left millions of graduates each year unable to find appropriate work and leaving them toiling in low-paying, menial jobs. These unfortunate students have become known as the "ant hill."[65] The COVID-19 pandemic has significantly exacerbated this trend of more graduates seeking fewer openings,[66] leaving even more graduates long-term unemployed or underemployed.

The Chinese higher education system itself is beset with significant and well documented issues. Quality of instruction, especially at the many newly established universities created to meet the exploding demand for tertiary education, is oftentimes low and based on rote memorization. Analytical skills and critical thinking are not emphasized and both cheating and plagiarism are common. Students, having completed the grueling *gaokao* exam to get into college, have a tendency to relax once they arrive, and are often passed despite poor performance.[67] The Ministry of Education is aware of these problems and in 2018 Minister of Education Chen Baosheng declared an intention to end the "exhausting high school, carefree university" system in which students treat higher education as a reward for surviving the *gaokao* rather than a time for rigorous education.[68]

China also continues to face significant daunting hurdles with the educational development of its poorer rural population. According to one major study, one in three rural children does not complete junior high school, and over half of eight graders in poor rural China have IQs below 90. Such statistics historically bode poorly for a China's ability to make the leap from middle-income to high-income country.[69]

KEY FINDINGS AND RECOMMENDATIONS

Finding: Given the PLARF's continued interest in pursuing dual nuclear-conventional weapons systems, future crises with China may be exacerbated by strategic ambiguity. The PLARF appears to have decided for the time being that the advantages of nuclear-conventional ambiguity outweigh the inherent risks of inadvertent escalation.

Recommendation: DTRA and DoD writ large should prepare for situations with a high degree of ambiguity to include China's nuclear missiles. Possible preparations could take the form of including strategic ambiguity in all scenario planning, modeling, and simulation, development of a robust Continuity of Operations plan, communications planning, and proper preparation and redundancy against cyber-attacks. The increasingly robust nuclear capabilities of the PLARF should also be taken into account; if the PRC restarts production of fissile material, allowing the PLARF to build up its nuclear forces to a level of closer parity with the United States, abandons its no-first-use policy, and moves to a more aggressive posture of launch-on-warning, all of which are possibilities in the coming years, DoD planning should include the possibility of ambiguity being used as part of a leadup to a first strike.

Recommendation: The PRC has to this point been reluctant to engage in bilateral talks about its nuclear capabilities. However, should it become more willing to engage in negotiations around nuclear issues with the United States in the future, whether government to government or military to military, the U.S. side should make discussions about strategic ambiguity a priority issue. Every effort should be made to persuade the PRC of the benefits of strategic clarity and clear communications in a crisis. The U.S. should also utilize multi-lateral mechanisms and organizations such as the International Atomic Energy Agency (IAEA) and Association of Southeast Asian Nations (ASEAN) to highlight the dangers of China' strategic ambiguity policy.

DTRA, INDOPACOM, and other DoD stakeholders should prepare by planning against future scenarios where it is ambiguous if China has launched a nuclear or conventional missile(s). From the planning perspective, the previously accepted norms and escalatory ladder regarding first launch and mutually-assured destruction does not remain intact when the intent and capability is ambiguous.

Finding: China will continue to close the gap in strategic capabilities in space between itself and the United States in the coming decade, and the PLA will increasingly be able to contest U.S. dominance in this domain.

Recommendation: DTRA should prepare for a near future in which the PLA is prepared to contest U.S. advantages in space and U.S. dominance is not assured. This should include ensuring sufficient redundancy, and plans for rapid replacement and orbital redistribution of space assets to deal with campaigns targeting U.S. space assets.

Recommendation: In order to avoid or forestall this eventuality, U.S. authorities should ensure proper funding for space-based strategic programs and GPS-denied operating environments. DTRA and other DoD stakeholders should ensure that planning scenarios incorporate Chinese near or actual parity in space and anti-satellite capabilities.

Finding: For all its significant improvements, the PLA continues to suffer from key weaknesses, including a secretive bureaucratic culture and a continued reliance on a relatively low-skilled talent pool. While it has certainly made strides in personnel recruitment and education, the PLA's personnel will likely continue to be a bottleneck for its ongoing attempts to transform itself into a high-tech force capable of complex operations.

Recommendation: While there is little the DoD or DTRA can do about a situation which hinges on the PLA's ability to self-reform, it is important to keep in mind that the PLA's increasingly high-tech ambitions will likely run ahead of its low-skilled talent pool for some time to come. As the U.S. continues to transition to an era of great power competition, it would do well to not fall into the all-too-common trap of thinking about China as "ten feet tall" but rather think realistically about both its strengths and weaknesses. It is also important to learn from the workforce competency issues experienced by China, and to refine and improve the U.S.'s recruiting and talent management practices accordingly.

Recommendation: The PLA (and PRC more generally) has historically attempted to make up for its lack of technological advantages and talent pool through cyber espionage. DoD can thus indirectly exploit this situation by engaging in good Operations Security (OPSEC) and Information Security (INFOSEC) practices, cutting off this route of advancement. The weak talent and technical skills also presents an opportunity to track the PLARF's progress. For the most part, recruitment and retention is done at the provincial level and by tracking promotions, recruitment incentives, and announcements, one is able to see what skills are being acquired by the PLARF. One additional possible opportunity for engagement in either bilateral or multi-lateral mechanism is the sharing of nuclear accident prevention best practices. This would also allow a further understanding of how China safely maintains and operates its nuclear infrastructure.

APPENDIX 1: FICINT SCENARIOS

Preparing for great power confrontations (and specifically confrontations with China) in the 2026–2031 timeframe has become increasingly important while simultaneously becoming increasingly difficult and complex. However, with so much noise and competition for leadership's attention, traditional studies may have trouble influencing key stakeholders. Current governments exist in a time of rapid technological change which often outpaces conventional forecasting or analysis. So, just as Human Intelligence (HUMINT) was soon joined by Signals Intelligence (SIGINT) when communications technologies progressed, "Fictional Intelligence" (FICINT) presents another tool to analyze advances in technology among revisionist powers, including China. FICINT is also uniquely suited to explore human social dynamics, a factor that can lead to potentially disastrous miscalculations.

The following FICINT narratives were prepared by BluePath Labs (BPL) in partnership with a leading FICINT subject matter experts and best-selling authors P.W. Singer & August Cole (Ghost Fleet, Burn-in, etc.). The first fictional narrative, "No Good Options," discusses hypersonic missiles and nuclear-conventional ambiguity. The second, "Contested Heavens," discusses China's growing space capabilities and their implications for the U.S. and its allies in the region, and the third, "A Matter of Evidence," discusses the human side of the People's Liberation Army (PLA) by touching on China's culture of bureaucratic secrecy while also asking whether the PLA's technological ambitions have run ahead of its human talent pool. All three present plausible, research-based scenarios which the U.S. and its allies may face in the 2026–2031 timeframe.

The research and analysis driving these narratives are addressed in detail by our Final Technical Report. While the scenarios presented below may seem dire, it is important to remember that they represent only possible futures should the U.S. and its allies be caught unprepared. It is our hope that this report will, by presenting the below realistic scenarios, lead to greater preparedness on the part of the U.S. and its allies, and (perhaps paradoxically) render these scenarios less realistic.

FINDINGS SUMMARY

This report presents three fictional scenarios which we believe to be plausible in the near future based on our research. Narrative 1, "No Good Options," urges policymakers to be aware of, and prepare for, a situation which is dominated by strategic ambiguity and uncertainty surrounding China's nuclear weapons. Given the continued interest of the PLA Rocket Force (PLARF) in pursuing such ambiguity in its deployment of nuclear weapons systems, apparently prizing the advantages it offers over the inherent risks, as well as its general lack of transparency around nuclear issues, the possibility of such a scenario will unfortunately continue to rise in the coming decade. This problem may be further compounded by the reduced reaction time brought about by hypersonic weapons. When factoring in other issues which are inevitable in the fog of war (or rather, the fog leading up to war), such as faulty communications or inability to contact an adversary, the situation can easily begin to spiral out of control. It is thus critical that the U.S. military and policymakers train for situations with a high degree of strategic ambiguity. Policymakers should also (so far as it is feasible) engage with the PLA on this issue, and hopefully convince them of the benefits of strategic clarity and clear communications.

Narrative 2, "Contested Heavens," discusses a potential future in which the PLA has gained the initiative in space, giving it a decisive advantage. It alludes to several areas decision makers should be thinking hard about in order to ensure such a scenario does not come to pass, from proper funding for GPS, to how to prepare for and respond to an anti-satellite campaign, and with sufficient redundancy and plans for rapid replacement and redistribution of surviving assets.

The final Narrative, "A Matter of Evidence," takes a different tack from the previous two. Rather than looking at the PLA's growing capabilities, it examines how some of the PLA's ongoing limitations, in both its secretive bureaucratic culture and its continued reliance on a relatively low-skilled talent pool. While the PLA has made some strides in remedying the latter problem, its increasingly high technological ambitions will likely run ahead of its talent pool for some time to come. As this story demonstrates, China faces its own very real set of problems, and as the U.S. gears up for an era of great power competition, it would do well to not fall into the all-too-common trap of thinking about China as "ten feet tall"[70] but rather think realistically about both its strengths and weaknesses.

NARRATIVE 1: NO GOOD OPTIONS

The following transcript was prepared by the United States House Select Committee on the Pacific Crisis of 2029. While this is an excerpt, the transcript is included in its entirety in the classified annex of the Committee's report. The original immersive virtual reality recording of the interview was corrupted during what is believed to be a Chinese cyberattack on the Select Committee's data. Fortunately, the staff used an analog tape-recording back-up for all of its interviews, as they anticipated the risk of a potential attack on their work from foreign or domestic elements.

CAROLYN BROWN (CB): OK, we're recording now. Just look into my viz glasses, so I can set the auto-focus.

HAROLD NAM (HN): Like this?

CB: Perfect. I think we're set. This is Carolyn Brown, principal investigator with … Oh, I should also inform you I am also using a secondary recording device – this one. (Tapping sound)

HN: Is that a tape recorder? Haven't seen one of those since I was a kid.

CB: My boss made me bring it; something she used back in the day. Anyway, for the record, I'm Carolyn Brown, principal investigator with the House Select Committee on the Pacific Crisis of 2029 (PC29). Today is March 3, 2031. This interview is being conducted at a TS [Top Secret] level and will be part of the Committee's classified annex. The time is 1424. Please state your name, age, and title during PC29.

HN: Harold Nam. Harold with an 'o' and N-A-M. 29 years old. I'm … I was an assistant to the deputy National Security Advisor.

CB: And how did you end up in that role?

HN: It was my first job after Georgetown School of Foreign Service, which I graduated from in summer 2029, or just a few months before. My professor had been the National Security Advisor's advisor … I mean my professor had supervised his PhD dissertation way back and recommended me. It wasn't like that, though. I spoke Mandarin … had worked in Beijing for the Times, then had a China focus in my studies at Georgetown …

CB: I'm sure you were qualified. So let's talk about July 28, 2029.

HN: (chuckles) Of course.

CB: We have plenty of documentation and data but to be honest, it's not a complete picture. What I'm hoping to do is get a sense of how this day, uh, unfurled from your point of view. You had fresh eyes, so to speak.

HN: I'm honored to add to the record, but I was just Situation Room seat meat.

CB: "Seat meat?"

HN: Sorry. I was there to fill a chair, classic back-seater.

CB: But you saw it all, then.

HN: Yeah, I guess I did.

CB: Go ahead, then.

HN: I got to work just before 5 a.m., trying to get read-in, as usual. It was a pretty stressful week already. The Hungarian-Ukrainian border business was playing out then and the Japanese navy and Chinese blue water militia had their spat near the Senkaku Islands. So I pulled together a couple diplo models based on overnight data, skimmed for news or social media from those fleets that her own clipper might have missed – all the usual stuff for the boss. So I sent the boss her package and then went to get her coffee; she liked to drink it while she read in. But, as I was dropping it off, a flash message came through.

CB: Did you see what it said?

HN: No. Reading over your boss's shoulder is a pretty good way to get fired.

CB: What happened next?

HN: I'm about to leave, but she stands up and says just one word, "Follow." So I did. As we're walking, she blasted through every message she can read in her viz glass, not saying a thing. But pretty quickly I figure out we're headed to the White House Situation Room.

CB: Do you know why she brought you?

HN: I think 'cause it was so early in the morning, I was the only one on the staff who had any China background that was in yet. That, or she just didn't want to go into the meeting without someone trailing behind her.

CB: So set the scene for me.

HN: Everyone's got their viz on but me; I hadn't even been issued any yet. So it's a bit weird. But I was focused on the wall screen that showed two PLA Rocket Force brigades equipped with DF-17 and DF-51 mobile launchers in Jilin Province. That's in northeast China. It's not unusual to see activity there.

CB: What makes you say that?

HN: When I was in grad school I was part of the OSINT club and we crowdfunded CubeSats over China all the time. We'd scoop up everything from their base construction in the SCS to exercises at their missile fields. I even published an essay in Foreign Policy magazine about it.

CB: Congrats. But did anything make it notable now?

HN: Yeah. What had everyone worked up was they were moving toward prepared launch sites that hadn't been detected before. They'd been concealed and all of a sudden China wanted us to see them.

CB: Did you know which PLA unit this was?

HN: I can remember exactly. There were two units, actually: 651 and 655 Brigades. They were in the area conducting as part of the annual Sky Sword exercise with the PLARF's OPFOR Regiment stationed in Jilin. The 655 Brigade was equipped with the PLARF's first-gen hypersonic DF-17 MRBM. Even more concerning, I knew that 651 Brigade was equipped with the new DF-51[71] hypersonic ICBM. This was brand new technology – they'd only publicly revealed it two years earlier at the PLA's 100th anniversary parade. To this point it wasn't even assessed to be fully operational yet. So that just added to the general sense of confusion in the room.

CB: Was this seen as a regional threat at this point, or a threat to the homeland?

HN: I don't mean to be flip, but is there a difference when you're talking about nuclear-armed hypersonic glide vehicles? It's more a question of the nature (emphasis) of the threat. These units' rockets are ready to

launch in an instant. And do you know how fast a hypersonic glide vehicle can go from Jilin to say Okinawa, or San Francisco? We're talking minutes, not hours – decision-making time is cut down to almost nothing. And everybody assumed those missiles were nuclear-armed. I mean, they had to.

CB: You say "assumed." Why the uncertainty?

HN: We knew the DF-17 could carry a conventional or nuclear warhead. They weren't shy about this capability. We knew much less about the DF-51, other than vague references to its "dual nuclear-conventional" capability in PLA media. We were also aware of the PLA's interest[72] in developing a conventional ICBM, so there was chatter about the DF-51 possibly being analogous to the U.S. military's PGS program.

CB: PGS?

HN: Prompt Global Strike. It was a U.S. military program with the aim of being able to hit any target on earth within one hour, possibly using a conventionally-armed ICBM. One of the reasons it got axed was due to concerns that China or Russia would assume any ICBM coming their way was nuclear and respond in kind. Too risky.

CB: So I understand there was a great deal of uncertainty in that moment, fueled in part by the nature of these missiles. What did you think?

HN: (Pause) When?

CB: In the moment.

HN: Well because of the East China Sea Situation …

CB: The Japanese Maritime Self-Defense Force and Chinese Coast Guard [People's Armed Police Force Coast Guard Corps] skirmishes, you mean?

HN: Correct. The JMSDF had lost four sailors in a collision with one of China's fishing vessel slash naval militia boats. And, so in retaliation, they had used a UUV to punch a hole in the hull of the mothership for the fishing boats slash militia. It sank, but with enough time for the crew to get off. They thought they'd sent a pretty clear message, enough to show they were pissed, but not what they thought was an escalation. But I guess it didn't get received that way in Beijing. Things were getting bad. Then they got worse.

CB: What does worse mean?

HN: Well, they send out a group of J-20s and PACAF [Pacific Air Force] sortied four F-22s from Okinawa, and JASDF [Japanese Air Self Defense Force] sent a dozen JSFs [Joint Strike Fighters]. Anyway, I guess it seemed to them like even more of an escalation. I mean, I get why. Everything's multi-mission. Looks like they're sending a strike at Japanese assets and we have our own heading right back at them.

CB: But that's not the only ambiguity that mattered.

HN: Yeah, ambiguity, that's the key word here. And this links back to the maneuvers in Jilin we were tracking. There's this notion in deterrence theory that communication and knowledge of an adversary's capability is essential. Which I guess I agree with. It's not that way in the real world, though. We think we know everything (emphasis) because the world is now basically one big sensor. So when you shake that confidence or create doubt … wow. And even worse if you deliberately try to do that, the way the Chinese started mixing their nuclear and conventional missiles in the same units, like some sidewalk shell game.

CB: Why do you think they did it?

HN: I'm not the expert here. I mean I studied it and all.

CB: Apologies. Let me rephrase the question. What was the discussion about it in the room?

HN: Well, we know they mixed their units to make it harder for us to think about striking them in a conventional fight, thinking it would deter us. Hit their missile units and you might be hitting their nuclear arsenal. But that ambiguity also means any time they acted provocatively, we had to think it might not just be a conventional strike, but a nuclear first strike. And with hypersonics shrinking reaction times and ability to defeat our ABM defenses, you had to take the threat even more seriously. At least, that's the way everyone in the room talked around it.

CB: Do you agree with what you witnessed?

HN: I mean it is easy to second guess everything after the fact. But, yeah, I think when you're in the moment, you have to assume the worst. And then you had all the other stuff the Chinese were doing around those missiles. They were using some of the usual countermeasures like heat emitters. But, they had some new ones we hadn't seen: electromagnetic decoy transmitters and radar reflectors designed to spoof space-based systems. Makes sense if they think a strike is coming at them, to complicate our targeting. But from our side, we were expecting to see 24 missiles fueling up, only there's now 72 … talk about, uh, pucker factor. People took off their viz glasses, just blinking away what they'd seen. And then they start debating how many of them are real and how many are just decoys.

CB: And at this point, the Deputy NSA is the most senior White House official in the room? No one more senior?

HN: Yeah, POTUS and the National Security Advisor were at a luncheon in Brussels with the other NATO leaders. Ironically, it was to be a China-focused trip too, the whole 6G strategy problem. That's also why the Asia czar wasn't there in person.

CB: Mmmm-hmmm. And then the President was able to join on viz with the Situation Room?

HN: Yeah. After a while, the deputy had sent me to go see if anyone from the China directorate had shown up at the office yet, and when I came back, she was there on the screen.

CB: This is an area of extreme interest to the Select Committee, the timing of how long until the President was part of the meeting or not …

HN: Well, I think they moved her to Air Force One for the viz, maybe 30 minutes? But, you have that information, right?

CB: We do. But I'm trying to determine how it seemed in the room, whether the passage of time influenced the perception of a crisis, or lack of action, and therefore urgency during a moment of acute strategic ambiguity.

HN: Uh, OK. (pause) I guess I don't have a precise answer.

CB: That's okay. You're doing fine. So, let's move forward to when the link with Air Force One was lost.

HN: Yeah, that creates a shitstorm. She just drops off. And then everyone's trying to figure out what's going on, whether it is just a glitch or someone is going after our comms. This enlisted Navy tech from White House Communications Agency is being yelled at by the SECDEF [Secretary of Defense], the CIA director is talking about who he thinks is behind it.

CB: At this level of classification, it's not something we can discuss … So who is (emphasis) in the room at this point at which the President is out of contact?

HN: People kept coming and going so it was hard to track all the staffers, but at the big kids' table, you had SECDEF and the Chairman of the Joint Chiefs. They made it over in person. So did the Deputy Secretary of State.

CB: What about virtually?

HN: Well, you had POTUS and the National Security Advisor, for part. Director of CIA for all of it. Vice President was at Walter Reed, recovering from his back surgery. So he was there, but honestly it didn't seem like he was really able to get much across. The VP's National Security Advisor kept speaking for him, which made it really unclear whether she was talking for herself or her guy.

CB: Did it feel like a leadership vacuum?

HN: (Pause) No. Everybody knew what they needed to do. It was more about an information vacuum. We couldn't figure out what to do until we could nail down the most important thing: Were the missiles that were prepping for launch nuclear-armed or not?

CB: Were those in the meeting aware whether the PLA or Central Military Commission [CMC] knew we were watching this, confused? Was any effort made to dispel that confusion?

HN: SECDEF reached out pretty quickly to General Li on the CMC. But he wasn't responding. Just straight out declines the call. No one knows whether he's doing it 'cause the PLA are prepping a strike and there's no reason to talk, or it's more messaging to us that they are angry, or he just doesn't want to get ahead of his own boss. So, after more talk, they decide to escalate it and reach out to the Chinese leader. There's a whole debate about who will talk to him if they do, what with the President out of contact and the VP out of it. But, anyway, it doesn't matter as they can't reach him. He's supposedly somewhere in Xinjiang at the launch of the Kashgar smart city program. There was a dust storm, the one that hit Beijing soon after. All these things together …

CB: So, after that, what did happen?

HN: You know what … You don't need me for that.

CB: I'll remind you of your obligation here. Not just the agreement with the Executive Branch to share all records and open its staff up for interviews, but as an American. Those next 17 minutes are some of the most significant moments in our history.

HN: I get it. So, they're swinging back and forth between running the meeting all professional and yelling back and forth, until finally the SECDEF slams his fist on the table. Hard, his hand like a mallet. The guy's an ex-general who still works out every day, so it makes this big old "whomp." He says we have to decide what to do, that we have to make a list of options and rank them. That we then present those choices to the President if we get the connection back, or push forward without her and decide which option to take.The only problem is that in a crisis like that one, between the fast-moving decisions caused by the tech, and, most of all, the ambiguity of information that China had caused by mixing their missiles, there were no good options.

CB: That last part, is that what he said?

HN: No, that's just my take.

CB: It is too bad that no one realized that … your professor would have been proud.

TRANSCRIPT EXCERPT ENDS.

NARRATIVE 2: CONTESTED HEAVENS

The following editorials and analysis describe a crisis around Taiwan illustrating the role that China's emergent edge in satellite systems and rapid-launch capabilities play in a crisis that ranges from Taiwan to Earth orbit. The content was widely shared around the world, particularly among Chinese and American online audiences.

Essay #1: A Chinese Newspaper Editorial

China Ascends to Leadership in Space

by Global Times Staff

Centuries from now, the summer of 2029 may be remembered as one of the most important periods in China's history. While much of the nation was on vacation, a new era began in the skies overhead, with a crescendo of momentous developments cementing China's status as the leading space-faring nation in the world.

Access to space from Earth is the right of all, but it is natural that after recent successes the world looks to China as the leader in orbit, on the Moon, and eventually on Mars. These space ambitions, which are an appropriate reflection of China's leadership on Earth, have now been secured for the future through a foundation made up of four pillars. These pillars are distinctly Chinese but offer a shared benefit to all of humanity and an alternative to the unreliable and often destabilizing offerings from the United States.

First, when drivers in Shanghai, or Manila, or New Delhi look for help finding their way, they now turn to the new version of "BDS" – not GPS. The BeiDou Satellite Navigation System has finally surpassed the United States' dated GPS constellation, with more users taking advantage of a system that is not bedeviled by political fights over funding like America's GPS. The BDS accuracy is unparalleled, offering down to sub-centimeter-level precision for military and civilian users alike, with a readily available and lower-cost BDS chipset.

Second is the launch of the new "Golden Pigeon" quantum communication network, which is the successful culmination of over a decade of cooperation between researchers in China and their counterparts in Switzerland. The "Golden Pigeon" network of space-based satellite transmitters connect users anywhere with secure communications though Quantum Key Distribution encryption and security software and hardware. This offers the Chinese government and Chinese companies, and soon close friends and allies, an unparalleled security advantage and data free from "Five Eyes" snooping. After sending his first message with a Golden Pigeon handset, one Beijing CEO said, "I feel like I can breathe again."

Third, this summer's first launches of the Space-Earth Integrated Information Network Mega Project only add up to just over 100 satellites out of an eventual 13,000 planned to be in orbit by the end of the next decade. But in any journey, though the first steps may be small, they are nevertheless the most important. A central pillar for China's Innovation 2030 plan, this network will transform every facet of life on Earth by creating a truly connected world for the first time. Anywhere at sea or atop the tallest mountains people will have access to information at the same speed as if they were at home. Such an accomplishment will be achieved through China's cutting-edge transformation of artificial narrow intelligence (i.e. things like GPS advancements) to artificial general intelligence (i.e. using machines that can perform any intellectual task that a human being can.) No other nation has ever dared attempt such a feat, as none would be able to succeed as China has.

The fourth pillar of this progress comes from a shared vision for China's future in space among China's visionary government departments and companies. Holding up its end of the bargain is the most innovative space-launch company on Earth, C-Space. Ask any satellite company who they trust with their beloved inventions and their customers' capital and it's C-Space. Moreover, C-Space is, according to a recent Xinhua News report, turning away business because it is booked for the next four years. This summer marked its 150th successful launch of a customer payload, and all at a price that reportedly undercuts SpaceX, which has only endured in the market due to indirect US military subsidies from launching spy satellites for the US Air Force and US Space Force.

China certainly has grand ambitions during the next decade and must balance competing areas of investment and attention. But it is entirely manageable as is befitting a harmonious relationship between government and private companies. During the next decade, space will not just be a story of taikonauts living permanently in lunar bases and launching the first mission to put a human on a planet other than Earth. It will also be a decade of China's friends and partners finding safety and security in Chinese systems for everything from navigation to secure communications.

Essay #2: US Think Tank OSINT Report

REVEALED! OPEN-SOURCE INTELLIGENCE SHOW NEW CHINESE MILITARY SPACE EXERCISES

by PSI Orbital Tracker

Readers of the PSI Orbital Tracker will be familiar with the significant developments unveiled by open-source intelligence over the past two weeks, showing that Chinese PLA air, sea, and ground forces have rapidly repositioned into locations associated with a potential offensive military operation against Taiwan. However, in an exclusive report, open-source launch and trajectory data and analysis from the Pacific Space Institute Orbital Tracker team have identified a series of terrestrial and orbital exercises by Strategic Support Force (SSF) units, demonstrating rapid-launch and satellite replenishment capabilities.

The following series of twenty-four images demonstrate key elements of mobilization and satellite-launch capabilities being rehearsed by the PLA in both terrestrial and orbital settings. Images 1-8, for instance, show a snap exercise of PLA mobile launch systems. These highly survivable, distributed mobile vehicles successfully conducted 18 launches of micro-satellites over six days, according to PSI Orbital Tracker CubeSat assets. This is the first time the PLA has demonstrated this capability at such scale. Moreover, they have never been deployed to the area before. By contrast, Chart A shows the tracking data of the Brilliant Phoenix satellite network repositioning during the same period. It provides evidence of a test of orbital "swarming" maneuvers, which could be utilized against other satellite networks. Overall they paint a picture of the space capabilities that the PLA has built up over the last decades being honed during a crisis moment.

Chinese leaders are well aware of the ability of the both US intelligence community and open-source cube-sat networks to observe this activity, which makes these activities out in the open a likely form of strategic messaging.

Combining PSI's CubeSat imagery and data with disaggregated social media campaigns within China and Taiwan, the Orbital Tracker team has high confidence that the recent maneuvers reflect a desire to demonstrate a deepening capability to both conduct and defend against space operations, amidst heightened political and social strife on the streets of Taipei this summer, widely believed by experts to be the result of an ongoing information warfare campaign being run by the PLA's Strategic Support Force targeting Taiwan.

The "show of force" activities uncovered by PSI demonstrate both the continued growth in China's military and civilian space assets, as well as the risks that any conflict over Taiwan would likely reach into space. That portends a new strategic reality the world may not yet be ready for.

Essay #3: A Western News Account

CHINA SATELLITE SHOOT-DOWN STOKES FEARS OF TAIWAN INVASION, WHILE DEBRIS FIELD THREATENS US MILITARY SPACE NETWORKS

by Washington Post

GUAM – American, Taiwanese, Japanese and Australian defense leaders met for crisis talks Sunday as they confront the double-barreled threat posed by Chinese military forces massing across the Taiwan Strait in the wake of an anti-satellite missile test that destroyed a defunct weather satellite. The missile test created a massive orbital debris field affecting military and civilian communications, navigation, and intelligence gathering across the Western Pacific.

"It's hard to imagine the situation getting any worse on the ground or in orbit, short of a shooting war, which may not be that far off," said Mary Armstrong, a senior fellow at the Center for Strategic Space Studies and a retired US Air Force intelligence officer. "My biggest concern is this test was a deliberate way to turn that satellite into a scattergun to take out American orbital communications and intelligence assets."

A senior official in Taiwan's defense ministry said the talks with US officials focused on preparing for the arrival of a land- and sea-based deterrent force of American, Australian, and Japanese units. This force, the official said, would only be able to reach Taiwan if the PLA doesn't use its advanced arsenal of ground, air, naval, and rocket forces that surround the disputed island nation.

"The irony is that the deterrent force can only deploy if the PLA doesn't announce a blockade first," the Taiwanese official said. "But we have to try, even if it escalates things with Beijing."

At the same time as tensions in the Pacific grow, the debris cloud from the PLA's anti-satellite weapons test continues to wreak havoc in orbit above, according to defense analysts and US officials. Imagery of the test shared on Chinese social media showed a successful "destructive" intercept of the Qi Tin 4 geostationary weather satellite.

The timing of the test, which occurred during a sweeping military exercise by the People's Liberation Army (PLA), was meant to demonstrate two things, according to Armstrong. First, it showed how China has progressed with its anti-satellite weaponry and what kind of destructive capabilities it can unleash. Second, a PLA rocket launched a replacement satellite immediately after, albeit in a different geostationary position that was out of the debris cloud. "This is a serious capability that the PLA's showing off for everyone to see," said Armstrong.

The test also created a debris field of at least 4,500 pieces of trackable size (golf ball size and larger) and more than 250,000 estimated smaller debris particles. These objects moving at the velocity of bullets have caused untold problems for everyone from telecommunications companies to oceanographic research programs, as engineers frantically repositioned satellites or dealt with damage. At least 25 military and civilian satellites were destroyed or sustained damage from the field, further adding to the cloud of "space junk." A NASA spokesperson angrily denounced the test as "threatening humanity's safety in space for decades to come."

China has also reportedly suffered the loss of several satellites to the ensuing debris field, although its losses have been considerably less severe, as the destroyed satellite was operating in an orbit relatively bereft of Chinese space assets.

The biggest risk, officials said, is a domino-like effect known as Kessler Syndrome, in which satellites crash into one another in an ever-expanding cloud of debris. If that continues unchecked, it can effectively leave certain orbits unsuitable for satellites for decades or far longer. Armstrong said she could not speak to any US defense satellites in the area of the Chinese test, but the larger questions raised by such a possibility are valid. "Either way, it underscores to the entire world that even a new generation of resilient US satellites may be vulnerable to Chinese anti-satellite weapons."

A source with a regional civilian satellite constellation operator indicated that the PLA may have used the test to deliberately target recently positioned US communications satellites in the area. Three weeks ago,

the source said, the targeted satellite was observed adjusting its orbit to roughly correspond with that of 11 recently launched communications CubeSats, and these were among the first victims of the ensuing debris field. "These were leased assets, not US military operated, but the customer was the US Space Force," the source said. "So was it a miscalculation, or was it essentially an act of war? The only people who know right now are in Beijing."

A Space Force spokeswoman referred questions to the Defense Department.

NARRATIVE 3: A MATTER OF EVIDENCE

Major General Li Jiang took another sip of the warm bottled water, but his mouth still tasted of dust. It had been four years since the retired PLA officer had been to the Xinjiang Uyghur Autonomous Region, but it was as if the arid and unforgiving area would not let him escape, no matter how hard he tried. Or rather, it was that the Party would not let him escape his responsibilities.

Just 24 hours ago he had been fishing at Lake Taihu, blissfully avoiding the Sina Weibo updates of the ongoing crisis with India, when the call from the Senior Vice Chairman of the Central Military Commission came in. There was no small talk about their grandchildren, complaints about medication side effects, or reminiscing about the old days as classmates at the 2nd Artillery Command College. Today, he was all business. Only hours before, there had been an explosion at the PLARF base outside Korla. It was not yet publicly reported, but the lives lost and potential radiation spread meant that a decision about how to handle it had to be carefully managed, and the Senior Vice Chairman strongly suspected that local commanders were not giving him the full story. Prior to the upcoming CMC meeting about the "incident," he needed someone that "he could trust" to give him a first-hand account of it. It was left unsaid that his old friend also needed someone who was disposable. The doctors had injected so much radiation into Li's body in a futile attempt to stop the cancer's spread, what was a few more rads?

A jet black Audi was already waiting by the time he tied his boat to the shore. It spirited him away to an air strip where a Gulfstream that belonged to a Chengdu construction magnate who owed his good fortune to the Senior Vice Chairman was waiting.

The flight had at least been enjoyable. They had thought of everything, from a freshly pressed uniform that fortunately still fit, to the galley being stocked with a decent American rye whiskey.

But now, as he left the base, Li dreaded what might come after his return. The admonition to not "kill the messenger" had its origins in the ancient codes of the Warring States period. He only hoped it still held now. He desired to spend what little time he had left chasing the carp of Lake Taihu on his boat, not locked down under house arrest, or even in some cell, for "spreading rumors." Or perhaps even worse, sent back to this desert to clean up the mess that he had found.

"General, we will arrive at your plane in a few minutes," said his driver, a short corporal with smooth cheeks, who lacked the ability to look him in the eyes, except when he was peering backward in the rear-view mirror.

Li shook his head with dismay and waved the water bottle at him to keep his eyes on the road. No luck. The kid went from gawking at Li back to fiddling with his phone with his left hand held low, while the right hand gripped the steering wheel.

Would it be better to die instantly from a distracted driver than to wither away slowly, mused Li? No, there were too many carp waiting to be caught.

Li pulled out his tablet and began to compose. He'd taken no notes while on base, so it was important to capture what he had seen before his memory failed him. The medication sometimes caused gaps to appear in his day, and this was too important to let that happen here.

My Friend,

Thank you for entrusting me with this important matter. It was invigorating to wear the uniform one last time and serve our dear people.

The following captures what I learned of the Korla incident, based on interviews with key PLARF officers and enlisted personnel, as well as an inspection of the incident site.

Please be patient with me before I deliver my conclusion because I believe the entirety of the situation needs to be understood for the good of the Party. As well, I recognize that my findings may inform your decision on any steps to be taken against external actors, if needed.

I arrived at Korla and immediately met with the base commander, who was accompanied by the political commissar. I explained the purpose of my visit. The base commander was visibly agitated, and I asked why. The commander explained to me that he felt personal and professional shame at the situation, despite the explosion being caused by Indian hackers. It seemed he was trying to walk the thin line between taking responsibility for what happened during his command, while trying to ensure that the blame fell elsewhere.

The PC was more self-confident, replying to the commander in a statement clearly meant for me, that our leaders would surely understand the failure to stop a cyber attack was not the fault of their command but a matter for the Strategic Support Force. I read it as a similar, but different attempt to displace the consequences.

In either case, I played along, offering that both were correct to be concerned about the role that some kind of cyber activity may have played in the explosion.

Both looked especially relieved. Using that moment of relief, I asked them to sum for me what exactly happened.

The base commander restated what he had reported after the incident to PLARF headquarters: A high-bay garage storing two DF-26 missiles had exploded. Thirteen soldiers and one officer were killed inside, with only one enlisted soldier surviving the initial fire. Another 82 outside the garage had been killed or injured in the subsequent explosion and wider fires that had left a 125 meter scar in the ground and damage to various nearby vehicles and buildings.

Fortunately, he explained, the nuclear warheads for the missiles had not been mated at the time of the incident. This was, of course, obvious, as we were not sitting in the midst of nuclear cataclysm, rather than the near miss of one. Given recent tensions with India, the warheads had been forward deployed from their central repository via rail to a closer depot outside Xining, and then transported via road to the brigade base. Had we been at a higher state of readiness, they may have actually been mated with their missiles, leading to disaster. The commander and PC again blamed the Indian hackers, who had been detected in the network by a subsequent review of the base's network logs.

I asked to see the base's network logs and what had been found so far.

At the base's operations center, the commander and PC showed me what the Strategic Support Force Network Operations Department and Ministry of State Security had remotely discovered. You have this information but I will summarize it again: Indeed, an Indian hacking group called "Patchwork" was inside the base's network at the time of the explosion. Whether this operation was sanctioned by the Indian

military or intelligence services is hard to know. With democracies, you often can't tell, whereas our own citizens, be they corporations or even criminal groups, would not dare to move ahead of the nation's interests.

Permit me to offer some of my experience here. This incident reveals a problem of attribution in a networked world. It is more difficult by the day. This matters not just for the Party's record of history, but for truly understanding the human dimension of a situation, such as a war.

But what was also troubling was that both local leaders were still unaware that our very same cyber organizations had also been tracking American and even Russian activity in their network. For all our efforts at creating a joint force, our various cyber and intelligence organizations continue to prioritize keeping their own secrets over providing needed information to other services and commands.

In either case, the local logs confirmed that hackers likely working on behalf of the Indian government had in fact been probing the base's systems, including climate control and ground surveillance systems of the high-bay garage. However, they also did not show any direct access to the missile systems themselves. We had evidence of what might be called regular reconnaissance activity, but no "smoking gun."

The commander and the PC had nothing further to add other than intimating that the Indians somehow must have triggered the explosion through yet unknown means.

Thus, I was faced with the dilemma that I assume is why you sent me to this desolate place in person: There was no evidence of how this cyber activity, Indian or otherwise, could have physically caused the explosion. It also lacked clear motive, as we, and the Indians, as well as the Russians and Americans, are all in a new era of mutual vulnerability.

I'm a simple soldier, I reminded myself amid so much technology. So I turned to the question of what would a simple soldier make of all this? And thus I asked to meet with the sole surviving soldier, to express our party's sympathy for the loss of his unit.

At this, the PC resisted. He stated that he had already spoken with the soldier to provide the party's thanks, but then made a nonsensical and clearly panicked excuse, saying the young man could still be contaminated with chemicals, and there was no need for a senior leader to take similar risks. I expressed that my body's cells had proven their power to resist chemicals (one must have some fun at what life has sent me). And, besides, I asked, why are you and I within arm's reach if he has contaminated you?

The commander gave his PC a quick look and they relented, taking me to the soldier, who was isolated in the medical wing.

Upon entering the room, I ordered the commander and PC to leave me alone with the young man. They saw the look in my eye that indicated I would not brook objection and immediately complied.

The soldier is a 19-year old enlisted man. He had burns across his arms and legs, but was otherwise able to speak with me to the best of his ability.

I asked him to recount what had happened to his unit. As soon as he replied however, it was clear that the words were not his. That is, it was his voice speaking, an evident accent placing him as being from rural Henan, but the words that he was saying were those of either his commanding officer or the PC. Blame lay beyond the base, he mumbled. Hackers were at work. We might never know the cause.

At this point my patience was lost. You may smile at memories of what it is like for someone to find themselves as the target of my impatience, having witnessed it in the past.

I had once commanded a PLARF maintenance company myself, I told the soldier. I would see through any lie he made to me and if he continued to do so, his entire family would face consequences that would make whatever he had been threatened with here seem like kisses from his mother. He had seen how quickly the commander and PC had followed my orders. So, if they feared me, who should he fear more, them or me?

At this, the soldier broke and began to recount what actually happened at the time of the accident. It seems that his unit had an ambitious young company commander, eager to shine in upcoming exercises. Each of the crews serving on the TELs was judged by how rapidly they were able to reload the missiles after launch. So, he had set his unit to practicing the steps again and again to gain an edge. Not at a training site, as that would let his peers know of the extra time spent. You could choose to reward this commander for his energetic leadership or punish him for violating our regulations, but, in either case, there is nothing left of him but ashes.

They took turns, repeating the exercise all night long. It is clear that our young soldier and his mates understood the basics of what they were doing, but did not comprehend the fundamentals, not just of nuclear weapons or rockets, but of the computers they used to control them, nor the advanced machinery of the launcher and vehicle on which they are mounted.

It is not that he lacked intelligence, but education. Only months earlier our young soldier had been a recruit, running through an obstacle course, while being yelled at by a drill instructor. A month before that, he was likely digging in the dirt with a spade, being yelled at by his farmer father. He only possesses a middle school education, and is now being asked to handle highly complex equipment in close proximity to explosive chemicals and nuclear warheads.

This is the cost of our force's rapid advance toward modernity.

We have leapfrogged generations of technology and multiplied the number of weapons and units. But much of the population that we must recruit from remains behind. Of course, I would still take our hardy youth over the American military's recruiting pool of fat video game addicts. But as much as you and I remember the past with fond memories, today's PLA asks far more of our soldiers.

Back to the incident itself. What I can best ascertain from the soldier is that the off-the-books training was being run on a DF-26 used for "cold launch" testing. This system was available in a way that the unit's other missiles and vehicles were not. Plus it was considered safer as the missile's engines had been removed. However, cold launch does involve a gas charge, in lieu of the engine of the missile being ignited. During one of the changeovers, the gas canister was somehow ruptured. The young soldier strongly suspects this was a maintenance issue – the squad tasked with repair and maintenance of this section of the TEL was disproportionately composed of new recruits who had been struggling to grasp the complexities of the machinery and computer systems of the DF-26, leading to frequent safety issues. Many of these recruits lacked even a rudimentary high school education, much less the kinds of skills needed to quickly understand and engage with such cutting-edge equipment.

This rupture of the canister was first noticed by another new recruit, this one from rural Guangxi, who apparently did not immediately recognize the seriousness of the situation until a fire had broken out, leading moments after to a fiery explosion on the TEL. Fueled by the gas charge, the fire spread quickly to

nearby vehicles and crates. After attempting to put it out themselves, our young soldier was ordered to go get help. His officer had delayed too long, though. Shortly after our young soldier ran from the high-bay garage, the fire evidently reached a high enough temperature to ignite the solid state fuel in the rockets, causing the subsequent explosion that killed not just all of the unit secretly practicing in the garage, but also other personnel nearby.[73]

At this point, the young soldier was in tears, filled with what I must assume is the guilt of the survivors.

I, too, nearly wept. We, as senior officers, must shoulder blame, as well. We allowed our capabilities to advance faster than our personnel system. We deploy technologies and mandate readiness at potentially unattainable levels within the PLARF, given the personnel that we have right now. Our orders are interpreted by junior officers who are infused with ambition but lack the courage to question any command. These orders are executed by soldiers who are patriotic, but may not be ready and oftentimes lack the requisite skillset for our new, high-tech force.

In sum, it was not the Indians who did this. Nor the Americans. Or Russians. It was ourselves.

Thank you for the opportunity to serve our great nation one last time. I hope you find this information of great value in your important deliberations ahead.

India to Blame for Cyber Attack on PLA Missile Site; Almost One Hundred Patriotic Soldiers Killed

BEIJING (GLOBAL TIMES NEWSWIRE) – The Chinese foreign minister on Monday squarely blamed India's cyber terrorist activity for last week's accident at the PLA Rocket Force base in Korla. Minister Fu Jiang promised that China would retaliate unless India apologizes and withdraws its forces from the disputed territories within 24 hours in the wake of its "perfidious attack on the PLA."

APPENDIX 2: LIST OF PLARF BRIGADES BY MISSILE TYPE

NUCLEAR			
DF-41	ICBM	644 BDE	Hanzhong, Shaanxi
DF-31/31A/31AG	ICBM	621 BDE^	Yibin, Sichuan
		622 BDE	Yuxi, Yunnan
		632 BDE	Shaoyang, Hunan
		641 BDE^	Hancheng, Shaanxi
		642 BDE	Xining, QInghai
		643 BDE	Tianshui, Gansu
		652 BDE	Tonghua, Jilin
		663 BDE	Nanyang, Henan
		664 BDE	Luoyang, Henan
DF-5A/B	ICBM	631 BDE	Huaihua, Hunan
		633 BDE	Huaihua, Hunan
		661 BDE	Lingbao, Henan
DF-4	ICBM	662 BDE^	Luoyang, Henan
DF-21A	MRBM	611 BDE	Chizhou, Anhui
		612 BDE	Leping, Jiangxi
		651 BDE	Dalian, Liaoning
CONVENTIONAL			
DF-21D	MRBM/SRBM	624 BDE	Danzhou, Hainan
		653 BDE	Jinan, Shandong
DF-17*	MRBM	614 BDE	Yong'an, Fujian
		627 BDE	Puning, Guangdong
		655 BDE^	Tonghua, Jilin
DF-16/16A	SRBM	617 BDE	Jinhua, Zhejiang
		636 BDE	Shaoguan, Guangdong
DF-15A/B/C	SRBM	613 BDE	Shangrao, Jiangxi
		616 BDE	Ganzhou, Jiangxi
DF-11A	SRBM	615 BDE	Meizhou, Guangxi
CJ-100*	GLCM	656 BDE	Jinan, Shandong
CJ-10/10A	GLCM	623 BDE	Liuzhou, Guangxi
		635 BDE	Yichun, Jiangxi
NUCLEAR-CONVENTIONAL			
DF-26	IRBM	625 BDE	Jianshui, Yunnan
		626 BDE	Qingyuan, Guangdong
		646 BDE	Korle, Xinjiang
		654 BDE	Dalian, Liaoning
		666 BDE	Xinyang, Henan
UNKNOWN			
		634 BDE	Huaihua, Hunan
		645 BDE	Yinchuan, Ningxia
		647 BDE	Xining, Qinghai
		665 BDE	Xinxiang, Henan

* Possible nuclear role hypothesized; ^Missile Type Unconfirmed but Probable
Note: Given their inland locations, all four of the unknown brigades are likely to be either nuclear or dual nuclear-conventional.

APPENDIX 3: CHINA R&D TRENDS: HYPERSONIC WEAPONS DEVELOPMENT AND MILITARY APPLICATIONS FOR ARTIFICAL INTELLIGENCE AND MACHINE LEARNING

This appendix is a supplement to the Imagining Armageddon: A Fictional Intelligence (FICINT) Approach to China-US Nuclear Competition study, prepared by BluePath Labs (BPL) for the Defense Threat Reduction Agency, which examines China's nuclear capabilities in the period of 2026–2031 using a combination of open source research and FICINT. Understanding the future development path of emerging technologies and major research and development (R&D) trends is central to this report and could prove critical to understanding how a crisis between the United States, China, and its neighbors proceeds. We therefore took advantage of BPL's big data tools to examine a series of key terms related to two of the technologies which we judged likely to have a significant impact on these futures: artificial intelligence/machine learning (AI/ML), and hypersonic weapon systems.

FINDINGS SUMMARY

We found that China has been increasing both its volume of publications per year in the fields of AI/ML and hypersonics and its proportion of publication output within those fields over the past 20 years. Similarly, China has continually increased the number of patents per year in these areas over the past 20 years.

Beyond stating the obvious fact that China is investing heavily in both AI/ML and hypersonics, a deeper dive into the data shows that China shows strong interest in technologies with military applications. All of the top technologies for hypersonic flight are critical to hypersonic missiles, space vehicles, and other military uses. The range of topics for AI/ML was much greater and included a large number of non-military topics, such as utilizing AI to improve medical diagnoses. However as the list of clusters above demonstrates, China is certainly interested in a range of topics with clear military utility, including information extraction (useful for intelligence gathering when dealing with large datasets), autonomous navigation and autonomous underwater vehicles, and technologies related to improving radar and guidance systems, such as target tracking, de-noising, and radar imaging.

METHODOLOGY

GENERAL

Documents within the corpuses of Microsoft Academic Graph (MAG) and the Patent Statistical Database (PATSTAT) were examined to determine the research and patent output activity of the People's Republic of China in the areas of AI/ML and hypersonic flight. MAG hosts over 200 million research documents, theses, conference proceedings, and other forms of scholarly works and is one of the most comprehensive databases for academic publications. Similarly, PATSTAT is one of the largest repositories of worldwide patents, with over 100 million documents from countries around the world.

DATA COLLECTION

BluePath Labs Elasticsearch indices of MAG and PATSTAT were used to harvest documents within the topical areas of interest. Elasticsearch is a full-text search engine that can rapidly search large numbers of documents to find subsets that fit specified criteria. The titles and abstracts of the documents were searched using curated keywords and phrases for the topics of interest published between 2002 and 2020

inclusive (see Appendix 1 – Keywords and Phrases). Each keyword or phrase was verified to return a vast majority of documents within the target area of interest.

These keywords gave 392,062 documents related to AI/ML and machine learning and 4,416 documents related to hypersonic flight with at least one Chinese affiliation from MAG. Patents were collected only from entities that were identified as non-individuals, such as companies or universities. Because the country affiliations of patent authors within PATSTAT are often incomplete, no country restriction was applied to our patent query. Using the same keyword sets for each topic, 37,417 AI/ML related patents and 1,676 hypersonic flight related documents were retrieved from both Chinese and non-Chinese authors.

DATA TREATMENT

Author institutional and country affiliations are widely present within MAG; in contrast, documents in PATSTAT are frequently missing country affiliations for both works and authors. For the AI/ML and hypersonic related documents within PATSTAT, approximately three-quarters were missing country affiliation data. Manually inspecting samples of these documents revealed a majority were authored by Chinese entities.

Due to the large amount of data with missing affiliation and a non-trivial proportion of these documents having Chinese authorship, we algorithmically determined the Chinese authorship of documents with missing PATSTAT affiliations. The unknown entities were classified as either Chinese or not Chinese based on the entities' names, using the names and affiliation of already labeled entities within the AI/ML and hypersonic documents as a training set. Our model had an overall 97% accuracy with a 93% true positive rate on classifying unknown affiliations as Chinese.

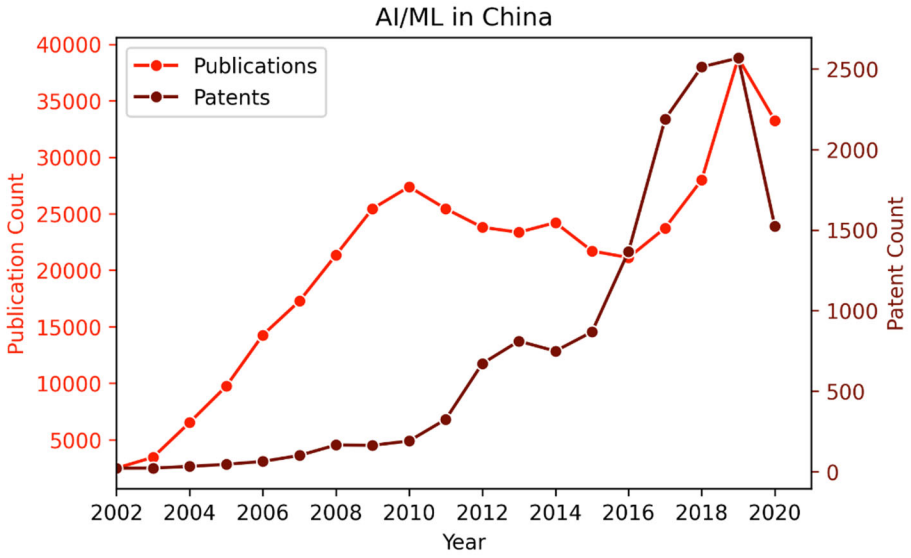
Applying the model to the documents with unknown affiliation gave 71% of unknown documents being labeled as Chinese. The entities with the highest number of patents from the model-labeled documents were examined; false positives and false negatives were removed manually. The top 100 producing entities labeled as Chinese were true positives, however there was a high false negative rate among the top entities labeled as non-Chinese. Of the top 200 entities labeled non-Chinese, 99 were found to be Chinese by manual inspection. Entities below the top 200 contributed 3 or less patents over the last 20 years and were treated as non-Chinese.

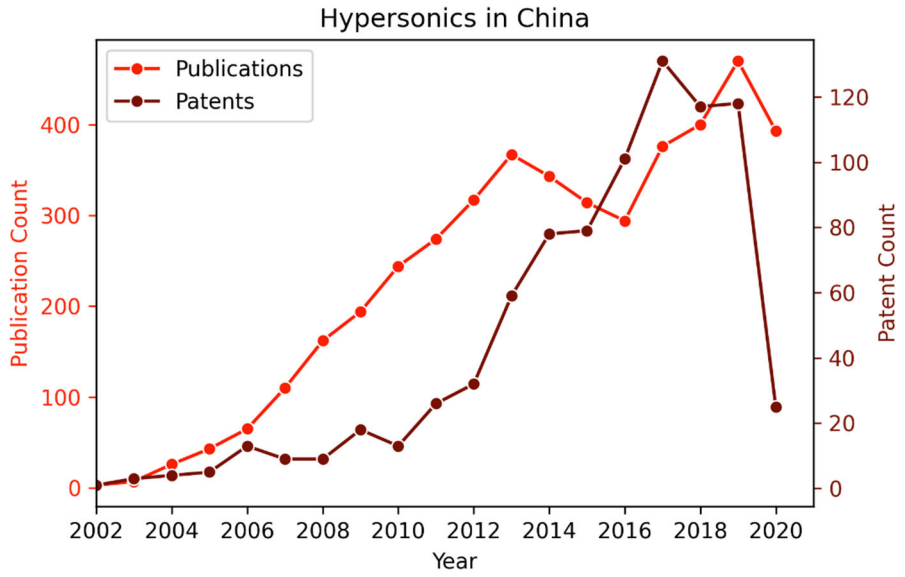
The published date for academic works was used as the basis for the year of that work. Patents have several different dates associated with their filing; for this analysis, the first patent filing date was used as the basis for this analysis.

ANALYSIS

China has been increasingly publishing works related to AI/ML and hypersonic flight, with an average year-over-year (y/y) growth rate of 11.6% and 19.5% respectively. This is markedly higher than the U.S.'s growth rates of 5.9% and 4.2%, respectively. Not only has the volume of publications in these areas increased, but the proportion of all published works from China in these areas has also risen, from approximately 4.6% of all research in 2002 to a high of 7.3% in 2019 in AI/ML, and from 56 publications per million (ppm) to a high of 908 ppm in 2018 in hypersonic flight.

In contrast, the U.S.'s proportion of published works are both smaller and have grown more modestly. The U.S.'s proportion of published works related to AI/ML had a low of 2.5% in 2003 and a high of 4.3% in 2019. The proportion of works related to hypersonic flight was at its lowest in 2002, with 190 ppm, and peaked in 2010 with 274 ppm, though the U.S.'s proportion has been relatively steady for the past 20 years.





Note: Dips in both publications and patents in 2020 are suspected to be due to the COVID-19 pandemic.

SUBTOPIC IDENTIFICATION

AI/ML and hypersonic flight are multidisciplinary fields which can span many different topic domains. To identify the most relevant technologies from a military perspective (and in particular, for the accompanying report and fictional narratives) we reviewed Chinese Defense White Papers and similar documents and drew on other research completed by our team to identify key terms which further narrowed the scope of our search.

HYPERSONIC FLIGHT

To determine any subtopics within the field of hypersonic flight, we used a document clustering algorithm to find groups of documents with similar subtopics using abstract text. Of the 4,416 documents related to

hypersonic flight with Chinese authorship, 4,006 had abstract data usable for topic clustering. Of these, 3,002 documents were readily assignable to one of 10 identified topic clusters listed in the table below.

Topic Cluster	Documents	% of All
Hypersonic vehicle control systems	911	20.6%
Mixing and combustion in hypersonic engines	454	10.3%
High temperature materials	386	8.7%
Hypersonic vehicle design	334	7.6%
Wind tunnel testing	236	5.3%
Hypersonic inlets	222	5.0%
Atmospheric reentry guidance and control	206	4.7%
Hypersonic boundary layers	197	4.5%
Hypersonic fluid, flow, and heat simulation	156	3.5%
Atmospheric reentry plasma sheaths	136	3.1%

AI/ML

A similar clustering methodology was used to identify subtopics within the AI/ML document set with one caveat: due to the large size of the AI/ML document set, approximately 10% of the documents collected were sampled at random to identify subtopic clusters. Of the 37,350 random sample documents used, 17,964 documents were assignable to one of 69 subtopic clusters. This result demonstrates the large breadth of topics within the field of AI/ML and machine learning. The clusters with the most militarily or dual-use relevant subject matter are listed in the table below, along with the approximate proportion of documents within the original pull.

Topic Cluster	Documents	% of all
Ant colony algorithms	760	2.0%
Text summarization and information extraction	601	1.6%
Image segmentation	497	1.3%
Fault diagnosis algorithms	429	1.1%
Target tracking	428	1.1%
Autonomous navigation	347	0.9%
Autonomous underwater vehicles and control systems	314	0.8%
Robotic manipulators and human-robot collaboration	304	0.8%
De-noising	254	0.7%
Radar imaging	63	0.2%

SIGNIFICANCE

Beyond stating the obvious fact that China is investing heavily in both AI/ML and hypersonics, a deeper dive into the data shows that China shows strong interest in technologies with military applications. All of the top technologies for hypersonic flight are critical to hypersonic missiles, space vehicles, and other military uses (though in fairness, the list of topics for hypersonics was relatively narrow and largely applicable to both military and non-military uses). The range of topics for AI/ML was much greater and included a large number of non-military topics, such as utilizing AI to improve medical diagnoses. However as the list of clusters above demonstrates, China is certainly interested in a range of topics with clear military utility, including information extraction (useful for intelligence gathering when dealing with large datasets), autonomous navigation and autonomous underwater vehicles, and technologies related to improving radar and guidance systems, such as target tracking, de-noising, and radar imaging.

While the gap in research output may appear dire at first glance, and certainly points to China's rapidly growing research capabilities and ecosystem, one important caveat is that quantity of output does not necessarily equate to quality of output. Chinese research institutions are known to place heavy emphasis on research *volume* as a way of quickly garnering prestige and funding within the state research ecosystem, even if this means neglecting research *quality*. When measured by quality (typically based on number of citations), China's research output continues to lag behind that of the United States and other countries, despite its progress.[74] This phenomenon holds true for patents as well. A recent study from Nikkei[75] illustrated this point perfectly: the study analyzed patent output in ten cutting edge technologies, including AI, since 2000. When judged by patent *volume*, China is shown systematically rising to the top of nine of the ten categories by 2017. However when judged by patent *quality*, China only has one institution cracking the top ten in any one of these categories, whereas the United States has 64 institutions in the top ten. For AI specifically, eight of the top ten institutions were from the United States, and none were Chinese.

LIMITATIONS

Numbers, statistics, and analysis should be treated as approximate values. Though the collections of MAG and PATSTAT are extensive and regularly maintained, they are not all-inclusive; missing documents contribute to error.

Due to the COVID-19 pandemic, the volume of publications and patents in 2020 deviated from the ongoing rising trends. Primary causes for this observation are likely to be decreased research capacity due to COVID-19 related restrictions and decreased administrative capacity at publishers and government offices due to operational restrictions from health measures. A similar trend was observed in the United States during this period, giving further credence to the idea that COVID, rather than some issue specific to China, was the proximate cause.

Though the number of publications is a readily quantifiable metric, it does not give a complete picture to a country or institution's contributions to a field of study; the quality of a publication and the process by which that is measured are important aspects to a more comprehensive description of an entity's performance. Due to the limited scope of this analysis, we did not incorporate any aspect of publication quality.

Military-related research and findings within the AI/ML and patent space are likely to be limited due to the generally classified nature of military work. Hypersonic flight is especially focused on military applications, leading to a high likelihood of a severe disparity in the amount of effort and work being invested in these areas based solely on their publication and patent counts.

The terms chosen for document collection were selected to retrieve documents from Chinese authors. Using the same terms to collect documents from non-Chinese authors may fail to retrieve all relevant documents; however, using different terms would give an unequal basis of comparison. Due to the limited scope of this analysis and the focus on Chinese authorship, we did not pursue a culturally broad query. Data on non-Chinese authored documents is used as a basis for approximate comparison and should not be interpreted as being comprehensive or having a high degree of precision.

APPENDIX 4: KEYWORDS/PHRASES

KEYWORDS/PHRASES

The keywords and phrases used to query our academic and patent corpuses are given below for AI/ML and hypersonic flight respectively. Documents were required to match the exact phrases/keywords between each comma. Phrases with parentheses and '+'s were required to have the exact phrases separated by the '+'s within the parentheses. (e.g., the document must have "big data" and "learning" somewhere in the document, but not necessarily together).

AI/ML QUERY TERMS

deep learning , cross-domain integration , man-machine collaboration , human-machine collaboration, collaborative intelligence, swarm intelligence , autonomous control , autonomous systems , (big data + learning) , (artificial intelligence + cross-media) , autonomous intelligence , intelligent warfare , intelligentization, intelligent computing , intelligentized missiles , (virtual reality + intelligent) , natural language processing , (hybrid enhanced + intelligent) , smart robots , smart terminals , smart logistics

HYPERSONIC FLIGHT QUERY TERMS

hypersonic vehicle , (hypersonic + ablative) , (hypersonic + combined propulsion) , Rocket-Based Combined Cycle , RBCC , Turbine-Based Combined Cycle , TBCC , hypersonic control , (hypersonic + aerodynamic heating), (hypersonic + scene matching) , (hypersonic + integrated control) , hypersonic flight

ENDNOTES

[1] Ma Xiu, "PLA Rocket Force Organization Executive Summary," China Aerospace Studies Institute, January 2022. https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLARF/2022-01-05%20PLARF%20Organization%20ExecSum.pdf.

[2] "Full Text of 2019 Defense White Paper: "China's National Defense in the New Era" (English & Chinese Versions)," *andrewerickson.com*, 24 July 2019. https://www.andrewerickson.com/2019/07/full-text-of-defense-white-paper-chinas-national-defense-in-the-new-era-english-chinese-versions/.

[3] Provided in U.S. Department of Defense (DoD) materials such as "Military and Security Developments Involving the People's Republic of China 2021," U.S. Department of Defense, 2021. https://media.defense.gov/2021/Nov/03/2002885874/-1/-1/0/2021-CMPR-FINAL.PDF.

[4] Ma Xiu, "PLA Rocket Force Organization Executive Summary," China Aerospace Studies Institute, January 2022. https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLARF/2022-01-05%20PLARF%20Organization%20ExecSum.pdf.

[5] See, for example, Ian Easton, "China's Evolving Reconnaissance-Strike Capabilities," *Project 2049 Institute* and *The Japan Institute of International Affairs*, 2014. https://www2.jiia.or.jp/pdf/fellow_report/140219_JIIA-Project2049_Ian_Easton_report.pdf.

[6] Peter Wood, Alex Stone, "China's Ballistic Missile Industry," *China Aerospace Studies Institute*, 2020. https://www.bluepathlabs.com/uploads/1/1/9/0/119002711/bluepath_labs_ballistic_missile_industry_report_2021.pdf.

[7] To give just one example of this, the prospect of conventional counterforce strikes against Chinese nuclear assets, an idea that has been periodically discussed but was likely unrealistic even under previous conditions, is now an even more remote prospect. See: Tong Zhao, "Conventional Counterforce Strike: An Option for Damage Limitation in Conflicts with Nuclear-Armed Adversaries?" Science & Global Security, 19:195–222, 2011.

[8] Leading deterrence expert James Acton did some basic math on this, which he described in the following Twitter thread:
James Acton (@james_acton32), Twitter, 29 July 2020 10:38AM.
https://twitter.com/james_acton32/status/1288484002748391424.

[9] "Fact Sheet: Transparency in the U.S. Nuclear Weapons Stockpile," US Department of State, 5 October 2021. https://www.state.gov/wp-content/uploads/2021/10/Fact-Sheet_Unclass_2021_final-v2-002.pdf.

[10] See, for example, Hu Liang [胡良], Li Mingri [李明日], "Da Bangtao: the three promotions of the mechanical Hua Tuo" [笪帮涛:"机械华佗"的三次升级], *Rocket Force News*, 21 September 2018.

[11] See, for example, Wei Jinqian [魏晋乾], Chen Renhai [陈仁海], "Adding a scaffolding of success" [加装成才脚手架], Rocket Force News, 3 January 2017.

[12] David C. Logan, "Making Sense of China's Missile Forces," *Chairman Xi Remakes the PLA*, NDU Press. https://ndupress.ndu.edu/Portals/68/Documents/Books/Chairman-Xi/Chairman-Xi.pdf.

[13] Roderick Lee, "Integrating the PLA Rocket Force into Conventional Theater Operations," *Jamestown Foundation*, 14 August 2020. https://jamestown.org/program/integrating-the-pla-rocket-force-into-conventional-theater-operations/.

[14] David C. Logan, "Making Sense of China's Missile Forces," *Chairman Xi Remakes the PLA*, NDU Press. https://ndupress.ndu.edu/Portals/68/Documents/Books/Chairman-Xi/Chairman-Xi.pdf.

[15] David C. Logan, "Career Paths in the PLA Rocket Force: What They Tell Us," *Asian Security*, 2018. https://www.researchgate.net/publication/322707851_Career_Paths_in_the_PLA_Rocket_Force_What_They_Tell_Us.

[16] Yasmeen Serhan, "When the World Lucked Out of a Nuclear War," *The Atlantic*, 31 October 2017. https://www.theatlantic.com/international/archive/2017/10/when-the-world-lucked-out-of-nuclear-war/544198/.

[17] "Nuclear Close Calls: The Norwegian Rocket Incident," *Atomic Heritage Foundation*, 15 June 2018. https://www.atomicheritage.org/history/nuclear-close-calls-norwegian-rocket-incident.

[18] Matt Korda and Hans Kristensen, "China Is Building A Second Nuclear Missile Silo Field," *Federation of American Scientists*, 26 July 2021. https://fas.org/blogs/security/2021/07/china-is-building-a-second-nuclear-missile-silo-field/.

[19] PW Singer, Ma Xiu, "China's ambiguous missile strategy is risky," Popular Science, 11 May 2020. https://www.popsci.com/story/blog-network/eastern-arsenal/china-nuclear-conventional-missiles/.

[20] Joshu Pollock, "CHINA'S DF-26: A HOT-SWAPPABLE MISSILE?", Arms Control Wonk. https://www.armscontrolwonk.com/archive/1209405/chinas-df-26-a-hot-swappable-missile/.

[21] Roderick Lee, "A Case for China's Pursuit of Conventionally Armed ICBMs," The Diplomat, 17 November 2021. https://thediplomat.com/2021/11/a-case-for-chinas-pursuit-of-conventionally-armed-icbms/.

[22] Kevin McCauley, ""Triad" Military Education and Training Reforms: The PLA's Cultivation of Talent for Integrated Joint Operations," The Jamestown Foundation, 5 March 2019. https://jamestown.org/program/triad-military-education-and-training-reforms-the-plas-cultivation-of-talent-for-integrated-joint-operations/.

[23] Roxana Tiron, "Hypersonic Weapons: Who Has Them and Why It Matters," *Bloomberg QuickTake*, 27 October 2021, https://www.bloomberg.com/news/articles/2021-10-27/hypersonic-weapons-who-has-them-and-why-it-matters-quicktake.

[24] David E. Sanger and William J. Broad, "China's Weapon Tests Close to a 'Sputnik Moment,' U.S. General Says," *The New York Times*, 3 November 2021, https://www.nytimes.com/2021/10/27/us/politics/china-hypersonic-missile.html.

[25] Demetri Sevastopulo and Kathrin Hille, "China tests new space capability with hypersonic missile," *Financial Times*, 16 October 2021, https://www.ft.com/content/ba0a3cde-719b-4040-93cb-a486e1f843fb.

[26] Stephen Chen, "China says it has hypersonic missiles with heat-seeking tech – years before US," *South China Morning Post*, 31 December 2021, https://www.scmp.com/news/china/military/article/3161762/china-says-it-has-hypersonic-missiles-heat-seeking-tech-years.

[27] "National University of Defense Technology," *Australian Strategic Policy Institute*, 23 November 2019, https://unitracker.aspi.org.au/universities/national-university-of-defense-technology/; Stephen Chen, "China says it has hypersonic missiles with heat-seeking tech – years before US," *South China Morning Post*, 31 December 2021, https://www.scmp.com/news/china/military/article/3161762/china-says-it-has-hypersonic-missiles-heat-seeking-tech-years; Patrick Knox, "NEED FOR SPEED China developing 6,000mph hypersonic nuke missile 'based on design ABANDONED by Nasa' as it forges ahead in arms race," *The Sun*, 9 December 2021, https://www.the-sun.com/news/4240185/china-developing-6000mph-hypersonic-nuke-missile-engine/; Alastair Gale, "China Is Expanding Its Effort to Launch Weapons From Hypersonic Missiles," *The Wall Street Journal*, 22 November 2021, https://www.wsj.com/articles/china-is-expanding-its-effort-to-launch-weapons-from-hypersonic-missiles-11637588925.

[28] Paul McLeary and Alexander Ward, "U.S. 'not as advanced' as China and Russia on hypersonic tech, Space Force general warns," *Politico*, 20 November 2021, https://www.politico.com/news/2021/11/20/hypersonic-technology-us-behind-china-russia-523130.

[29] Ryan Beene, "Mach 5 Missiles Spur New Arms Race as U.S. Seeks to Match China," *Blomberg News*, 28 December 2021, https://www.bloomberg.com/news/articles/2021-12-28/the-u-s-is-behind-china-on-hypersonic-weapons-and-billions-are-at-stake.

[30] Elsa Kania, "Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power," *Center for New American Security,* 28 November 2017, https://www.cnas.org/publications/reports/battlefield-singularity-artificial-intelligence-military-revolution-and-chinas-future-military-power.

[31] Jon Harper, "China Matching Pentagon Spending on AI," *National Defense Magazine*, 6 January 2022, https://www.nationaldefensemagazine.org/articles/2022/1/6/china-matching-pentagon-spending-on-ai.

[32] Ashwin Acharya and Zachary Arnold, "Chinese Public AI R&D Spending: Provisional Findings" *Center for Security and Emerging Technology*, December 2019, page 7, https://cset.georgetown.edu/wp-content/uploads/Chinese-Public-AI-RD-Spending-Provisional-Findings-1.pdf.

[33] Daitian Li, Tony W. Tong, and Yangao Xiao, "Is China Emerging as the Global Leader in AI?" *Harvard Business Review*, 18 February 2021, https://hbr.org/2021/02/is-china-emerging-as-the-global-leader-in-ai.

[34] Sophy Yang, "China's 2,041 Government Guidance Funds Size Reaches $530B: Report," *China Money Network*, 12 November 2018, https://www.chinamoneynetwork.com/2018/11/12/chinas-2041-government-guidance-funds-size-reaches-530b-report.

[35] "The China AI and Autonomy Report," *Center for Naval Analysis*, Issue 6, 13 January 2022, https://www.cna.org/centers/cna/cip/china/china-ai-newsletter.

[36] James Vincent, "Artificial intelligence research continues to grow as China overtakes US in AI journal citations," *The Verge*, 3 March 2021, https://www.theverge.com/2021/3/3/22310840/ai-research-global-growth-china-us-paper-citations-index-report-2020.

[37] Sachin Waikar, "AI Report: Competition Grows Between China and the U.S." *Stanford University Human-Centered Artificial Intelligence*, 8 March 2021, https://hai.stanford.edu/news/ai-report-competition-grows-between-china-and-us.

[38] Daitian Li, Tony W. Tong, and Yangao Xiao, "Is China Emerging as the Global Leader in AI?" *Harvard Business Review*, 18 February 2021, https://hbr.org/2021/02/is-china-emerging-as-the-global-leader-in-ai.

[39] John Xie, "China's Rival to GPS Navigation Carries Big Risks," *Voice of America*, 8 July 2020, https://www.voanews.com/a/east-asia-pacific_voa-news-china_chinas-rival-gps-navigation-carries-big-risks/6192460.html.

[40] Raymond McConoly, "China's Beidou GPS is a strategic challenge for the U.S," *Naval* Post, 24 May 2021, https://navalpost.com/chinas-gps-beidou-is-a-strategic-challenge-for-the-u-s/.

[41] Ryan Woo and Liangping Gao, "China set to complete Beidou network rivalling GPS in global navigation," *Reuters*, 11 June 2020, https://www.reuters.com/article/us-space-exploration-china-satellite/china-set-to-complete-beidou-network-rivalling-gps-in-global-navigation-idUSKBN23J0I9; Catherine Shu, "China Is Investing $810M In Beidou, A Navigation System It Hopes Will Eventually Rival GPS," *Tech Crunch*, 2 May 2013, https://techcrunch.com/2013/05/02/china-beidou-investment/.

[42] "China's Beidou navigation system to serve $156 bln home market by 2025," *Reuters,* 26 May 2021, https://www.reuters.com/world/china/chinas-beidou-navigation-system-serve-156-bln-home-market-by-2025-2021-05-26/.

[43] Alura Winfrey, "Developments in China's Commercial Space Sector," *The National Bureau of Asian Research*, 24 August 2021, https://www.nbr.org/publication/developments-in-chinas-commercial-space-sector/; Neel V Patel, "China's surging private space industry is out to challenge the US," *MIT Technology Review*, 21 January 2021, https://www.technologyreview.com/2021/01/21/1016513/china-private-commercial-space-industry-dominance/.

[44] "Queqiao: The bridge between Earth and the far side of the moon," *Phys Org Science and Technology*, 11 June 2021, https://phys.org/news/2021-06-queqiao-bridge-earth-side-moon.html.

[45] Andrew Jones, "China is developing plans for a 13,000-satellite megaconstellation," *Space News*, 21 April 2021, https://spacenews.com/china-is-developing-plans-for-a-13000-satellite-communications-megaconstellation/.

[46] Brian Waidelich, "A Chinese Starlink? PRC Views on Building a Satellite Internet Megaconstellation," *The Jamestown Foundation China Brief*, volume 21, issue 20, 22 October 2021, https://jamestown.org/program/a-chinese-starlink-prc-views-on-building-a-satellite-internet-megaconstellation/.

[47] Sandra Erwin, "Pentagon report: China amassing arsenal of anti-satellite weapons," *Space News*, 1 September 2020, https://spacenews.com/pentagon-report-china-amassing-arsenal-of-anti-satellite-weapons/.

[48] David Makichuk, "Space Force tracks Shijian-21 satellite 'companion'," *Asia Times*, 8 November 2021, https://asiatimes.com/2021/11/us-detects-companion-orbiting-alongside-shijian-21/.

[49] "Military and Security Developments Involving the People's Republic of China 2020," *Office of the Secretary of Defense – Annual Report to Congress*, September 2020, Page 81, https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF.

[50] "Military and Security Developments Involving the People's Republic of China 2020," *Office of the Secretary of Defense – Annual Report to Congress*, September 2020, Page 81, https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF; Andrew Jones, "An object is now orbiting alongside China's Shijian-21 debris mitigation satellite," *Space News*, 5 November 2021, https://spacenews.com/an-object-is-now-orbiting-alongside-chinas-shijian-21-debris-mitigation-satellite/.

[51] Editors Brian Weeden and Victoria Samson, "Global Counterspace Capabilities – An Open Source Assessment," *Secure World Foundation*, April 2021, section 1, page 24, https://swfound.org/media/207162/swf_global_counterspace_capabilities_2021.pdf.

[52] "Challenges to Security in Space," *Defense Intelligence Agency*, January 2019, page 20, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.

[53] Nectar Gan, "China's birth rate drops for a fifth straight year to record low," *CNN Business*, 17 January 2022, https://www.msn.com/en-us/news/world/chinas-birth-rate-drops-for-a-fifth-straight-year-to-record-low/ar-AASR4li?ocid=uxbndlbing.

[54] "China Moves to Three-Child Policy to Boost Falling Birthrate," *Bloomberg News*, 31 May 2021, https://www.bloomberg.com/news/articles/2021-05-31/china-to-allow-couples-to-have-three-children-to-boost-births.

[55] "Is China's population shrinking?" *The Economist*, 29 April 2021, https://www.economist.com/china/2021/04/29/is-chinas-population-shrinking.

[56] Iori Kawate "Marriages in China post biggest drop in decades amid pandemic," *Nikkei Asia*, 24 April 2021, https://asia.nikkei.com/Economy/Marriages-in-China-post-biggest-drop-in-decades-amid-pandemic; Hao Zhou "Can China boost its birth rate with education and housing reforms?" *South China Morning Post,* 6 July 2021, https://www.scmp.com/comment/opinion/article/3139968/can-china-boost-its-birth-rate-education-and-housing-reforms; Chen Jie, "Reducing the housing burden key to boosting births," China Daily, 30 July 2021, https://global.chinadaily.com.cn/a/202107/30/WS6103316ba310efa1bd6655e1.html; Dennis Normile, "One in three Chinese children faces an education apocalypse. An ambitious experiment hopes to save them," *Science*, 21 September 2017, https://www.science.org/content/article/one-three-chinese-children-faces-education-apocalypse-ambitious-experiment-hopes-save.

[57] "China Aims to Lower Child Expenses in Effort to Boost Birth Rate," *Bloomberg News*, 20 July 2021, https://www.bloomberg.com/news/articles/2021-07-20/china-aims-to-lower-child-expenses-in-effort-to-boost-birth-rate; Nectar Gan, "China's birth rate drops for a fifth straight year to record low," *CNN Business*, 17 January 2022, https://www.msn.com/en-us/news/world/chinas-birth-rate-drops-for-a-fifth-straight-year-to-record-low/ar-AASR4li?ocid=uxbndlbing.

[58] "Limiting access to abortions won't solve China's population woes," *The Economist Daily Chart,* 1 October 2021, https://www.economist.com/graphic-detail/2021/10/01/limiting-access-to-abortions-wont-solve-chinas-population-woes.

[59] Vivian Wang and Joy Dong, "A Graying China May Have to Put Off Retirement. Workers Aren't Happy," The New York Times, 27 April 2021, https://www.nytimes.com/2021/04/27/world/asia/china-retirement-aging.html.

[60] Xiang Li and Xindong Zhao, "Does low birth rate affect China's total factor productivity?" *Economic Research*, 11 October 2021, https://www.tandfonline.com/doi/full/10.1080/1331677X.2021.1977671.

[61] Frank Tang, "China's state pension fund to run dry by 2035 as workforce shrinks due to effects of one-child policy, says study," *South China Morning Post*, 12 April 2019, https://www.scmp.com/economy/china-economy/article/3005759/chinas-state-pension-fund-run-dry-2035-workforce-shrinks-due.

[62] Adi Gaskell, "What Role Does Population Play In Innovation?" *Forbes*, 9 March 2018, https://www.forbes.com/sites/adigaskell/2018/03/09/what-role-does-population-play-in-innovation/+&cd=11&hl=en&ct=clnk&gl=us.

[63] Mandy Zuo, "China's universities produce millions of graduates each year, but many can't get a decent job and end up unemployed or in factories," *South China Morning Post*, 16 July 2021. https://www.scmp.com/news/people-culture/social-welfare/article/3141313/chinas-universities-produce-millions-graduates.

[64] "OECD: Number of degree-holders worldwide will reach 300 million by 2030," ICEF Monitor, 17 July 2019. https://monitor.icef.com/2019/07/oecd-number-of-degree-holders-worldwide-will-reach-300-million-by-2030/.

[65] See, for example, Lotus Yuen, "Why Chinese College Graduates Aren't Getting Jobs," *The Atlantic*, 23 May 2013. https://www.theatlantic.com/china/archive/2013/05/why-chinese-college-graduates-arent-getting-jobs/276187/. Also see Andrew Jacobs, "China's Army of Graduates Struggles for Jobs," *New York Times*, 11 December 2010. https://www.nytimes.com/2010/12/12/world/asia/12beijing.html.

[66] Zuo.

[67] See, for example, Zhang Duanhong, "The Problem with Chinese Universities? Not Enough Dropouts," *Sixth Tone*, 15 January 2019. https://www.sixthtone.com/news/1003440/the-problem-with-chinese-universities%3F-not-enough-dropouts. Also see Jenny Anderson, "China's education system leaves students woefully unprepared for the real world," Quartz, 2 March 2016. https://qz.com/629407/chinas-education-system-leaves-students-woefully-unprepared-for-the-real-world/. Also see Javier C. Hernández, "Study Finds Chinese Students Excel in Critical Thinking. Until College.," New York Times, 30 July 2016. https://www.nytimes.com/2016/07/31/world/asia/china-college-education-quality.html.

[68] Zhang.

[69] Dennis Normile, "One in three Chinese children faces an education apocalypse. An ambitious experiment hopes to save them," Science, 21 September 2017. https://www.science.org/content/article/one-three-chinese-children-faces-education-apocalypse-ambitious-experiment-hopes-save.

[70] Ryan Hass, "China Is Not Ten Feet Tall," Foreign Affairs, 3 March 2021. https://www.foreignaffairs.com/articles/china/2021-03-03/china-not-ten-feet-tall.

[71] The DF-51 does not currently exist, and the PLA does not currently field a hypersonic ICBM (although the hypersonic DF-17 MRBM is currently in use with the PLARF). However given the PLA's substantial investments in hypersonic weapons systems, and Russia's deployment of a hypersonic ICBM in 2019, it is plausible that the PLA would field such a weapon by 2029.

[72] For a good summary of the PLARF's attitudes toward conventional ICBMs, see: Roderick Lee, "A Case for China's Pursuit of Conventionally Armed ICBMs," The Diplomat, 17 November 2021. https://thediplomat.com/2021/11/a-case-for-chinas-pursuit-of-conventionally-armed-icbms/.

[73] See: "From Rockets to Ruins," NASA Safety Center, November 2012. https://sma.nasa.gov/docs/default-source/safety-messages/safetymessage-2012-11-05-pepconexplosion.pdf?sfvrsn=ceae1ef8_6.

[74] Futao Huang, "Low Quality Studies Belie Hype about Research Boom in China," Scientific American, 21 December 2018. https://www.scientificamerican.com/article/low-quality-studies-belie-hype-about-research-boom-in-china/.

[75] See: "Patent Wars in Digital Era," Nikkei Asia, Accessed 7 January 2022. https://vdata.nikkei.com/en/newsgraphics/patent-wars/.

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