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EABO concepts will be challenged by Chinese ISR capabilities that are set to overmatch current US plans for low signature and will allow long range, precision fires to rapidly target US forces operating in the Chinese periphery.

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MASTER OF MILITARY STUDIES

TITLE:
China's ISR Threat to US Expeditionary Advanced Base Operations

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

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Executive Summary

Title: China's ISR Threat to US Expeditionary Advanced Base Operations

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Thesis: EABO concepts will be challenged by Chinese ISR capabilities that are set to overmatch current US plans for low signature and will allow long range, precision fires to rapidly target US forces operating in the Chinese periphery.

Discussion: The People's Republic of China (PRC) is defying international norms, asserting claims in the South China Sea (SCS), and seeking regional hegemony over East Asian nations without intercession from Western nations or international bodies. To deter international action the PRC has implemented Anti-Access / Area Denial (A2AD) on a massive scale along their coastlines and on artificial islands constructed throughout the SCS. Their capabilities are increasingly formidable and numerous, posing a serious risk to the large, expensive assets owned by the US military. To counter A2AD, the US is proposing innovations such as dispersing the force, investing in smaller/cheaper/more numerous assets, and operating with a dual-postured "inside/outside" force (referring to areas inside Chinese threats and outside the range of China's strike forces). Even so, these concepts, including the US Marine Corps' Expeditionary Advanced Base Operations (EABO), may not sufficiently take into account the extent of the Intelligence, Surveillance, and Reconnaissance (ISR) investment being made by the PRC or what advancing sensor technology will make possible. To be sure, EABO advocates understand the need for low-signature operations to avoid detection, but this thesis argues China's detection capabilities, enabled by artificial intelligence, will overmatch US low-signature measures. Overlapping systems of sensors can overcome the weaknesses of any one sensor technology in order to detect, identify, and target US assets. As the data from each of the sensor systems is fed into an integrated network and filtered, the results can be used to tip and cue higher fidelity sensors for positive identification of targets. EABO becomes untenable when long range, precision fires are combined with accurate targeting that is rapidly acquired and persistently maintained. Traditional counter detection technologies like stealth will soon become obsolete in a ubiquitous sensor environment, especially as quantum radar is developed and fielded. The key for such a system to operate rapidly is to distinguish between military and non-military traffic and the best means for doing so will be machine learning. While this area is saturated with sensors it is also filled with commercial and personal vessels, and the US military must alter its behavior to blend into the crowd. Risk to forces will be high and losses must be expected, a force with numerous cheap assets will be critical for any hope of success in such a conflict.

Conclusion: The US and its allies must adapt to a reversal in the situational awareness paradigm and exploit any gaps in China's ISR system if concepts such as EABO are to succeed. US forces must blend with local traffic and conditions to confuse the enemy's detection algorithms as traditional low signature technology, such as Stealth, will be insufficient.

DISCLAIMER

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

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Preface

My regular work involves geospatial imagery, and my decision to pursue writing a thesis came from observing the rapid growth of Chinese remote sensing capabilities. As I evaluated open source information on China's capabilities, I was concerned both with their rapid technical development but more so with the sheer number of assets available to them. I became especially interested in the implications should China marry its numbers of sensors, which would allow an amazing amount of global coverage, with its equally strong efforts to develop the techniques and software for full exploitation of the data. This explosion of data will be especially helpful for machine learning. I wanted to write on this topic to highlight the threat this poses to US forces and our allies.

I am grateful for the assistance given by my advisor, Dr. Richard Hegmann, the CIA Chair at Marine Corps University. He has provided me with resources and assisted me in focusing my topic to something that I could accomplish in this short time and would be most accessible to others, while also helping to ensure I steered clear of classified information. The military and civilian faculty of Command and Staff College have been most helpful in increasing my general knowledge of the Marine Corps and how the US military operates. I would finally like to thank my wife for her patience and understanding as I went back to school, and she effectively became a single parent.

Introduction

The US has enjoyed an advantage in Intelligence, Surveillance, and Reconnaissance (ISR) from World War II until now, losing that advantage would deal a crippling blow to the US military, rendering it blind and ineffectual. Not only would the United States be less capable of "seeing" China, China would also be more able to use its own capabilities to "see"—and counter—US military operations. Much focus has been on the Chinese proliferation of long range, precision fires but it is the development of a comprehensive, integrated ISR system of systems that will be critical for the Chinese to exert effective control over the Western Pacific. The US reliance on ISR and its strategic value are treated in a vast literature in the academic security studies field, but are also powerfully illustrated in popular writings such as *Ghost Fleet* by P.W. Singer and August Cole. *Ghost Fleet* is a science fiction novel centered on technology, that either currently exists or is in development, and explores the military implications through a hypothetical war with China. Chinese forces strike first and are able to deal staggering military defeats to the US military throughout the Pacific and are then able to consolidate control that encompasses the Third Island Chain including Hawaii. In addition to drones, medical enhancements, laser weapons, and rail guns, the most decisive strategic advantage was in ISR. The first battles of this hypothetical future war were conducted in space as China pursued ISR supremacy that gave them the initiative and an advantage in every conflict. As depicted in *Ghost Fleet*, book, China "owns the heavens - satellites, space stations, everything. They can see every move we make and target at will."[1]

China is building global ISR capability and, in particular, the architecture being set up for the Western Pacific may eventually surpass the US and erase the ISR advantage it has held for over half a century; unless the US takes action to account for Chinese advances the US will lose

[1] P.W. Singer & August Cole, *Ghost Fleet* (Boston, Massachusetts: Houghton Mifflin Harcourt, 2015) 95

the ability to present a credible challenge and gradually cede control of the region to China. This paper first briefly outlines the background history of China's claims and the measures it has taken to protect that territory, given that other works have gone into much greater detail concerning China's territorial disputes. Suffice to say, the stakes that China has invested in its territorial claims will make it unresponsive to diplomatic pressure without some strength to support the US position. Next, the paper examines the ISR capabilities and architecture that China is developing and how these systems operate together as a whole that is greater than the sum of its parts. Finally, the paper analyzes the implications that this ISR architecture holds for the US Navy and Marine Corps, the US military as a whole, and the US in general.

Background

China has claimed the South China Sea (SCS) and the East China Sea (ECS) to be its sovereign territory as part of its Nine-Dash-Line (NDL). To enforce this position China has artificially constructed a series of islands within the SCS and the People's Liberation Army (PLA) has militarized them in what they term an 'active defense' posture.[2] These artificial islands and the Chinese coastline are covered with airfields, land-based radar systems, Coast Guard ports, anti-ship cruise missiles (ASCM), surface to air missiles (SAM), and other capabilities that support China's Anti-Access Area Denial (A2AD) approach to countering US military power projection.[3] An oft overlooked component of A2AD is the ISR that is the eyes and ears of the system. Being able to detect targets further and more accurately than an adversary is often the decisive factor in modern battlefields, and China is seeking ISR dominance at least within the island chains that it claims form the Chinese sphere. This paper will first explain some of the Chinese ISR capabilities and their significance.

[2] Franz-Stefan Gady, *China to Embrace New 'Active Defense' Strategy* (Washington DC: The Diplomat, 2015)
[3] Andrew Krepinevich, Barry Watts & Robert Work, *Meeting the Anti-Access and Area-Denial Challenge* (Washington DC: Center for Strategic and Budgetary Assessments, 2003)

1. ISR and the Integrated System of Systems

A popularly held belief is that dogs can only see in shades of black and white. This is not strictly true; it is more accurate to say that the limited color perceivable to a dog tends to blend together and cause everything to appear more muted. Dogs see in this panchromatic fashion because their eyes only have receptors capable of collecting and interpreting light at two wavelengths. Thus, their sense of sight mostly discerns the degree of light intensity but not color.[4] The human eye collects light at one additional wavelength, and this increase from two collected wavelengths to three is responsible for all of the colors of hue and shade that we see in a rainbow of colors.[5] Some human females have a rare mutation that lets them collect light at a fourth wavelength and reportedly the growth in color and vibrancy between three and four wavelengths is just as remarkable as from two to three.[6] A similar principle can apply to remote sensing and ISR; the intelligence value of a variety of sensors integrated into a common system and then intelligently processed and exploited can yield results unachievable by examining any single sensor type no matter how excellent its capability.

ISR Development and Multiple Sensor Integration

[4] AKC Staff, *See What the World Looks Like to a Dog*. (American Kennel Club, 2014)
[5] Reena Mukamal, *How Humans See In Color*. (American Academy of Ophthalmology, 2017)
[6] Alexandra Ossola, *This Woman Sees 100 Times More Colors Than The Average Person.* (Popular Science, 2014)

Historically the path taken by nations, including the US, as they develop ISR capabilities has been straightforward: the nation develops a sensor, deploys it, and utilizes the collections.[7] Then a new sensor is developed that improves upon the design and capabilities of the earlier sensor: the sensor might be tested against new applications, flying at a different altitude or orbit, or new processing techniques might be developed to improve performance. A variety of sensors might be developed that focus on different remote sensing disciplines or collection types. A greater number of these sensors might be built to increase the coverage or revisit rate of the collection. In the end, no matter how exquisite the design, a sensor of a given collection type will perform very well against some applications and less well in others. Traditionally the collection from these sensors has been viewed independently and used by an analyst to create a standalone product that is published and disseminated. A combination of different collection types can compensate for weaknesses of any collection type and increase chances of detection, identification, and targeting. Efforts at "Multi-Int" or geospatial intelligence (GEOINT) fusion have combined the outputs of multiple sensor types into a single product for improved results.[8]

ISR vs. Denial and Deception

Denial and deception (D&D) activities are intended to defeat the ability of an adversary to accurately and reliably detect or correctly identify assets.[9] Similarly, to the strengths and weaknesses of different collection types, efforts at denial and deception are better suited to defeating some collection types than others. Camouflage counters panchromatic and even multi-spectral collection if they use paint that covers the correct wavelengths.[10] Improving stealth

[7] Richard A. Best. Intelligence, Surveillance, and Reconnaissance (ISR) Programs: Issues for Congress. (CRS Report for Congress, 2005)
[8] Dave English, *How multi-INT enables deciphering the indecipherable*. (C4ISR.net, 2015)
[9] Donald C.F. Daniel, *"Denial and Deception". In Jennifer E. Sims; Burton L. Gerber (eds.). Transforming U. S. Intelligence*. (Georgetown University Press, 2005) 134–141
[10] Willi G. Nielsen, "*Mat for multispectral camouflage of objects and permanent constructions*" (US Patent # 4287243, 1979)

characteristics make the radar cross section of a plane or other vehicle so small by either scattering or absorbing the energy return that the vehicle avoids detection.[11] Low signature overlaps with stealth, but it also describes characteristics intended to avoid signals intelligence (SIGINT) detection through emission control. It is difficult or impossible to counter all of the different types of ISR collection, and an integrated system or system of systems that utilizes a mix of sensors simultaneously could negate efforts to avoid detection. The situation in the seas east of China with its variety of redundant sensors may defeat US efforts at avoiding detection through stealth, low signature, and dispersed forces.

Integrated System of Systems

The next generation of ISR will involve Computer Vision, Machine Learning, and Artificial Intelligence (AI). Computer vision takes the place of a human imagery analyst and uses algorithms for detection and identification, greatly speeding results. The next level would be feeding all of the different collection types into a common system that utilizes algorithms developed by machine learning to detect patterns and anomalies. This could maximize chances of detection and targeting accuracy. An all-encompassing ISR system of systems could automatically detect assets like enemy ships, aircraft, or missiles, and then cue over a high-fidelity sensor like a higher resolution satellite or a reconnaissance Unmanned Aerial Vehicle (UAV) already loitering in the area. An AI system with a decision protocol in place could determine the need for a strike and even carry it out faster than a human would even register the enemy incursion. It is necessary to analyze the different systems utilized by China and contributions they could make to an integrated system of systems ISR architecture.

[11] Charlie Gao, *Russia Has One Way to Find and Kill U.S. F-22 and F-35 Stealth Fighters*. (The National Interest, 2019)

This is related to the concept of net-centric warfare first discussed in the 1990s, describing a distributed network of sensors, C2, and weaponry that would provide unmatched situational awareness, targeting, and lethality.[12] Two issues prevented net-centric warfare from becoming reality. The first issue was decades of the War on Terror against low tech insurgents that limited the need or impact of such a system. The second was the extraordinary difficulty in overcoming the bureaucratic and technical hurdles of integrating different systems and networks of numerous government agencies, organizations, services, and allied partners. However, as technology has advanced the impact of successfully creating such a system of systems has increased.

Net-centric warfare or the integrated system of systems is the goal motivating current Chinese military reform and development, the Chinese refer to it as Informatization.[13] Unlike the US, China has not spent the last decades fighting insurgents in the dessert and mountains. Instead, China has been seeking the means to deter or defeat a world class military power so that China will be the undisputed regional hegemon. The Chinese leadership are avid believers in the integrated system of systems as the means to informatize their forces and enable joint operations.[14] Additionally, China has the centralized leadership that may be helpful in commanding the implementation of the necessary bureaucratic and technical changes to make this type of warfare a reality.

Conclusion of the Fully Realized ISR System

[12] William A. Owens, *"The Emerging U.S. System-of-Systems"*. (Strategic Forum. Institute for National Strategic Studies, Archived 2010)
[13] Elsa Kania and John Costello, *China's Quest for Informatization Drives PLA Reforms*. (Washington DC: The Diplomat, 2017)
[14] Kevin McCauley, *PLA System of Systems Operations: Enabling Joint Operations*. (Washington DC: The Jamestown Foundation, 2017)

John Boyd's concept of the OODA loop, which stands for Observe, Orient, Decide, Act, can be simplified as the time taken to react to a situation and execute the appropriate action. In a combat setting the combatant who is able to run through the process of the OODA loop faster than their opponent gains an advantage that can disorient and often defeat their adversary.[15] A classic example is the German Blitzkrieg that moved and acted so quickly that it got within the OODA loop of the French leadership which caused it to collapse.

An ISR system of systems that uses a variety of sensors, tied together into a common network would provide the most complete intelligence picture. Using machine learning and computer vision to determine targeting would give real time order of battle. Lethal unmanned systems, connected to this Command, Control, Computers, Communication and ISR (C4ISR) network, could be combined with automated decision protocols to execute instantaneous response to threats.[16] This chain would compress the OODA loop to less time than it takes to say the name granting an overwhelming advantage to the side that completes such a system, especially if combined with a significant number of long-range, precision fires.

2. China – ISR Assets and Capabilities

In keeping with its role as a growing superpower, China is creating a military that can project force globally. To act globally, China needs to have global awareness, and it is developing the ISR and communications architecture to achieve this goal. In addition to China's global acquisitions, Beijing is particularly focused on developing a series of assets and architecture with redundant coverage in its immediate periphery, giving China unprecedented

[15] John R. Boyd, *The Essence of Winning and Losing*. (Washington DC: Project on Government Oversight, 2020)
[16] Elsa B. Kania, *Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power*. (Washington DC: Center for New American Security, 2017)

ISR access. This effort at comprehensive monitoring and control is in keeping with their stated goal of being the dominant regional power and Chinese leaders are obsessed with piercing or even eliminating the fog of war.

China's Assets: Space-Based Systems

While many of these satellites are claimed to be dedicated to civilian use or scientific research, they are still controlled to some extent by the PRC government. They can be utilized to serve military needs if the situation calls for it. Not every satellite, space-oriented organization, and system architecture will be listed here but an assortment of examples to represent the type of activities that China is pursuing. Understanding the different types of Chinese ISR capabilities is critical, in this paper's view, to fully appreciating the true nature of the challenges US forces will face in attempting to operate undetected in China's back yard. Even restricted to open source information, this paper can paint a daunting picture of Chinese capabilities.

Strategic Support Force

The PLA Strategic Support Force (SSF) takes its place as a military service alongside the Ground Force, Navy, Air Force, and Rocket Force; and amongst several other missions it is responsible for space-based C4ISR.[17] The SSF was formed in 2015 as part of sweeping military reforms.[18] This effort to consolidate resources and tasks will likely facilitate better coordination and eliminate redundancy of efforts but seems to have other more ambitious goals. The first is integration of peacetime and wartime operations, allowing a continuous spectrum of military options that may be applied to any situation without wasting time to mobilize resources. The second is an organizational shift from disciplines to domains. Previously a unit would specialize in cyber espionage and another unit would handle offensive cyber operations. Now the

[17] Peter Mattis, *China reorients strategic military intelligence*. (IHS Jane's, 2016)
[18] Stratfor Worldview, *China Takes Bold Steps Toward Military Reform*. (Austin, Texas: stratfor, 2016)

integrated intelligence, reconnaissance, attack, and defense model makes possible full-spectrum war-fighting and never before seen levels of unified planning, force construction, and operations.[19]

An organization like the SSF is a necessary step to achieving the common ISR network or system of systems. There are many challenges to reaching the goal of a cohesive ISR picture such as common data formats, and interoperability between systems, services, and networks. However, bringing everything under one organization will allow for directive control to subordinates to make the required changes.

China's Space Program

In addition to the overtly military SSF is the Chinese space program overseen by the China National Space Administration (CNSA) which creates policy, directs research, and plans space activities.[20] The organization is similar to the US National Aeronautics and Space Administration (NASA)'s role in coordinating the development and testing of space technology. Most of China's missiles, satellites, drones, and the assorted support architecture are tested and validated as part of the Chinese space program. The state-owned China Aerospace Science and Technology Corporation (CASC) is the main contractor for the space program and designs, develops and manufactures a range of spacecraft, launch vehicles, strategic and tactical missile systems, and ground equipment.[21] CASC is also modeled after the US space program with contractors supporting government organizations, but in this case the contractor is owned by the state and operated as a business in the interest of efficiency. It should be clearly understood that both CNSA and CASC are controlled by the PRC and serve its interests. Programs and

[19] John Costello, *The Strategic Support Force: Update and Overview*. (The Jamestown Foundation: China Brief Volume: 16 Issue: 19, 2016)
[20] Elizabeth Howell, *China National Space Administration: Facts & Information*. (Space.com, 2016)
[21] SpaceChina.com, *China Aerospace Science and Technology Corporation – Company Profile*. (spacechina.com, 2020)

technology pursued by the Chinese space program can and will be utilized by the PLA if it is considered expedient to achieve PRC objectives.

BeiDou Constellation

Beidou-3 is a global satellite navigation system and the constellation is expected to be complete by mid-2020. It provides the same functionality as the US Global Positioning System (GPS), the Russian GLONASS, and the EU Galileo.[22] Beidou developers claim their system will be more accurate than rival services, down to millimeter level accuracy, and will be less susceptible to jamming or spoofing.[23] The Chinese system was designed to be compatible with foreign services so that BeiDou users would benefit from additional satellite coverage. Beidou-3 is the third generation of the system, the previous generations provided only limited coverage mainly over China and the surrounding region. Though it was partially a proof of concept for China, Beidou-2 is still operational and provides redundant coverage for the region.[24]

BeiDou offers more than just an alternative to GPS for positioning, navigation, and timing; it also provides a messaging service for users.[25] This has been used by China in areas like the SCS. The Chinese Maritime Militia operate in the SCS as a plausibly deniable force that monitors and intimidates other nations. This messaging service has been used by the Chinese Maritime Militia in the SCS to signal for additional ships or even military support. This allows China to flexibly monitor a situation without committing itself or respond with force more rapidly than its rivals.

A more critical issue presented by BeiDou is its greater resiliency over GPS. If China and the US were involved in a conflict, the US GPS is notably more susceptible to jamming and

[22] Li Wang, *Directions 2017: BeiDou's road to global service*. (GPS World, 2017)
[23] Li Yan, *China's BeiDou to overtake GPS*. (Ecns.cn, 2017)
[24] BBC News, *China's Beidou GPS-substitute opens to public in Asia*. (BBC News, 2012)
[25] People's Republic of China, *Beidou Navigation Satellite System, System Overview*. (Beidou.gov.cn, 2020)

spoofing than BeiDou. This is due to the BeiDou system using multiple frequencies and greater power for its signals. Also, the BeiDou system is more resilient due to the redundant coverage that is provided by multiple constellations and the BeiDou satellites sitting at different orbital altitudes. China would enjoy a significant advantage in navigation, targeting, and weapons' guidance if it has access to accurate positioning but the US does not.

Micius and (QUESS) Quantum Experiments at Space Scale

The Micius satellite is a Chinese research project in the field of quantum physics. The significance of this experiment is the very real potential for a Quantum based communications system.[26] This would allow for communications that cannot be intercepted during transit. This is a potential game changing technology that will render many SIGINT capabilities obsolete. Long range communication has already been accomplished transferring data and images from China to Europe. China has pursued 'unhackable' communications in response to the leaks from Edward Snowden, QUESS was designed to counter US capabilities and deny traditional SIGINT collection.[27] The feasibility of this technology has been solidly established but as with many of the topics covered in this paper is whether the Chinese can employ it across all of their systems and networks. If and when they are successful then their C4ISR architecture would be significantly more resilient and secure. Once the transmission between satellite and ground station is secure, communications and systems would still be vulnerable on the ground but collection would suffer significant weaknesses. For the US, the costs of collection will be significantly higher, collection will be more sporadic, targeted collection will be less responsive, and in general less reliable.

[26] Tomasz Nowakowski, *China Launches World's First Quantum Communications Satellite Into Space*. (Spaceflight Insider, 2016)
[27] Jeffrey Lin, *China Launches Quantum Satellite In Search Of Unhackable Communications.* (Popular Science, 2016)

Space View Technology – Gaofen, GaoJing, Zi Yuan, and Huan Jing

Based in Beijing, Space View Technology Co. Ltd. is a subsidiary of CASC that operates several remote sensing satellites and has been granted distribution of the produced imagery by the Chinese government.[28] While the company will task collection and sell imagery commercially, the company and satellites are owned by the PRC and the desires of the government will take precedence. This can include supplying collection to the government or masking locations that the government does not want to have collected.

Gaofen – "High-Resolution"

Gaofen actually means high resolution, and these satellites will be part of the China High-definition Earth Observation System (CHEOS). The stated goal is for near real time (NRT) observation for disaster prevention and relief, climate change monitoring, geographical mapping, environment and resource surveying as well as for precision agriculture support.[29] To perform this mission the Gaofen satellites have an array of sensors available, the rapid pace of launching new satellites allows the replacement of new sensors to achieve different requirements. Many of the Gaofen satellites possess optical sensors, recent versions have sub meter resolution panchromatic cameras and many also carry eight-meter resolution multi-spectral cameras. Of the Gaofen satellites at least Gaofen 12 has a sub meter resolution synthetic aperture radar (SAR) sensor for the stated purpose of land census, urban planning, land rights, road network design, crop estimation, disaster prevention / mitigation, and other fields. It is suspected that Gaofen 12 is a civilian version of Yaogan 29.[30]

GaoJing AKA Superview-1 & Superview-2

[28] Global Defence Geospatial Intelligence (DGI), *Beijing Space View Technology Co., Ltd. (Space View*). (Royal Lancaster, London: DGI Geospatial Intelligence for National Security, 2020)
[29] Globalsecurity.org. *China High-resolution Earth Observation System (CHEOS)*. (Washington DC: globalsecurity.org, 2020)
[30] Gunter Dirk Krebs, *Gaofen 12.* (Gunters Space Page, 2019)

GaoJing is another remote sensing constellation run by Beijing Space View Tech Co Ltd. The constellation initially consists of two satellites and provides imagery with 0.5-meter panchromatic resolution and 2-meter multispectral resolution. So far there are four satellites in the constellation spaced 90° from each other on the same orbit.[31] This resolution will allow a user to differentiate different vehicle types such as cars from trucks and may even find individual people by their shadows. A satellite in Low Earth orbit will orbit the earth about every 90 minutes and revisit the same spot over the earth every 11-12 hours. Having four satellites equally spaced in the same orbit will allow them to revisit the exact same spot about every three hours, though a satellite could slew its view over to the side and take a slanted image if more coverage is required.

Ziyuan

The original Ziyuan satellites were jointly launched and operated between the PRC and Brazil. Its stated mission was for monitoring resources, land use, and ecology. Its low earth sun-synchronous orbit is conducive to its goal of high resolution easily interpreted imagery. It has three panchromatic cameras that can take images with a best spatial resolution of 2.5 meters and an infrared multispectral camera that has a resolution of 6 meters.[32] The latest versions the Ziyuan-II and Ziyuan -III are operated by the Chinese military. Possible military applications could include stereo mapping which can create a digital elevation model (DEM), which creates a 3-dimensional model of the terrain and allow for more accurate mensuration. The infrared multispectral camera could be used for detection of military targets and counter D&D.

Huan Jing "Environment"

[31] Gunter Dirk Krebs, *GaoJing-1 01, 02, 03, 04 (SuperView 1).* (Gunters Space Page, 2019)
[32] Rui C. Barbosa, *China opens 2012 with ZiYuan-3 launch via Long March 4B.* (NASAspaceflight.com, 2012)

These small satellites are operated by the China Centre for Resources Satellite Data and Application (CRESDA). The sensor payload for the satellites in this constellation will include a high-resolution panchromatic camera and either a SAR sensor, hyperspectral camera or an infrared camera.[33] Huan Jing is also known as the Small Multi-Mission Satellite (SMMS) of the Asia Pacific Space Cooperation Organization (APSCO) and is a joint venture between China, Iran, South Korea, Mongolia, Pakistan, Thailand, and Bangladesh. This is an example of China's efforts to promote close ties to nations in the region and can be understood as providing an alternative to the US.

Yaogan Weixing

Yaogan are a series of Chinese reconnaissance satellites launched in the early 21st century. Chinese media describe the satellites as intended for "scientific experiments, land survey, crop yield assessment, and disaster monitoring,"[34] although they are likely primarily used for military purposes. Yaogan has filled about every remote sensing mission there is, including electro-optical, SAR, SIGINT, and ocean monitoring. The series includes SIGINT satellites launched into orbit as triplets, which can be used to collect electronic signals from ocean going vessels and triangulate those signals for precise positioning.[35] The high-resolution optical sensors should be able to distinguish between different models of military vehicles or detect identifying markings on ships or missiles.

HaiYang

HaiYang are a series of marine remote sensing satellites developed and operated by China since 2002. As of October 2018, five satellites were launched and four more are planned. The HaiYang series is operated by NSOAS (National Satellite Ocean Application

[33] Gunter Dirk Krebs, *HJ 1A, 1B (SMMS 1).* (Gunters Space Page, 2019)
[34] Gunter Dirk Krebs, *Yaogan 9, 16, 17, 20, 25, 31 (JB-8 1, 2, 3, 4, 5, 6).* (Gunters Space Page, 2019)
[35] Gunter Dirk Krebs, *Yaogan 9, 16, 17, 20, 25, 31 (JB-8 1, 2, 3, 4, 5, 6).* (Gunters Space Page, 2019)

Service), a subordinate agency of the State Oceanic Administration. They will measure sea surface height, sea surface wind field, and ocean temperatures.[36] While they serve their stated public purpose of monitoring marine resources their capabilities for wide area, persistent coverage would be a powerful component for integrating a C4ISR system of systems.

Shijian - "Practice" or "Experimental"

The Shijian series has included about two dozen satellites that are testbeds for new satellite technology and scientific demonstrations. Performing a variety of missions, they have utilized new technologies before they are applied to other satellite programs. The rapid pace of launching these satellites and the evolution of their capabilities is a sign of the resources China is applying to the Chinese space program.

Jilin-1

The Chinese commercial venture, Chang Guang Satellite Technology Co. Ltd. was founded in 2014 to develop, manufacture, and operate satellites and UAVs.[37] The venture operates the Jilin constellation, which provides high resolution panchromatic imagery, multispectral imagery, and video from orbit for commercial customers. Plans for the year 2030 project that the Jilin constellation will have 138 satellites in orbit, providing an all-day, all-weather, full-spectrum capability with a 10 minutes revisit capability for any global arbitrary point.[38] This unprecedented level of global coverage would represent the world's best high temporal and spatial resolution collection.[39] High resolution video from space could use the densely packed constellation of satellites to focus on an arbitrary point on the surface with collection being passed from one satellite to another. This system could be used for persistent

[36] Gunter Dirk Krebs, *HY 2A, 2B, 2C, 2D* (Gunters Space Page, 2019)
[37] Chang Guang Satellite Technology Co. Ltd., Company Profile, (charmingglobe.com, 2020)
[38] Rui C. Barbosa, *Long March 2D launches Kuanfu-1 and co-passengers*. (NASAspaceflight.com, 2020)
[39] Deyana Goh, China's ExPace launches Jilin-1 Gaofen-02A satellite. (spacetechasia.com, 2019)

coverage of an arbitrary point or just as easily for tracking of a moving target, such as a US aircraft carrier or another Navy ship as they transit the SCS. In effect, this constellation could perform the acquisition and targeting normally performed by a drone. Jilin being a commercial venture means that its development is effectively subsidized by international investors. Like the other systems listed here the Jilin constellation operates at the discretion of the PRC government and would serve the needs of the PLA if requested.

Tianlian

Tianlian I, also known as Tian Lian 1, TL-1, and CTDRS-1 is a Chinese data tracking and relay communications satellite series.[40] It was planned to provide communication coverage for manned Shenzhou missions, from Shenzhou 7 onwards. It will likely also support military and intelligence missions as it relays data from reconnaissance satellites that are beyond line of sight from a ground station.

China Assets: Land-Based Systems

RADAR

A key component of the land reclamation and territorial expansion in the SCS has been to accommodate the placement of ground-based radar that monitors the surrounding seas. The emitter and receiver can be separately located and multiples within a system can make the entire system more effective. A sufficiently high-powered radar system can perform Over-The-Horizon (OTH) radar that will as the name suggests see beyond the horizon. These sensors will essentially bounce the radar signal off the atmosphere to detect objects at great distances.

Quantum Radar

Quantum radar should allow for reliable detection of stealth assets. At its most fundamental level, traditional radar relies on transmitting energy in a direction and then receiving

[40] Gunter Dirk Krebs, *TL 1A, 1B, 1C, 1D* (Gunters Space Page, 2019)

the returning energy to discern the presence of objects. Stealth technology reduces the radar cross section of an object to appear smaller by returning less energy to the receiver, so that the object may be lost in the ambient noise that is always present in such a system. Quantum radar defeats stealth by being able to determine what returning energy was produced by the radar emitter, separating the signal from the noise.[41] Even the best stealth assets return some energy and rely on 'hiding' amongst the noise. Further development and widespread fielding of this technology would allow reliable detection of stealth assets like the F-35 combat aircraft, and multiple radar systems could create networks over a wide area that would provide accurate targeting information. Such a system would largely negate the benefits of stealth and the value of the huge US financial investment in the F-35.

Ground Stations

Data collected in space needs to be transmitted to ground stations; without a ground station or a relay satellite, the data will be lost. The number and placement of these ground stations is indicative of Chinese plans and intentions as it identifies the priorities for data collection, these numbers continue to grow with China's needs.[42]

China Assets: Airborne Systems

Manned and unmanned aircraft are the workhorses of theater level ISR and are the primary means of keeping the commander informed. Commanders with airborne assets can dynamically task these assets to the areas requiring greater persistence and fidelity. Tasking these assets is either done in preparation for a planned operation or tasking can be done in

[41] Nick Stockton, *Quantum Radar*. (Bellingham, Washington: spie.org, 2019)
[42] GlobalSecurity.org, *Chinese Space Facilities,* (Washington DC: globalsecurity.org, 2020)

response to a tip from another intelligence source, such as a lower fidelity sensor platform with wide-area coverage that detected a suspicious object.

Manned Assets

Manned assets are the traditional source of airspace intelligence. China has a variety of patrol aircraft and systems outfitted with radar capabilities similar to the US. The US has long relied on airborne reconnaissance systems like AWACS, JSTARS, and others like them for surveillance but these systems have always enjoyed air supremacy which will likely be contested in a future conflict. China may choose to largely dispense with manned systems as the capabilities of unmanned surveillance systems improves. Also, the creation of artificial islands in the SCS with permanent monitoring and surveillance capabilities decreases the need for tasking of manned assets. Finally, the space-based systems that China is developing and launching into service are creating an increasingly finer ISR net covering the globe.

Unmanned Assets

The ability to loiter for extended periods of time will be a significant contribution to the persistence of high-resolution ISR coverage. The US history of drone use should be considered indicative of the role that the systems would play for China. China will likely utilize them in their regional periphery, to patrol the SCS and ECS. If anything, China will likely feel even more obliged to use drones in an aggressive manner due to their claim of territorial sovereignty over the region.

China Assets: Sea-Based Systems

While each component of the PLA-Navy will contribute some aspect of ISR the key will be disseminating the total intelligence derived picture to the ships at sea. This enhanced situational awareness will allow more informed decision making for commanders plus greater

responsiveness and synchronization of response to incursions into Chinese claimed maritime territory. Finally, if an over-arching ISR picture taken from all of the different sensors and platforms can be fed into a common system that also supplies targeting information for ships then the Chinese fleet will be significantly more formidable.

Surface and Subsurface Fleet

Ships can also be equipped with their own radar, Sonar, and other ISR systems. Targeting ship-based weapons rely on ISR, particularly radar. The mere number of surface vessels can be a determining factor in how a conflict situation is resolved even if they don't actively use military capabilities. Filipino fishermen may know they have a right to work in an area of their EEZ but when they are surrounded by Chinese vessels it can be very intimidating. China will have the largest number of surface vessels and submarines available for any conflict within its claimed waters. Using BeiDou for its positioning and messaging services will simplify rapidly gathering a large number of ships and submarines if the need arises. China will augment its manned submarine fleet with Underwater Unmanned Vehicles (UUVs), which have the potential to operate for longer periods of time in more dangerous environments. China has intercepted US UUVs and reverse engineered them to accelerate their own program.

Chinese Coast Guard and Maritime Militia

China has a policy of relying not only on Navy ships for its security and pursuing its interests. When the Chinese made incursions into Vietnamese waters for oil and gas exploration, the majority of vessels used to screen the rig were either Coast Guard or Maritime Militia. Coast Guard vessels are growing in size, number, and capability. Indeed, the largest of the new Chinese Coast Guard ships are more akin to Navy vessels in size and capability. This wide-

ranging naval presence offers China great opportunities for monitoring US movements in the region.

The Maritime Militia is if anything more consequential than the Coast Guard. The number of Chinese fishing trawlers is so high that if they were all actually engaged in fishing it would deplete the entire SCS within a year.[43] The number of these ships and the fact that they can so easily deny their official function gives the PRC the chance to have more eyes spread through its claimed maritime territories than any other nation. It should be assumed that any Chinese vessel encountered in the SCS will report the activities of foreign Navy ships to their superiors and then likely be tasked with shadowing the foreign naval ship.

3. Implications for the US and the USMC

The Commandant's Planning Guidance (CPG) states, "The Marine Corps will be trained and equipped as a naval expeditionary force-in-readiness and prepared to operate inside actively contested maritime spaces in support of fleet operations."[44] To fulfill this vision, the Marines are developing a new doctrine of Expeditionary Advanced Base Operations (EABO) combining naval maneuvering forces and Expeditionary Advanced Bases (EABs) forward within the A2AD environment. Specifically, EABO are designed to support a naval campaign to accomplish sea denial and sea control operations, complicating an adversary's operations and enable joint US forces to maneuver and engage effectively.

As a concept in response to the US losing its presumption of freedom of maneuver and immune basing and access, EABO is a necessary paradigm shift in how the Marine Corps will

[43] Gregory Poling, *China's Hidden Navy* (Washington DC: foreignpolicy.com, 2019)
[44] *38th Commandant's Planning Guidance*. (Headquarters Marine Corps, 2020) 1

fight in the future. Even an open source, unclassified review of US doctrinal developments—primarily in the CPG and the EABO Handbook, makes clear the Marine Corps is actively addressing myriad force structure, technological, and operational changes that will determine the success and viability of the Corps in the future. In particular, Marine leaders and planners clearly understand the need for "low signature" approaches to allow friendly forces to operate inside China's Weapons Engagement Zone (WEZ). However, this paper asserts there are some issues with the growth of adversary ISR that may not be sufficiently addressed. The paper acknowledges that ongoing work in the classified realm no doubt includes greater granularity on the nature of the Chinese ISR threat and in developing creative, covert methods for achieving low-signature operational art. Nevertheless, the paper aims to support such efforts by providing an unclassified, but focused and expert, "outside" look at the nature of the problem and in proposing some potential opportunities.

The New Character of War: Doctrines and Applications

In the past few decades, China has grown into an economic powerhouse and has invested significant resources to modernize and expand its military power. Research and development of technology has grown by leaps and bounds as China has purchased or acquired intellectual property that previously took years to develop. Modernizing all of its forces with the new technology is a massive undertaking that is not yet complete. Likewise, training and expertise need to be developed and cannot be accelerated. Overall, China is not yet a military match for the US, but in its immediate neighborhood China currently has the capacity to challenge the US military and impose heavy costs on any US operations in the region. The PRC is concerned about domestic instability and foreign interference, hence its social controls and the massive

growth of A2AD. In sum, China's A2AD is intended to cause foreign nations to reconsider before initiating an armed conflict.

The exploration of China's current and projected capabilities gives a glimpse of the type of war that China expects. China is invested in the Asia-Pacific region and considers the periphery around China to be their domain. The current and planned Chinese ISR architecture is designed to keep the US and other foreign powers out of the area. China is already practicing preemptive missile strikes against US bases within the region.[45] This missile inventory is currently only an implicit threat to be used in the event of open conflict. However, even now ISR is an active component of the gray zone conflict that China is using to achieve its objectives without resorting to open war.

The combination of global satellite coverage and extensive ground coverage within the SCS and ECS are intended to provide Beijing with complete "Maritime Domain Awareness" within the region, allowing China to know everything that moves within the two island chains. The ISR combined with comprehensive A2AD is intended to control that area, exclude foreign powers, and deter intervention in Chinese domestic affairs.

A2AD

A quick review of A2AD may be useful context for understanding this paper's main arguments on the role of ISR in China's strategy. A2AD refers to mutually supporting military capabilities that prevent or constrain the deployment of opposing forces into a given theater of

[45] Thomas Shugart, *Has China Been Practicing Preemptive Missile Strikes Against U.S. Bases*? (War on the Rocks, 2017)

operations and reduce their freedom of maneuver once in theater.[46] One of the most significant capabilities of A2AD is the growth of long range, precision fires. The ability to precisely target and destroy targets from great distances is no longer a monopoly of the US but now available to US adversaries who recognize it as a key to thwarting US military intervention.[47] Along with precision strikes are a host of other technologies and investments designed to make operations in the area as costly and difficult as possible, including coastal defenses, hardened installations, submarines and surface ships, and naval mining. Horatio Nelson famously observed, "A ship is a fool to fight a fort!"[48] A significant investment in A2AD, like what China has created along its coast and the SCS, acts as the modern fort threatening a US Navy that has enjoyed decades of uncontested sea control.

Potential adversaries of the US have pursued A2AD after observing how the US operates. Commandant Berger acknowledged that China is watching the US very closely. "Even training will have to change in light of a sensor-filled globe and an always watching adversary. 'It wasn't long ago we could take the whole joint force out to Alaska or China Lake and nobody could see what you were doing. That's no longer the case. So, a lot more training will have to be done 'out of sight.'"[49] A2AD invalidates exquisite legacy systems that are both very large and expensive, namely US aircraft carriers, amphibious ships, other large surface combatants, and, perhaps critically, logistics and support vessels that tend to be single points of failure. When most of the fleet is exquisite, expensive, and rare it becomes exceptionally brittle. If US forces were compared to a game of chess then there are no pawns worthy of risk. The largest issue is that in the event of hostilities the cost imbalance between large, expensive, exquisite assets filled with

[46] Luis Simon, *Demystifying The A2/Ad Buzz*. (War on the Rocks, 2017)
[47] Andrew F. Krepinevich, *Maritime Competition in a Mature Precision-Strike Regime*. (Center for Strategic and Budgetary Assessments, 2015)
[48] James Holmes, *Anti-Access and the 'Fortress-Fleet'*. (Washington DC: The Diplomat, 2012)
[49] Todd South, *The Marine Corps has 'to get smaller to get better,' commandant says*. (Marine Corps Times, 2020)

personnel are grossly disproportionate to the huge stockpiles of economical missiles available to the PRC in the SCS.

New US Military Doctrine:

EABO is to be conducted by low-signature naval and joint forces with operationally relevant sea control and denial capabilities – in particular, the ability to offensively target and strike adversary naval and air platforms, and defensively form the nucleus of an active integrated maritime defense-in-depth.[50] Essentially, EABO envisions the use of small, cheap but lethal assets to operate within the A2AD environment and well within the WEZ so they can complicate the planning and activities of an adversary. This conjures the amusing picture of large numbers of young marines on Jet-Skis armed with Man Portable Air Defense Systems (MANPADS), but the actual plan is much more nuanced and comprehensive, with unmanned assets, submarine launched drone swarms, personnel setting up missile systems on isolated pieces of land, and caching materiel on barges for mobility. The objective is to create an 'inside force' that supports a more resilient infrastructure and enables future operations or ideally will deter a future conflict. Finally, EABO is planned to enable the related doctrines of Distributed Maritime Operations (DMO), Littoral Operations in the Contested Environment (LOCE), and Joint Concept for Access and Maneuver in the Global Commons (JAM-GC).

The assumption of EABO and the related doctrines is that these small, low signature forces will be more difficult for the Chinese to detect than the very large and powerful assets that have dominated the US arsenal, namely aircraft carriers and their escorts. The importance of successfully evading the growing Chinese ISR architecture is highlighted in the key insights of the wargames that guided the CMC's Force Design 2030. "The hider-versus finder competition

[50] Art Corbett, *Expeditionary Advanced Base Operations (EABO) Handbook, Considerations for Force Development and Employment, Version 1.1.* (Marine Corps Warfighting Lab, 2018) 5

is real. Losing this competition has enormous and potentially catastrophic consequences. This makes success in the reconnaissance / counterreconnaissance mission an imperative for success."[51]

Efficacy of EABO vs Comprehensive ISR

For EABO to serve as the foundational component that enables LOCE and DMO, it must be employed inside China's WEZ's and ISR observation coverage. The EABO Handbook states,

> "EABO creates a more resilient forward force posture that circumvents the efforts and obviates the investments of aspiring peer competitors employing long-range precision fires directed at dislodging US forces dependent upon legacy bases, fixed infrastructure, and large targetable platforms…EABO is conducted by ***low-signature*** (author's emphasis) naval and joint forces with operationally relevant sea control and denial capabilities—in particular, the ability to offensively target and strike adversary naval and air platforms, and defensively form the nucleus of an active integrated maritime defense-in-depth. EABO is premised on the creation of an alternative forward force posture based on a more ***difficult to target, low-signature, and dispersed*** forward-basing infrastructure. The lethal, yet resilient, combination of ***low-signature*** forces operating from a more amorphous forward-basing infrastructure will enable US naval and joint forces to *persist, partner, and operate [*Handbook's emphasis*]* within range of adversary long-range precision fires--particularly ballistic and cruise missiles designed to attack critical joint, fixed, forward infrastructure, and large platforms."[52]

Persistent ISR with reliable detection is the potential Achilles heel of EABO. If China can achieve its goal of comprehensive ISR with wide area coverage over the region then all US forces will be threatened at all times. A key component of EABO is the assumption that

[51] David H Berger, *Force Design 2030.* (Headquarters Marine Corps, 2020) 5
[52] Art Corbett, *Expeditionary Advanced Base Operations (EABO) Handbook, Considerations for Force Development and Employment, Version 1.1.* (Marine Corps Warfighting Lab, 2018) 5

reconnaissance assets will lose track of the target or fail to track all of the EABO forces, so they can set up in several locations to complicate the adversary's decision making. However, if the enemy's ISR never loses track of the target and monitors its movements, then the adversary could prepare for all of the EABs that are created, making targeting and neutralization a simpler affair. This may be performed, for example, by the Jilin constellation which allows for persistent video coverage of a target as it traverses through Chinese claimed territory.

China almost certainly plans to use its advancements in machine learning for surveilling an area as large as the SCS. If persistent wide area collection is performed for certain length of time then the regular pattern of traffic behavior can be discerned, this must account for seasonality and unusual events such as extreme weather. If this data is fed to a machine learning algorithm then it can detect the patterns and create a baseline for pattern of life. This baseline could then be used to observe future traffic and detect anomalous activity, when a ship or aircraft is behaving in a way unusual for the location. If this detection system is part of a larger system then it could automatically tip and cue a higher fidelity sensor to focus on the target for identification. Computer vision algorithms are already used to allow a computer to identify a target based on a library of images. For example, open source discussions have raised the potential for EABO to employ anti-ship missiles hidden in commercial shipping containers; however, AI could assist in the automatic tracking of such containers, the introduction of new containers, or suspiciously static or housed (for security purposes) containers, particularly if matched with change detection tools covering warehouses and other commercial properties in the region.

EABO Pursuit of Low Signature

Future EABO are likely to face an integrated system of comprehensive ISR using a combination of sensor types to detect even low signature assets. It is difficult or impossible to hide from every type of ISR asset. Chinese planners determined to avoid failed or delayed detection would use a combination to overcome the weaknesses of any one sensor type. Even so, several methods hold promise for EABOs to avoid ISR detection or identification, including camouflage, thermal masking, stealth technology, and emissions control. However, it should be noted that these methods of D&D only reduce the chances of detection and do not guarantee the safety or survivability of EABs. These methods operate as countermeasures against types of sensors, some are more effective than others, but none are effective against all means of detection.

Camouflage

Efforts to use camouflage to avoid detection is the most basic form of D&D. Camouflage breaks up the outline of vehicles and personnel to blend with the background or confuse attempts to accurately count numbers. This is true both for the military and herds of Zebra whose striped pattern make them blend together. Camouflage is effective against human observers and panchromatic imagery. Basic multispectral imagery (MSI) commonly has four bands Red, Green, Blue, and Near IR (NIR). NIR is noteworthy because the signature for living photosynthetic vegetation is so distinct that a false color MSI using NIR easily defeats basic versions of camouflage trying to blend with vegetation. A crafty enemy will use paint or materials that attempt to mimic the spectral properties of vegetation at the wavelengths commonly used by MSI sensors. Whereas MSI collects a handful of bands, hyperspectral imagery (HSI) collects dozens or hundreds of bands. HSI allows matching against a spectral library of materials and identification of not just paint colors but paint brands and degree of

weathering on surface materials. Efforts to create camouflage paint or materials to defeat HSI are exceedingly more difficult. Some other ISR collections commonly used to overcome camouflage are SAR, Polarimetric Imagery (PI) and Thermal Infrared (TIR).

Countering Thermal ISR

TIR collects emissions in the IR wavelengths of the EM Spectrum, Shortwave IR (SWIR), Mid-wave IR (MWIR), and Long-wave IR (LWIR). There are many applications for this type of sensor. The first is, it can be used to show activity levels for vehicles, small power generators, and large, industrial power plants. The amount of energy used by a vehicle's engine is translated into heat that can be detected. Also, a thermal shadow is left in the shape of a vehicle when that vehicle is moved because it had previously been casting a shadow over a surface that is now measurably cooler than the surrounding sunbaked surface. Thermal sensors are often used for detection of personnel and equipment as they stand out from the background.

Low signature efforts usually revolve around insulation materials that trap the heat or dispel it in a less noticeable way. This is not always successful and often relies on the training and discipline of the forces avoiding detection. One common example is thermal blankets used for masking the heat of an individual from searching drones. This effort could be overcome with other sensors that could detect the reflective surface of such blankets, such as SAR, HSI, or PI.

Stealth and Radar Jamming

Stealth is designed to defeat radar and stealth technology has been in development for decades. For military vehicles the shape, materials, and paint all contribute to making the smallest radar cross-section as possible. A well-designed vehicle can avoid detection or confuse

targeting by presenting a much smaller return than would be expected for their size.[53] Stealth effectively causes a ship or aircraft to get lost in the noise of radar. Jamming is an active countermeasure to defeat radar detection as it overwhelms the system with erroneous noise to drown out the signal. Radar operators are constantly working to defeat stealth by designing better or more powerful radar systems and improving the Signal to Noise Ratio for better detection.

Unfortunately for stealth proponents, the development of quantum radar has the potential to negate stealth and jamming entirely. The use of entangled photons inherent in the quantum technology make distinguishing the signal from the noise of a radar return a trivial endeavor. Theoretically, if a radar possessed the power to emit energy to a target and for even a single photon of that energy to return then the radar system could establish a legitimate target. If quantum radar is fully developed and widely distributed throughout the Chinese ISR architecture then the role of the F-35 aircraft in EABO would be severely compromised. [54]

Emissions Control

Emissions control largely revolves around avoiding SIGINT detection by not emitting any signals. The goal of becoming a black hole of emitted signals would help avoid assets like the Yaogan SAR sensors, which, as discussed above, have been set up in triplets specifically to triangulate the position of ships based on their signals. However, the issue then becomes the anomaly that is presented by a ship that is not emitting any signals. All ships of a certain size are required to broadcast an automatic identification signal (AIS) with their ship's name, affiliation, and position. A ship can turn off the AIS and not broadcast any other signals but in a way that

[53] DARPA Timeline. *HAVE BLUE and Stealth Technology.* (Arlington, Virginia: Defense Advanced Research Projects Agency, 2020)
[54] MIT Technology Review. *Quantum radar has been demonstrated for the first time* (Massachusetts Institute of Technology, 2019)

raises suspicions because wide area ocean monitoring without relying on emitted signals is likely to still show the position, heading, and speed of vessels. If that data is combined with SIGINT collection then all of the ships that do not match up with an AIS transponder are referred to as a 'dark target,' and they are assumed to be trying to conceal themselves. Dark targets might be smugglers, pirates, Chinese Maritime Militia looking for trouble, or commercial ships with cheap equipment that is broken. Focusing attention on the dark targets it is then helpful to analyze the 'behavior' of the suspicious targets for anything anomalous. Commercial and fishing traffic follow regular patterns. Some of the behaviors that are indicative of commercial shipping are targets located within established traffic lanes and traveling at top speeds set according to safety and insurance regulations. For fishing vessels, it is staying in or near good fishing locations or traveling to and from those locations, also it should be remembered that fishermen have a regular routine for when they head out to work and when they return home. Dark targets outside of the standard local pattern will stand out if an analyst is familiar with the area or if machine learning has been used to analyze the regular traffic patterns. If a Navy ship were actively trying to avoid detection then it would be helpful to adopt behavior similar to the local traffic. This subterfuge would not require the ship to actively lie about being a commercial vessel in any overt sense but moving in a certain way will make it less likely that they will be picked out as anomalous.

Distributed Forces

Avoiding grouping forces together to avoid presenting conspicuous, high value targets may be one of the more effective strategies. However, spacing out forces may not be enough to avoid detection, targeting, and destruction. Some ISR assets will rely on the observable behavior

of the targets for detection before cueing a higher fidelity sensor for positive identification. Trying to mirror the characteristics of commercial and civilian traffic will decrease the chances that a target will appear anomalous. Certain actions like moving in a formation or convoy can be indicative of military activity. Another issue is speed of travel, commercial traffic maintains a certain maximum speed due to liability issues, ships traveling at higher speeds may be a military vessel. Moving outside of common shipping corridors or flight paths is another key to identifying non-civilian activities. Generally, for aircraft, commercial carriers stick to straight efficient paths and aircraft that perform maneuvers or especially acrobatics at higher speeds are only seen in the military.

Consideration of local behavior probably should be incorporated into EABO plans and operations. US forces might think more like members of an underground resistance. If it is impossible for a member of the underground to avoid ever watchful surveillance in public then they must blend into the crowds within the town as they perform their mission. Police officers will tell you that as they observe a crowd, they watch for people who do not fit in.[55] In a market it might be people who are moving too fast, not stopping to browse, waiting in one spot for no apparent reason, dressed in an unusual fashion, and many other signs that something is not normal. US forces must assume they are observed and try to avoid attracting extra attention by acting like they don't belong.

4. EABOs in Reality—No "Low Signature" Magic Wand

[55] Washington Metro Police, *What is Suspicious Behavior*? (Washington DC: Metropolitan Police Department, 2020)

This paper's main argument is that even if the US employs all of these low-signature, counter-detection, and denial and deception practices, China will likely detect a large portion of EABs. The main implication of this argument is that EABO will face heavy losses, requiring redundancy and a willingness to suffer casualties to ensure enough EABs survive to support the naval campaign. EABOs may be possible, and may be the only real option against an enemy that gets a vote in a war's outcome, but EABOs will be a profoundly dangerous mission.

To support this argument, this section will present three EABO scenarios or activities: surveillance, strike, and logistics. Each scenario includes the general purpose of such a mission and a basic treatment of how the Marines might conduct it. This is followed with the means the Chinese might use to detect and target such a Marine activity. Finally, this section offers potential mitigating measures the US might take to better hide that activity, increase its chance of success, and increase survivability for the Marines tasked to perform it. Nevertheless, these mitigating efforts are likely to only reduce, not eliminate, China's ability to detect and attack EABs.

Surveillance and Reconnaissance EABOs

To support the US naval sea control and sea denial campaign, Marine EABOs would provide detailed intelligence and targeting information on the location and strength of Chinese ship and aircraft movements. EABs established primarily as a surveillance activity, or surveillance activities spread among multipurpose EABs, would provide the proximity to enemy forces necessary for the purposes of gathering information. EABs typically would be small, shore-based observation posts, but can also be augmented with air and naval reconnaissance. These might include using seaplanes and small surface connectors involved with resupply and relocation missions also fielding sensors capable of tracking Chinese naval forces. These EABs

would also require communications capabilities to send its tracking information to higher headquarters or to nearby naval strike EABs. Because US "ISR EABOs" would lack organic strike capabilities and have a small footprint they would be the smallest and easiest to hide of the EABO variants; even so, they would face significant challenges in hiding from China's ISR system.

Chinese ISR vs Reconnaissance EABO

To detect a small shore-based observation post with all of the requisite sensors and communications capabilities, China would first employ SIGINT satellite and airborne sensors to detect transmissions and emissions. Yaogan triplet SIGINT satellites can provide accurate location information by triangulating the position of an emitted signal. China may also use SAR, thermal, and spectral sensors to detect changes or monitor pattern of life, such as the use of power generators to run sensors. With enough available sensors and a limited area, detection becomes simpler and more rapid. Smart Chinese intelligence would assess the most advantageous locations for such an observation post and regularly direct these sensors to sweep those locations. The search may even become automated, satellites and drones operating according to preset routines that search the areas highlighted as most likely observation points. Machine learning can establish the regular pattern of life for those areas and detect anomalous activity when something changes, such as fluctuations in traffic or the construction of new buildings. Computer vision can be used to assess those locations and determine the likely use of new facilities and compare any vehicles or equipment to a library of images for matches with US hardware.

Air and sea reconnaissance assets benefit from constantly being on the move and operating away from those predetermined locations. However, moving targets are also some of

the easiest to detect and with the proper use of machine learning to distinguish normal traffic from unusual traffic, the span of time between detection, identification, and targeting continues to narrow. Also, the Chinese can counter air and sea reconnaissance assets with one of their most dangerous assets which is also one of the simplest, the Maritime Militia. The Chinese Maritime Militia roam around the SCS looking for suspicious activity and foreign vessels to investigate and intimidate. The Maritime Militia regularly gets tasked with observing suspicious foreign vessels and shadowing them. Military assets will automatically be noted as soon as they are detected and closely observed by Chinese forces. Even nonmilitary ships and vessels without a legitimate purpose for being in the area may attract attention and be shadowed by Maritime Militia, Chinese Coast Guard, or UAVs. Every Chinese ship should be assumed to be reporting the activity of suspicious vessels, and since they are all tied into Beidou they can easily send text messages to nearby vessels with accurate location information.

US Mitigation Opportunities

The surveillance mission actually has a better chance of success and survival than other missions because it can remain small and inconspicuous. There are some basic guidelines for greater survivability in this mission. First, active means of sensor collection such as radar are detectable by the target, so passive sensor collection should be the priority for EABO assets to avoid detection. Also, spreading as many decoys as possible throughout the area, will increase the safety of the real EABO assets and further complicate the task for the Chinese forces.

Regarding the small shore-based observation post, there are a number of means that might increase its success and survivability. Limiting the transmissions from the location would be the priority to decrease the chances of SIGINT detection. The Marines operating the post would practice emission control and avoid obvious signs of their mission, such as replacing gas-

or diesel-run power generators with battery-powered sensors and C2 systems. Some type of subterfuge would be advisable, such as appearing to be beachgoers seeking an isolated retreat or as fishermen set up on the shore. Ideally some means of transmitting away from the actual observation post location would be best. This could be accomplished through several different means: cables connecting from the observation post on an island in the SCS to a mainland with the infrastructure to carry the data, a small vehicle capable of traveling from the observation post to some distance away before transmitting, or establishing some regular commercial traffic near the location that can receive a low powered transmission during transit. Any means to avoid the observation post signaling itself to Chinese SIGINT collection.

For the airborne and sea-based collection, the Marines tasked with this mission should seek identification as something more innocuous, like a Philippine fishing boat, tour boat, or yacht, something to make the Marines blend into the normal traffic of the area. It should be noted however that the PRC have claimed the right to police the SCS. One of their Coast Guard ships may decide to perform a search or safety inspection, so the risk is still present. However, an open military asset shadowing the adversary's military vessels and loitering near emplaced A2AD will draw immediate attention. US forces could use similar tactics as the Maritime Militia and procure modified civilian vessels crewed with military trained personnel, this complicates the steps a military combatant would be expected to follow before armed action. Another possibility is organizing Filipino fishermen and tasking them to report any Chinese activity; this would not only increase the US intelligence picture of the SCS but also boost the Philippines' national security. A small bounty paid to the crew of the Philippine fishing boat for a reported sighting of a Chinese vessel with location and a description of the vessel's activity should be sufficient.

Maritime Strike EABOs

EABO strike capabilities create a maritime defense-in-depth and deny seas to Chinese naval forces. This mission will include air interdiction, missile defense, sea control, sea denial, and the integrated, active, maritime defense to close straits to enemy traffic. However, these strike capabilities require a realistic plan to protect the assets necessary to execute the operations when needed. As the Force Design 2030 says, "The individual / force element which shoots first has a decisive advantage."[56] If the Chinese can reliably detect, target, and destroy US forces before a strike can be executed then the mission objectives will have failed. This scenario will consider both Marines deploying from an EAB to perform a strike and a land-based EAB that can perform the strike directly.

In the mobile strike scenario, Marines would deploy from an EAB to perform a strike against an enemy asset, ship, aircraft, or land target. This could be Marines on Jet-Skis armed with MANPADS, although something like the civilian SeaBreacher, a recreational semi-submersible craft that looks like a shark, would be even better.[57] Groups of Marines would be stationed at some isolated EAB with small, fast vehicles and their anti-ship, anti-air weapons. The Marines' duty would be concealing themselves and their equipment as best they can. Upon being activated these Marines could deploy and perform a strike before retreating back to their EAB or to a new location before they can be targeted. This mobility provides flexibility in choosing targets and the opportunity to better respond to developing situations, although the firepower punch of these options would be light.

[56] David H Berger, *Force Design 2030*. (Headquarters Marine Corps, 2020) 5
[57] Brent Rose, *My Wildly Fun Test Drive of a Seabreacher Submersible*. (Outside Magazine, 2018)

A land-based EAB could be armed with anti-ship cruise missiles, such as the Naval Strike Missile (NSM).[58] The NSM is recommended as a common munition because it is available for multiple platforms and applicable against an array of targets, the EABO handbook recommends dual-use resources to minimize footprint and increase versatility.[59] An example firing battery might have four mobile launchers, with each launcher equipped with a container of four missiles. This EAB set up might have similar manning as a HIMARS unit but again modified to fire NSMs. Or there might be an unmanned option, such as a JLTV fitted with NSMs moving to a predetermined site and fired remotely. The Marines responsible for the equipment would take the opportunity to conceal the equipment but ultimately would require an opening or view out to sea to the area of a planned targets. There may or may not be an associated C2 element, depending on if the Marines must wait for an order to fire or can operate independently. There should be no missile resupply for this mission for two reasons, a limited footprint will help minimize the EAB signature and once fired the EAB should be assumed detected, targeted, and destroyed. Even so, if one "fire and forget" USMC firing battery can sink or damage even just one Chinese surface combatant, that would be a significant contribution to the naval campaign, with the impact multiplied by the number of actual coastal defense EABOs in action.

Chinese ISR vs Naval Strike EABOs

Similar to detecting signals from the surveillance EABO, SIGINT will be the first option for finding an EAB designed for strike missions, so similar methods of emission control will be

[58] Raytheon Technologies, *Naval Strike Missile*. (Raytheon Technologies, 2020)
[59] Art Corbett, *Expeditionary Advanced Base Operations (EABO) Handbook, Considerations for Force Development and Employment, Version 1.1*. (Marine Corps Warfighting Lab, 2018) 60

assumed.[60] Unlike the surveillance EABO, the strike EABOs require more assets and will create a larger footprint that must be concealed. Detecting the EABO strike assets will be a matter of defeating their D&D. For comparison of how this might be conducted, the US intelligence community has been occupied with developing new means for the difficult task of defeating the D&D of insurgents for years. The difficulty in finding insurgents often lies with the rudimentary nature of the targets helping them blend with the surrounding population but a modern military with distinctive military assets is much more conspicuous. An EAB prepared to support strike EABOs will require recognizable military assets and equipment which will make the task easier for the Chinese ISR.

As ISR technology advances, new means of detection become available or perfected but it is the synergistic combination of different sensor types that may provide the breakthrough for identifying concealed targets. SAR and PI are ideal for penetrating through canopy and foliage to detect vehicles and structures. TIR can monitor for heat and indicate artificial activity like engines or electrical power. Spectral sensors can defeat camouflage and help identify targets. Prior to hostilities, China likely would do terrain and trafficability geospatial studies to identify the most likely launch points and travel routes for US strike units, which would help focus Chinese collection efforts away from areas assessed as not suitable for US vehicle movements. A combination of these sensors will increase the capability of defeating D&D and the biggest limitation will be sensor availability and coverage. The next greatest limitation is skilled analysts to exploit the data, as China increases the number of available sensor assets it will likely pursue advances in computer vision to increase the ability to automatically process and exploit sensor data.

[60] Art Corbett, *Expeditionary Advanced Base Operations (EABO) Handbook, Considerations for Force Development and Employment, Version 1.1.* (Marine Corps Warfighting Lab, 2018) 52

While they remain static, mobile forces face the same potential risk of detection as other stationary EABs, but the moving units of a strike force face an additional risk. To detect these mobile assets, the Chinese can use wide-area, low fidelity coverage that monitors for anomalous behavior outside of the baseline pattern of life. A large group of fast-moving objects heading towards a Chinese militarized island or a Naval vessel might trigger a tip and cue for a higher fidelity sensor such as a high-resolution satellite like Gaofen, UAV, or even surface vessel to investigate. For the purposes of anomaly detection, fast moving is understood to be traveling faster than the top speeds for commercial traffic in the area, and it is a simple affair to create a watchbox near assets like artificial islands with A2AD infrastructure or even mobile watchboxes for ships in transit. Upon identification of suspicious targets, a higher fidelity sensor can be tasked for identification or in the case of an armed UAV, interdiction of the EABO forces.

US Mitigation Opportunities

The key would be to position EABO strike assets close to targets or known transit lanes so there would be limited time to respond. These EABO missions would revolve around keeping joint capabilities hidden and only venturing out for brief hit and run raids. A mix of land and sea assets would present the Chinese with more complicated targeting. There would also need to be a surveillance system to signal for the ideal moment to strike. Any of these systems are at risk of detection to an increasingly formidable Chinese ISR architecture but are necessary for EABO to have validity.

These strike missions will be extremely dangerous, likely either being discovered at the EAB source, detected en route to the target, or targeted on the return from a strike mission. It should be recommended that unmanned assets be used to the greatest extent possible or a conflict

will be seen as too costly for the US population to accept. Ubiquitous assets will be required to account for potential losses and greater viability of threat to the adversary.

Logistics and Support EABOs

In regards to logistics support to operations within the enemy WEZ, "optimally, equipment, platforms, munitions, and other hard to transport items will be prepositioned, and the rapid transportation of troops into the area of operations will enable US and allied forces to quickly seize the initiative and field integrated naval and joint forces forward."[61] Marines manning these support EABs, will include mobile FARPS, fleet support activities, battle damage repair, and rearming and refueling of surface ships and flotilla forces. For better safety and security, these logistics EABOs would be distributed throughout the area of operations and be broken down between activities with a small footprint and those with a larger operational footprint.

The smaller logistics and support EABOs will support the daily activities of nearby EABs while facilitating the larger specialized EABOs that support fleet functions. To support daily operations of EABs, the EABO handbook plans to use more locally sourced resources for joint and allied units, this might include allowing Marines to use credit cards to purchase supplies and material from local vendors without the usual bureaucratic process. This vision of Marines living off the land for food, ammo, and water will require some adjustment from the personnel and the Marine Corps as a whole. However, this organic method of supporting the EABs with local resources will make them both more sustainable and more resilient. Establishing a network to support nearby EABs will help those EABs remain concealed, safe, and ready to activate.

[61] Art Corbett, *Expeditionary Advanced Base Operations (EABO) Handbook, Considerations for Force Development and Employment, Version 1.1.* (Marine Corps Warfighting Lab, 2018) 62

The larger logistics EABOs will be more difficult to disguise and should ideally remain mobile or concealed until activated in the event of hostilities. These EABOs will support the major muscle movements of a Joint force such as fueling aircraft, fueling ships, arming strike aircraft with bombs and missiles, and conducting repair and maintenance. The equipment and facilities required for these missions are more recognizable and more costly if lost so special care must be taken to safeguard them. The first purpose of these logistics operators will be to transport materiel into the area that cannot be locally sourced and the second is distributing them to a concealed final cache site. One interesting proposal would be to store logistics, supplies, and military assets inside standard shipping cargo containers as they are moved into the area of operations. An EABO mission might be transporting NSMs or other munitions into the area of operations. Starting with loading NSMs into a standard 20-foot shipping container, transport on a commercial cargo ship for the trip to the SCS, offload the missiles at a civilian port, and store them in a non-military warehouse until they can be transported by commercial box truck to a hidden cache site. Another might be to transport bulk quantities of aviation fuel, store it in insulated barrels, and submerge it off of a coast so it can be retrieved and used for later operations. One possible idea to avoid detection while resupplying a logistics EAB might involve literally hitching a ride on an established commercial ship with a small submersible attached to the hull below the waterline. The submersible would detach from the commercial ship at the nearest point to the EAB as the ship traveled its route and move quickly to its destination, limiting the time available for detection. Regardless of how the materiel arrives to the area, it must be distributed and cached for later use. Cached supplies might be buried on land or kept on civilian barges for ease of movement and ready disguise.

Chinese ISR vs Logistics EABO

To disrupt the logistics and support of EABO and other distributed operations the Chinese must either find the cache sites or the personnel attached to them. There are many ways to conceal a cache of materiel and the method of discovering that cache will depend on the type of concealment. Some common methods include burying the cache, concealing larger items like vehicles with camouflage netting, or inside disguised structures. Digging and burying creates spoil piles that might be an indicator of digging activity, these spoil piles can be discovered with SAR or PI sensors. As this paper discussed earlier camouflage netting or paint can be defeated with the right combination of sensors that either see through the netting, SAR, PI, and TIR or can detect the attempts at camouflage with Spectral sensors.

China almost certainly would attempt to exploit any laxness in US personal security measures. In recent years, alleged "secret" US government sites in foreign nations were discovered because the very fit personnel at the site wore fitness trackers as they went for morning runs around the perimeter.[62] This easily accessible data gave indications for the area of the site, the number of personnel assigned to the site, how often they traveled around the perimeter, and even a decent sense of their fitness goals. These failures would be amusing if they were not such a serious threat to these secret sites. Related to these would be other social media failures. Personnel uploading posts of themselves to friends and family that inadvertently reveal their location and activities. Many tools are currently available for data mining where this kind of information is collected and analyzed. The dangerous practices continue despite numerous mandatory trainings, safety briefs, and directives.

US Mitigation Opportunities

Recommendations for burying of caches would be to dispose of the spoil piles further from the site or disguising them, such as at a nearby farm or construction site. Personal

[62] Jeremy Hsu, *The Strava Heat Map and the End of Secrets*. (San Francisco, California: wired.com, 2010)

electronic devices provide a wealth of intelligence to enemies and threaten detection and destruction to EABs, unfortunately removal of all personal devices will be difficult in today's connected culture and will only become even more so in the future. The EABO handbook mentions having organic devices to monitor for electronic signatures of the EAB and those devices would be critical to avoid these embarrassing operational failures. On a related topic is the tendency for personnel to post too much revealing information on social media, which must be curtailed as an aspect of discipline. Alternatively, social media could be used to disguise activities, personnel taking on the persona of a social media 'influencer' that is living an enviable life partying on a beach in the SCS. Other than avoiding obvious self-defeating items, some of the best advice is to have as many other confusing targets as possible, decoys and designing EABO buildings and vehicles to look like the locals as possible.

Utilizing civilian infrastructure has a host of benefits. Preexisting infrastructure means avoiding the cost of building something new and an old building is less noticeable than a new structure being built in a strategic location. However, the US will not often enjoy the convenience of a preexisting structure available to its needs. Investing in new infrastructure has the side benefit of promoting the community and strengthening the bond with the people. Ideally the US could assist in developing roads, networks, and communities along coastlines facing the SCS. These bolstered communities would be better positioned to compete for SCS resources, stronger communities would demand more assertive action from their national government, and those communities would be better able to support the needs of EABs in the future. A more urbanized coastline gives more potential targets for Chinese ISR to search through in an attempt to detect and target US forces. Logistics EABs could be hidden in one warehouse among many and enjoy the same networks and support as the civilian businesses.

Giving Marines credit cards and telling them to go out into the community and purchase food and supplies may be a practical and even economical solution for providing logistics. However, there may be danger of detection if an American guy that no one has met before rolls into a town of Filipinos and regularly buys up everything on the store shelves. There should be greater awareness of the local customs and expectations of an area otherwise this may be noted and reported and the Chinese could be monitoring social media for mention of such activities. Lessons could be learned from clandestine agencies on how they are able to avoid attracting local attention to themselves. Perhaps by using local agents for purchases, using front companies, starting rumors of a construction project for a civilian purpose to cover the expenses of building an EAB.

These concepts for using civilian cover for EAB logistics has great potential but there should be some items of concern to consider. Mimicking commercial and civilian activities might be one of the best ways to disguise US military activities and keep them safe, but it also might place civilians in danger as adversaries discover those activities. Loading munitions and EAB supplies into commercial cargo containers on civilian ships will increase the difficulty of the Chinese detecting those shipments but what is the responsibility of the Department of Defense if the Chinese increase their search and seizure of commercial traffic in the SCS? What if civilian vessels become classified as legitimate targets by the Chinese military?

Conclusion

The nascent US doctrine and concepts surrounding EABO identifies the critical requirement for “low signature” approaches if EABOs are to survive and fight within China’s

"ISR WEZ." However, this paper's presentation of China's ISR capabilities suggests additional, rigorous follow-on concepts, wargames, and experimentation will be required to mitigate China's ISR threat. Progress in mitigating the developing Chinese ISR architecture will help, but the USMC should be under no illusions about the potential for China to detect and locate most EABO, whether emplaced in peacetime or inserted during war. Maintaining a mobile EABO force may help with complicating Chinese tracking but movement also provides new opportunities for the Chinese to detect US assets. The implication for planners is the need to assume many EABs detected, so redundancy and resiliency is even more critical. This also strengthens the argument for further unmanned efforts already underway, an asset is going to be hit, better machines than Marines destroyed. EABO is a necessary paradigm shift but does not negate the necessity of the will to execute a high-intensity war. A high-intensity war will come with heavy costs and high casualties.

Sun Tzu said, "…the highest excellence is to subdue the enemy's army without fighting at all. Therefore, the best military policy is to attack strategies; the next to attack alliances; the next to attack soldiers; and worst to assault walled cities."[63] The C4ISR architecture that China is developing within the island chains, if fully integrated with the A2AD represents Sun Tzu's walled city and the way it is being used by the Chinese is an attack against the established US strategy in accordance with Sun Tzu. The US must appreciate the impact that losing ISR advantage would entail. In the event that the Chinese succeed in joining all of their sensors together into a common picture and use machine learning to quickly locate and identify targets then they would have a significant advantage. Capping that off by using AI to perform targeting or even making the decision to strike would be the scariest possibility, effectively shrinking the OODA loop to an instantaneous reaction. The *Ghost Fleet* scenario of the Chinese declaring a

[63] Roger Ames, *Sun Tzu, The Art of War*. (New York: Ballantine Books, 1993)

line in the water and then destroying any US asset that crosses the line without being able to defend itself could become a reality.

The linchpin for this paper's argument that China's advanced intelligence capabilities will threaten US EABO is whether China's organizational and command culture will be able to successfully integrate its specific capabilities into a fused system. This is an open question. Having a lot of sensors and drones with top shelf technology is not enough; instead, the comprehensive C4ISR and the integrated system of systems feeding targeting information directly to shooters is the step that would revolutionize warfare. This is a hard problem to solve, the US has long struggled with organizations not talking to each other or not sharing information, in the US this tendency has been termed stove-piping. This paper has covered what is essentially a worst-case scenario in which the Chinese leadership are able to use their centralized authority to direct subordinates to collaborate and integrate. What makes the Chinese different? Will their autocratic government be able to succeed in mandating common data formats readable by a centralized system of systems? Will the PLA Strategic Support Force operate jointly with the PLA Rocket Force or the PLA Air Force? It is hard to say whether the Chinese will be successful in this effort until after they have already accomplished it. The point of this paper is to prepare the US military for what could happen so as to avoid a catastrophic surprise. The possibility is real and the US must prepare now while the time is available.

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