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14. ABSTRACT China's rising global status and aggressive actions in the South China Sea in threatening freedom of navigation, anti-aircraft, area denial, and false territory claims have prompted the Commandant of the Marine Corps to create Force Design 2020, pivoting focus and operational concepts towards addressing these issues and utilizing space technology to achieve success in the future operating environment. The following examination of policy documents and joint publications along with the relevant critiques and an assessment of recent technological advances in space capabilities is presented to demonstrate how Marines can and should integrate space capabilities into their operations and the joint fight.						
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MASTER OF MILITARY STUDIES

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**TITLE:**

SPACE AND OPERATIONS IN THE INFORMATION ENVIRONMENT:  
EQUIPPING MARINES FOR THE FUTURE

SUBMITTED IN PARTIAL FULFILLMENT  
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## **Executive Summary**

**Title:** Space and Operations in the Information Environment: Equipping Marines for the Future

**Author:** Joellen W. Welch

**Thesis:** The Marine Corps is not prepared to support Naval efforts to maintain U.S. freedom of navigation in the South China Sea and U.S. status as a Great Power because it lacks readiness in both the space and information domains. In order to retain its relevance and lethality, the Corps requires an increase in its stake and interest in OIE and space capabilities by developing the force, integrating space capabilities to support OIE, and collaborating with the Joint Forces and Intelligence Community.

**Discussion:** The Commandant of the Marine Corps' latest release of the future planning document, *Force Design 2030*, emphasizes the need for Marines to take advantage of space concepts and capabilities. China's rapid and continuing advancement of its military and its actions in the South China Sea have brought the country to a peer or near-peer status as a Great Power. Its A2/AD and anti-satellite capabilities threaten freedom of navigation and demonstrate an aggressive posture to claim territory that it claims to be part of China. *Force Design 2030* and *Commandant's Planning Guidance* do not adequately address the processes and measures necessary to equip Marines to full functionality in the information and space domains to compete with China. The following examination of U.S. joint publications, doctrine, and service level directives along with relevant critiques are presented to identify deficiencies in these documents. The main themes of this research are centered on integration of space capabilities to support OIE, collaboration with the Joint Forces and the Intelligence Community, and force development to equip Marines to ensure U.S. status as a Great Power and freedom of navigation in the South China Sea are maintained.

**Conclusion:** Critical omissions from Marine Corps future planning documents, such as strategies for integration of space capabilities to support OIE, collaboration with the Joint Forces and the Intelligence Community, and force development will leave the Corps ill-equipped and unprepared for success in the future operating environment, specifically in the South China Sea. This study offers several recommendations across those three focus areas to better prepare and equip the Marine Corps with space capabilities and OIE.

## **Preface**

From personal experience conducting intelligence, surveillance and reconnaissance (ISR) for most of my career, I have primarily relied on space systems and recognize them as a critical component in supporting my various missions. As my career progressed, I realized the growing importance of space assets for ISR and additional operations and their importance in the information domain. As China develops capabilities to compete with the United States, so too have they developed systems and capabilities to contest U.S. space superiority. I have worked with the Marine Corps for several years now and realize that although the Corp does not own any space assets, they rely on them heavily and that reliance will only increase. The Marine Corps is a branch deep in culture and tradition, known as the world's most lethal fighting force. The Corps must increase involvement in the space and information domains to maintain their lethality and leverage the warfighting support capabilities that space systems have to offer. The culture is shifting, though rather slowly, which is what motivated me to understand the reasons the Corps is reluctant to invest resources and dependence on space assets and the information environment, expose reasons why it must integrate space operations into its daily operations, and the steps it needs to take to leverage these capabilities. This thesis is an original work by Joellen Welch. No part of this thesis has been previously published.

Throughout the course of my research and writing, I would like to acknowledge the following people for their support, time, and mentorship throughout this process:

**My sons,** James (13) and Nathan (10)

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## Introduction

The information environment (IE) and the space domain are critical for supporting military operations. Space has become more of a contested environment for the United States and less of a sanctuary as peer and near-peer competitors such as China leverage counter-space and anti-access, area denial (A2/AD) activities as a display of power, and as an effort to counter and contest U.S. Freedom of Navigation operations in the South China Sea. In an annual report to Congress, the U.S. Department of Defense posits the likelihood that China aims to develop its military to be equal or superior to that of the United States or any other great power it views as a “threat to its sovereignty, security, or development interests.”<sup>1</sup> China’s People’s Liberation Army (PLA) is developing capabilities and operational concepts to conduct offensive operations in the South China Sea, the Indo-Pacific region (INDOPACOM), and in some instances worldwide with a focus on information, cyber, and space and counter-space operations.<sup>2</sup> The Marine Corps recognizes this emerging threat and describes the need to counter it in *Force Design 2030*, and Corps leadership is responding with emphasis on information as a warfighting function and the challenges it could face in future competition or conflict. The following study examines U.S. policy, service-level guidance, and the Corps’ deficiencies in operations in the information environment (OIE) and space and the and provides a way forward to increase the Corps’ capacity and capability in those areas as it pivots to the Pacific to compete with China. From forward-deployed expeditionary units back to the rear support echelons, the Marine Corps has a vital and unique role in its contributions to the Joint Force. The Marine Corps is not prepared to support Naval efforts to maintain U.S. freedom of navigation in the South China Sea and U.S. status as a Great Power because it lacks readiness in both the space and information domains. In order to retain its relevance and lethality, the Corps requires an increase in its stake and interest in OIE

and space capabilities by developing the force, integrating space capabilities to support OIE, and collaborating with the Joint Forces and Intelligence Community.

This study offers several recommendations in the categories of force development, integration of space capabilities to support OIE, and collaboration with the Joint Forces and Intelligence Community to best prepare the Corps for the future operating environment described in *Force Design 2030*. Within force development, the Marine Corps must add space and OIE as core concepts to successfully “train to fight” in future operating environments. The Corps must also integrate space capabilities to support OIE and gain the information advantage in competition and conflict. Finally, collaboration with Joint Forces and Intelligence Community will strengthen cohesion and increase the likelihood of success on the battlefield. The importance of identifying common mission sets and requirements provides opportunities for improved mutually advantageous readiness, identification of reliable partners, and future cost savings in the acquisition of next-generation equipment the Corps requires to engage in joint all-domain operations.

### **China: Emerging Threats**

Since the decline of the Soviet Union in the 1980s, the U.S. has remained a military power with no peers. However, China’s rapid and continuing advancement of its military and its actions in the South China Sea have brought the country to a peer or near-peer status as a Great Power. China’s increased A2/AD operations, including but not limited to advances in ability to target landing ships, increased sophistication in anti-landing operations, and ability to detect low-flying aircraft in flight with target detection radars, increase risk in areas of competition like the South China Sea. China conducts malicious activity to display power, but in a way that falls below the threshold of armed conflict in an area of competition known as the “grey zone.”<sup>3</sup> With



its anti-access, area denial tactics, China's immediate goal is to drive the U.S. out to what it calls the "first island chain" from Japan extending to the south through the Philippines, and to then extend its control of the maritime region to what it calls the "second island chain," reaching Guam by 2050.<sup>4</sup> To achieve this goal, China has advanced its warfighting tactics and capability with increased lethality, range, and speed, challenging the unmatched military advantage the U.S. has enjoyed for decades. China's broad lineup of A2/AD actions in the gray zone includes military intimidation, paramilitary activities, information operations, industrial and academic espionage, and economic coercion.<sup>5</sup>

In what has become a highly contested information environment, China's sophisticated A2/AD capabilities continue to improve with extended range, increased speed, and enhanced targeting precision with intent to deny the U.S. military freedom of navigation in the South China Sea and to mitigate U.S. combat power effectiveness in an armed conflict.<sup>6</sup> These A2/AD capabilities continue to threaten the joint forces' ability to establish and maintain air superiority and naval supremacy. Chinese forces also intend to use their space and A2/AD capabilities to deny U.S. access to space and are developing capabilities to disrupt the U.S. advantage, such as spoofing and jamming GPS satellites. While China has slowed its development on kinetic anti-satellite capabilities, it continues to develop non-kinetic and electronic anti-satellite technology targeting satellites in orbit.<sup>7</sup> For example, China has been implicated in cyberattacks against U.S. satellites as early as 2007, causing interference with ground station communications.<sup>8</sup>

### **The Importance of OIE and the Space Domain**

The IE is growing in importance, most notably in the space domain. The Joint Publication 3-13, *Information Operations*, describes the IE as "the aggregate of individuals, organizations, and systems that collect, process, disseminate, or act on information."<sup>9</sup> Some space operations

that support the IE include intelligence, surveillance, and reconnaissance (ISR); satellite communications; and space-based positioning, navigation, and timing (PNT),<sup>10</sup> all of which are necessary for Fleet Marine Forces' operational readiness.

While the Marine Corps specifically does not conduct satellite operations or own space assets, it is crucial to note that it relies heavily on space systems more than it realizes because space, as a domain and operations therein, are ubiquitous in several arenas. Space is crucial in operations in the IE for GPS, electronic warfare, ISR, satellite communications, and beyond-line-of-sight targeting.<sup>11</sup> These capabilities integrate into decentralized combined arms operations and the IE.

### **Intelligence, Surveillance, and Reconnaissance**

Military ISR plays an essential role in supporting grey zone operations. Space-based Intelligence assets and tactical surveillance on aircraft and ships, along with ground-based collection and analysis cells, provide early warning to deny adversaries the opportunity to surprise the U.S. and its allies in a strategic attack or to confirm incidents that involve paramilitary activities or intimidation.<sup>12</sup> For example, the Chinese Peoples' Liberation Army-Navy (PLAN) often shadows regional fishing vessels operating outside of the exclusive economic zone and harasses them.<sup>13</sup> Military Combatant Commands use organic airborne and ground-based ISR to support readiness via war plan development, providing essential data that supports future weapon systems' development and acquisition, ensuring the U.S. maintains continuity of a competitive military and information advantage over its adversaries.<sup>14</sup>

ISR also has a central role in the "kill chain," the six-stage target cycle of finding, fixing, tracking, targeting, engaging, and assessing (F2T2EA) a target. It is responsible for finding,

fixing, and tracking (FFT) targets for the forces, critical pieces of information for the fleet marine forces (FMF) to make critical decisions on whether to execute long-range fires. ISR operates in all domains -- space, cyberspace, land, sea, and air. Legacy airborne, space-based, ship-based, and terrestrial ISR systems have historically operated separately from one another but without synchronizing the resulting intelligence products, resulting in duplication of effort or intelligence failures.

A great deal of the ISR that the Marines use for planning operations comes from space-based assets. Space-based intelligence provides leaders and planners with timely and accurate information for joint planning of the information environment (JIPOE) to create a competitive advantage in conflict or competition.<sup>15</sup> In terms of application to the kill chain, the ISR acronym is often suffixed with ‘targeting,’ or ISR&T. There are many subtypes of intelligence, but generally, intelligence is information concerning foreign nations, potentially hostile forces or elements, and areas of actual or potential operations. It can also refer to the activities that result in the product. Some examples of space-based ISR products include a suite of geospatial intelligence (GEOINT) products, measurement and signature intelligence (MASINT) products, and products derived from signals intelligence (SIGINT).

Geospatial intelligence products result from exploitation and analysis of literal electro-optical images, non-literal images such as synthetic aperture radar products, and geospatial information on physical features and geographically referenced activities in a target area. ISR satellites include those that utilize passive sensors that collect electro-optical imagery such as panchromatic and multispectral images, and those that utilize active sensors like synthetic aperture radar (SAR). GEOINT products may include imagery intelligence from satellites

(IMINT) or other intelligence geographically referenced from space. Marine planners, operators, analysts, and others use the technically derived products from GEOINT satellites to conduct JIPOE, monitor and establish patterns of life, find indications and warnings of adversary activity, analyze terrain, identify helicopter landing zones, and conduct other, more technical functions in the classified domain. Taking advantage of different portions of the electromagnetic spectrum, each type of imaging sensor has unique characteristics that add value to an extensive suite of geospatial and advanced geospatial products.

### **Other Space Assets that enable and support Marine Operations**

In addition to ISR, space assets support a great deal of Marine Corps operations, such as GNSS/PNT, communications, information warfare (IW), electronic warfare, (EW), and cyber warfare (CW). There are several different types of global navigation satellite systems (GNSS), and the DoD uses the Global Positioning System (GPS) as its primary source for PNT.

Positioning is what determines the geographic location of a person, object, or signal. Navigation calculates a route from one point to another. The third part of the PNT acronym, timing, ties position and navigation together to determine the duration of travel along a route and provides accurate time globally. Though a Program of Record under the Air Force, GPS provides precise PNT from space using radio signals to military, civil, and commercial users.

PNT facilitates Marine operations and satellite communications that depend on the functions of this precise timing. This is particularly important for encrypted communications requiring hundreds of frequency changes per second. Using PNT, Marines can track and target adversary activity, navigate within land, air, and sea, and determine the accurate location of themselves, joint forces, allied partners, and the adversary.

Marines also rely on space-based assets for their communications capabilities. Satellite communications provide a significant advantage over terrestrial means as space-based systems provide coverage across the globe in real-time, whether the communication is voice or data-driven. With real-time, over-the-horizon transmissibility, the use of communications through satellites provides a significant advantage in support of mobile forces and operations.<sup>16</sup> While it is important to remember that space-based assets can be subject to jamming by the adversary and unintentional electromagnetic interference by human-made or natural phenomena, the advantage of global coverage remains unmatched by other systems. Some communications systems have the capability of selectively “nulling” certain parts of the transmitting radio frequency interference negating the adversary jamming attempt.<sup>17</sup>

In addition to military communication satellites, Marines also rely on communications satellites from the commercial sector. The use of commercial satellites provides more capacity to the suite of communication satellites, and adds bandwidth, flexibility, and alternative networks upon which to communicate. In a contested environment, commercial satellites potentially offer additional redundancy to support continuity of services. Additionally, the commercial sector possesses the ability to develop and acquire systems more rapidly than the military and is able to launch systems into orbit at a faster rate than typical government development and acquisition processes.

Integrated with space operations, IW and its sub-disciplines EW and CW are heavily interdependent upon one another in enabling Marine Corps operations. Electronic warfare consists of a wide array of capabilities, from defeating radio-controlled roadside improvised electronic devices to neutralizing a satellite using directed energy. Functions of EW applied to

Marines involve deceiving and disrupting adversary radio and radar or protect friendly systems.<sup>18</sup> EW can also disable or disrupt adversary satellite operations non-kinetically by jamming the communications link between the ground station and the satellite.<sup>19</sup> CW disrupts, degrades, or disables adversaries through information systems and the Internet and exploits adversary computer networks through intelligence collection. Conducting electronic countermeasures by effectively utilizing using EW and CW capabilities can disrupt adversary information systems and even disable its missile systems by jamming GPS uplink to interfere with navigation.<sup>20</sup>

In the IE, the party generating, preserving, denying, and projecting information first and fastest has the competitive combat, kinetic or non-kinetic advantage. This concept is becoming increasingly evident as technology progresses in operating environments. ISR, GEOINT, PNT, IW, EW, and CW capabilities rely on information collected from space-based assets.<sup>21</sup> A fully operational FMF must employ and integrate all of these capabilities to fully take advantage of what space-based assets offer in the realm of satellite communications, information warfare, and intelligence.<sup>22</sup>

### **Policy, Doctrine, and the Commandant's Directives**

The *National Space Policy* (NSP) and its subsequent Directives declare the nation's priorities and objectives in space. The NSP continues to list guidelines for the national security sector to implement for maintaining space domain accessibility, security, and stability.<sup>23</sup> While the document lists the U.S. Space Force as the primary responsible branch, other branches and Combatant Commands will also be responsible supporting these activities.<sup>24</sup> The NSP did not name specific branches of the armed services, but other military branches besides the Marine

Corps are actively more involved and immersed in understanding and supporting space operations as the NSP describes, as demonstrated by updated doctrine.

DoD Space doctrine exists in the form of Joint Publication 3-14, *Space Operations*. The military services, in turn, published their space doctrine. The Army published FM 3-14: *Army Space Operations*, the Air Force published AFI13-602V3: *Spacecrew Operations* along with AFDD Annex 3-14, *Counterspace Operations*, and Space Force recently released its doctrine entitled *Spacepower*. The Marine Corps, however, does not have a space operations warfighting publication but instead has an 11-page document entitled Marine Corps Order 5400.53, *Marine Corps Space Policy*. The policy describes decentralized operations and non-linear battlefields,<sup>25</sup> appropriate at the time and still applicable today. Still, the Marines require space warfighting doctrine including operations aligning with the Great Power Competition. The 2009 document mentions the ongoing reliance on space-based systems as critical components to support over-the-horizon combat operations,<sup>26</sup> but today there doesn't appear to be a significant change in implementation within the Corps, despite technological advances in space systems. Additionally, the Corps published *Warfighting Publication (MCWP) 3-32, Marine Air-Ground Task Force Information Operations*. However, MCWP 3-32 merely provides IE concepts and lacks comprehensive guidance on practice. These manuals read more like a list of aspirational goals and objectives, lacking direction to execute any effective action. For example, JP 3-14 states that the Marine Corps utilizes space assets in decentralized combined arms operations, offering tactical leverage over an adversary during the Fleet Marine Force (FMF) operations,<sup>27</sup> but it does not describe how the Corps utilizes those assets.

The Commandant of the Marine Corps recognizes emerging Chinese threats in *Force Design 2030*, emphasizing the shift of primary focus to the Indo-Pacific (INDOPACOM)

Region. He outlined shortfalls in capabilities supporting emerging operating concepts at the naval, Marine, and joint levels.<sup>28</sup> The commandant also emphasizes the importance of force design and the need to discover different approaches as they apply to A2/AD threats in contested environments.<sup>29</sup> He understands the importance of the space domain and has directed Marines to leverage space to increase readiness.

Numerous publications discuss advances in information operations and the importance of increasing readiness in the joint forces. In a January 2019 bulletin, then-Commandant of the Marine Corps, Gen Robert Neller, officially added *Information* as the seventh warfighting function.<sup>30</sup> He explained that the “establishment of Information as the seventh warfighting function is intended to integrate and maximize IE capabilities, resources, and activities across the Marine Corps in support of the Service, the Joint Force, and the Combatant Commands.”<sup>31</sup> Marine Corps Deputy Commandant for Information (DC I) LtGen Lori Reynolds sends a clear message that all Marines must understand and utilize space as a warfighting domain to operationalize the IE.<sup>32</sup>

When the DC I formalized the four priorities in the information environment, she stressed the importance of the Marine Expeditionary Forces Information Groups’ (MIG) integration of intelligence, communications, electronic warfare, signals intelligence (SIGINT), cyber, and space “in a way that provides a more holistic picture of what’s happening in that environment.”<sup>33</sup> With the understanding that much of the information environment is supported by space-based systems, the Marine Corps ISR Enterprise (MCISRE) must increase emphasis on the importance of space systems and space situational awareness. The NSP explains that “the United States will employ all elements of national power to deter and prevail if necessary, over hostile activities in, from, and through space”<sup>34</sup> if an adversary were to threaten to endanger the



benefits derived from space.<sup>35</sup> The NSP's Cross-Sector Guidelines state that heads of all executive departments and agencies shall execute guidance to develop and retain space professionals where applicable.<sup>36</sup>

For the Marine Corps, proactive development and integration of activities and capabilities that would apply to the NSP and LtGen Reynolds' direction highlight the space domain's importance in safeguarding critical infrastructure vital to national and economic security<sup>37</sup> and protecting the electromagnetic spectrum for military and commercial use.<sup>38</sup> Most importantly, the list includes developing and retaining space professionals<sup>39</sup> to provide assurance of national critical functions. The service intelligence chiefs and subsequent Marine Corps leadership share a primary objective for the U.S. military to shift from a "manpower-intensive, permissive environment force to an automation-intensive, high-threat environment force:" one that would reduce cost, find and fix elusive targets reliably across the grey zone in contested environments, and enable gaining and maintaining the information advantage.<sup>40</sup>

### **Marine Corps ISR Enterprise**

The Marine Corps ISR Enterprise (MCISRE) is the "mechanism, via personnel, equipment, and processes, that merges disparate nodes of the Marine Corps intelligence effort" into a combined set of capabilities to support decisionmakers.<sup>41</sup> The Marine Corps' Director of Intelligence (DIRINT) developed the MCISRE 2025 strategy supporting the Commandant's planning guidance with the intent of accelerating capability development in the MCISRE by "pursuing innovation and disruptive technologies."<sup>42</sup> By integrating data, information, and intelligence, the MCISRE supports decision-making, aiming to promote a culture that leverages technology and teamwork between humans and machines for Marines to outpace and outthink

threats.<sup>43</sup> The strategy gives the Marines a general ISR vision for the expeditionary advanced base operations (EABO) concept to pursue fulfillment of the National Defense Strategy requirements.<sup>44</sup>

In response to the 2025 strategy, MCIA, the “Hub of the MCISRE,” conducted a capabilities-based assessment (CBA) to examine MCIA’s current state on intelligence production to identify gaps and develop recommendations to address these emerging threats. Much effort and research investigated gaps and shortfalls in the MCISRE’s knowledge base, and the Corps is developing solutions based on recommendations from that research. One of the primary problems identified in the CBA is that military services and agencies do not fully understand the information environment or the products and support MCIA does, could, and should provide.<sup>45</sup> The CBA does, however, provide a summary of current capabilities to include shortfalls in manning, training, and skillsets which addresses the need for codified doctrine. But the document addresses these capabilities in a general sense, where OIE is a complex system of disciplines and sub-disciplines. The training and education portion lacks a breakdown of analytic roles in each individual discipline of the information environment (cyberspace, electronic warfare, space, intelligence, acquisition) or any type of training matrix to bring analysts to a sufficient state of readiness to support OIE. The result of the CBA was the 2019 charter of a project to provide intelligence support to (OIE). Though the DC I charged Marines with including space in MCISRE support, but the CBA does not list anything about the requirement for integrating space-related concepts into the curriculum.

MCIA approved a proposal to improve operations in the information environment in July of 2020 with a list of recommendations for Fiscal Year 2021, focusing on three lines of effort

(LOEs): training, working groups and conferences, and partnerships and integration.<sup>46</sup> The LOEs for training mandate sending Marines to IO planning courses,<sup>47</sup> but only to provide OIE perspective to regional commands, not to the Corps writ large. MCIA's Weapons and Technology Division (WTD) analysts are not mentioned in the proposal. WTD core skill sets include intelligence, communications, electronic warfare, signals intelligence, cyber, and space operations. Many members of the division have IO-related certification, education, and experience as these are requirements of the positions. However, these professionals are mentioned neither as potential sources to share their technical knowledge and expertise with the Command, nor as potential candidates to offer more specialized IO-related training related to their disciplines out to the forces. Marines returning from the proposed IO planning courses will be merely tasked to provide the perspective gained from these courses to the regional commands, but not to WTD or the Geospatial-Intelligence Support Division. The proposal also mentions partnerships and integration with various Marine and external organizations that would bolster collaboration among MCIA and these other organizations to increase awareness of additional capabilities and expertise in various aspects of OIE.<sup>48</sup>

### **Deficiencies**

The NSP states that the Intelligence Community and the Department of Defense shall provide continuous worldwide access for GPS, develop and retain space professionals, improve the development and procurement of space systems, and strengthen interagency and commercial partnerships.<sup>49</sup> MCIA's current proposal<sup>50</sup> lacks sufficient detail in space operations to sufficiently equip Marines to meet those objectives; in fact, space is not even mentioned. The establishment of space as a warfighting domain drew attention to space as a novel concept, but

space operations have transparently supported FMF operations in the background for decades. This transparency may be the reason Marines either ignore or fail to recognize the role space systems play in operations. Marines may not realize the extent of their reliance on space assets and space operations, but they are the systems upon which they depend for a great deal of warfighting functions. Similar capabilities supporting operations exist in the tactical environment without using space systems and are undoubtedly important, but a wealth of more resilient and capable resources exist in orbit, and space capabilities are growing. Derived from space assets, there exists a suite of advanced GEOINT ISR products that the MCISRE require in preparation of future conflicts. MCIA's S2 office has developed objectives and milestones for its geospatial intelligence analysts,<sup>51</sup> but nowhere in the professional continuum plan does it mention the use of national system tools or space situational awareness, even when the Corps lacks institutional training.

Over the past two decades, the MCISRE focused its efforts on counterterrorism and counterinsurgency. As a result, the Corps designed ISR operations and processes for a permissive environment that ensured airspace and battlespace dominance, not a contested environment. Though many tools exist from simple web-based visualization applications to complex data analysis algorithms, there is no mention in any literature about space awareness tools and their training programs available at intelligence agencies that would directly support some of the Marines' training and education shortfalls.

### **Arguments against Adopting New Processes**

The Marines Corps has four main arguments against leveraging more space-based ISR into operations. First, it believes it can rely on its own organic tactical and long- range

communications and ISR systems. Second, the process of tasking, collecting, processing, exploiting, and disseminating (TCPED) ISR products takes too long for external providers to disseminate to the FMF. Third, the DoD leaves itself vulnerable as it only has a small number of satellites. Fourth, the Marines have two space-related military occupational specialties, and those space officers are expected to provide sufficient support to Marine OIE.

Marines indeed bring a number of tactical communications and ISR systems to their operations. They possess organic tactical airborne and ground-based sensors, but effective use is only feasible in a permissive environment where U.S. forces can attain and maintain air superiority. In a contested environment with a peer or near-peer adversary taking proactive measures to deny airspace, air superiority is no longer a given. Legacy TCPED processes from space-based ISR systems are lengthy, sometimes taking days or weeks for sensors to obtain collections within desired parameters. Some of this delay can be attributed to access limitations due to sensor's orbital properties or revisit rate. Even then, some ISR data is rather cumbersome for tactical systems to process due to complexity of data or file size. In theater, tactical intelligence analysts rely on analysts in the continental U.S. (CONUS) for processing, exploiting, and disseminating large data sets. These processes delay the timely delivery of ISR products to theater, as they involve tasking from a downlink to a ground station back in the U.S., and then a lengthy processing, exploitation, and dissemination processes. These processes are often further delayed with manual procedures and single points of failure with limited number of satellite operators and analysts.

Limitations also exist in the number of exquisite, multi-billion-dollar national systems the military could launch into orbit. From concept to operational status, the milestones in requirements, acquisition, development, launch, and calibration would take several years and

consume a wealth of resources. While systems like these are invaluable in ISR operations, their limited number and predictable orbits leave them vulnerable to attack. If an adversary were to disrupt just one satellite, the results could be devastating to U.S. operations. In peer and near-peer competition, risk and possibility also exist for an adversary to disrupt a link in system architecture and render process inoperable in part or in its entirety.

The Marine Corps has two space-related military occupational specialties (MOSs). The Marine Space Operations Officer, MOS 8866 was established to provide subject matter expertise in space operations, but 8866 officers cannot perform all operational functions alone.<sup>52</sup> The MOS is awarded to candidates who complete a two-year program at the Naval Postgraduate School. While the Space Operations Officer program provides a significant amount of education on space operations and concepts, it provides no training on how to implement them.<sup>53</sup> A second space-related MOS, the Space Operations Staff Officer, MOS 0540, is neither a billeted nor a highly trained MOS. 0540 officers attend a two-week course that introduces basic operational concepts in an educational setting but offers no training. These two space MOSs are not sufficient in their current state for FMF readiness or integration of space operations across all phases of expeditionary operations. The Corps is a consumer of space-derived data and by failing to integrate more space training and education across all occupational fields, will not have a stake in informing future space concepts and systems.

### **Problems with Traditional Processes**

At present, most Marines and their leadership have spent the majority of their career focusing on counterinsurgency (COIN), but as the U.S. finds itself in a resurgence of the Great Power Competition, Marines will rely on space operations more than before which will require a shift in cultural mindset from COIN. In the event of a conflict air superiority and naval

supremacy are necessary to stage successful joint forcible entry operations (JFEO). Airspace and battlespace dominance are no longer a given. In scenarios where U.S. forces cannot achieve air superiority, aerial assets may not even be able to fly within collection range of the target to conduct ISR. The arguments against leveraging more space capabilities may have held validity in the past, but as new systems and capabilities launch into orbit, Marines will find space-based systems are increasing in number and capability to perform more tactical support. The Marine Corps will put itself at a significant disadvantage without access to assets or knowledge of conducting integrated space operations with the joint force. Ignoring new systems or technologies hinders future operations and operational readiness.

### **Future Operating Environment**

Recent developments in the proliferation of low earth orbit satellites (pLEO) bring hundreds of low-cost, rapid-launch, expendable communications satellites and intelligence collectors into orbit. With this proliferation of low earth orbit sensors for ISR, deep sensing from orbit enables intelligence collection and targeting beyond the range of vulnerable aerial assets and without alerting the adversary. In recent years the massive push for pLEO and associated systems that provide tactical support further enforce the necessity for Marines to learn about and utilize these systems.

Proliferated LEO is defined as an increased number of satellites carrying ISR payloads, leading to more collection opportunities in less time. This increase in access and coverage requires the right equipment and modernized tasking orchestration. Soon, this will enable deployed forces to access ISR products in less time than it currently takes to complete a collection request. These satellites are smaller, more expendable, less expensive, and easier to launch – all of which lead to more resilience of capability and capacity. In the past, if an

adversary were to disrupt or disable one of DoD's few, exquisite, multi-billion-dollar sensors, the resulting loss would be immediate detrimental effects for FMF, the DoD, and the Intelligence community, potentially lasting decades. While that potential loss remains valid, even if the payloads are less exquisite, pLEO constellations provide continuity of operations. When implemented, the sheer number of pLEO satellites in orbit lessens the detrimental effects of an adversary's anti-satellite attempts. While adversaries may eliminate a few assets, hundreds would remain on orbit and operational. The DoD intends to have a ready supply of replacement small satellites to launch back into the constellation.

As more space-based systems launch into operations, having a high number of remote sensing systems available will advance ISR&T toward achieving persistence or near-persistence. ISR&T, able to integrate faster FFT into sensor-to-shooter operations. Currently, tactical ground- and ship-based systems are also under development to provide direct tasking and downlink of satellite ISR data to warfighters in theater. The persistence or near persistence of pLEO ISR&T constellations, combined with tactical systems designed to task and downlink ISR data, reduce reliance on connectivity to CONUS if those linkages are disrupted. The future operating environment will depend upon the successful integration of ISR&T capabilities to not only shorten the kill chain, but it also to degrade or disrupt an adversary's kill chain.

Shortening the kill chain results in faster, more efficient operations. Advanced ISR collection will enable deep sensing, which is targeting from long distances over the horizon and beyond the line of sight. pLEO means a great deal of data collection and can end up being more than analysts can process, exploit, and disseminate. Such a deluge of high-value data will also necessitate incorporating AI and machine learning algorithms to integrate, analyze, and identify



high-value target information at machine speed and feed it to its fires capabilities to close the kill chain and counter A2/AD.

ISR and space operations would likely play a central role in these new command and control operations. This approach, known as joint all-domain operations (JADO), is defined as “operations conducted across multiple domains and contested spaces to overcome an adversary’s strengths by presenting them with several operational and/or tactical dilemmas through the combined application” of power,<sup>54</sup> and has the potential to provide a significant military advantage by utilizing multiple tactical or operational methods (space, cyber, nuclear deterrence, transportation, electromagnetic spectrum operations, missile defense) simultaneously, overwhelming the adversary across functions, domains, environments, and space.<sup>55</sup>

Where the Marine Corps falls short in its ISR design maturity as it mainly aims to develop the network capability of its manned and unmanned aircraft and unmanned surface vessels (USVs) to cue rapid targeting of adversary forces and support decision-making while omitting space. For example, the Corps has invested resources into the F-35 fighter aircraft, which has long-range fires collection, data fusion, targeting.<sup>56</sup> It will team with the Navy to invest in unmanned surface capabilities like the large and medium unmanned surface vehicles, which will have ISR payloads,<sup>57</sup> but there is no mention of leveraging space-based assets or collaborating with NRO on the development of future ISR systems.

The Marines rely heavily on the joint and intelligence community’s collection systems, but they don’t always provide input of their own on their needs for expeditionary support. The U.S. Army, for example, has established a joint partnership with the National Reconnaissance Office (NRO) and the National Geospatial-Intelligence Agency (NGA) on the development of

NRO's experimental ISR systems. This partnership adds resources that shorten development timelines for NRO systems and enables the Army to inform the NRO of its requirements so that the NRO may align its capabilities with the Army and support JADO in the future. The Marine Corps is developing its Expeditionary Advanced Operations (EABO) concept and could benefit from such a partnership, but as of this writing there have been no such efforts.

### **Expeditionary Advanced Base Operations (EABO)**

The EABO concept design aims for FMF to operate with minimal need for fixed infrastructure within the region of adversarial A2/AD threats and operate with the smallest physical and electromagnetic footprint necessary to accomplish the mission. EABs are transient in nature and use passive defenses to the greatest of their ability and rely on versatility, deception, and concealment to make it more difficult for the adversary to target them.

In a conflict, amphibious assault is often the first step in setting up logistics and base operations. Expeditionary forces need to perform these operations without the sophisticated equipment typically found at a port facility. As they have in the past, Marines will encounter circumstances when these landings are necessary for future conflicts, but with these future concepts comes the likely complication of A2/AD threats. As the A2/AD threat continues to advance, so will the joint services' ability to collect, exploit, and analyze these threats. Joint forces will first have to focus on countering space and cyber A2/AD threats through initiatives to disrupt, degrade, or destroy them. The Joint Operational Access Concept (JOAC) lists several operational access precepts<sup>58</sup> to ensure joint forces can accomplish the mission by projecting military power into an operating area with ample freedom of movement.<sup>59</sup> Today, an essential principle in the 2012 document is to "exploit advantages in one or more domains to disrupt

enemy A2/AD capabilities in others.”<sup>60</sup> The EABO concept has the objective to “mitigate peer competitors’ anti-access/area denial capability by creating a more survivable, resilient, and persistent forward-postured force.”<sup>61</sup> It would consist of a forward-postured force in allied or partnered territory or seized terrain, and its design would be to hold adversary targets at risk via long-range fires, creating a deterrent effect.<sup>62</sup> One of the deficiencies with the EABO concept, however, is sensor coverage. Without the support of or space-based ISR, an EAB would only be able to “see” as far as the range of its land-based sensors. With a striking reach upwards of 110 miles, naval surface missiles will need better coverage than a ground-based radar that can only cover 18-25 miles.<sup>63</sup>

### **Littoral Operations in Contested Environment (LOCE)**

In *Force Design 2030* the Commandant mentions the priority of developing a new ISR platform to support littoral operations in contested environments (LOCE).<sup>64</sup> The LOCE concept characterizes and provides coherent context to littoral naval operations in the light of emerging challenges for Navy and Marine Corps innovation. It puts a renewed focus on the battle for and acquisition of sea control, including the use of sea-based and land-based Marine Corps capabilities to support the fight for sea control. In Commandant General David H. Berger’s 2019 planning guidance, he addressed how critical ISR is, stating that “a likely vision of warfare centers on the reconnaissance/counter-reconnaissance contest. This guidance demands an agile, stealthy, tactical system that employs forces that can locate, target, and fire precisely first.”<sup>65</sup> Future conflicts will involve a highly sophisticated, heavily contested A2/AD environment, and the side that outpaces, outmaneuvers, and outthinks its adversary across multiple domains (space, air, land, sea, cyber) will be victorious.<sup>66</sup>

## **Integrated OIE system: Army TITAN**

The Tactical Intelligence Targeting Access Node (TITAN) is a future U.S. Army system under development and is expected for a prototype in 2022 and delivery in 2024. TITAN is a scalable and expeditionary intelligence ground station that integrates space, high altitude, aerial, and terrestrial layer sensors to provide targetable data to fires networks and multi-INT support to targeting and situational awareness and understanding.<sup>67</sup> The TITAN “system of systems” consolidates what were once disparate capabilities to provide deep sensing from JADO.<sup>68</sup> Space-based, joint, and interagency sensors in LEO will integrate with Army drones and ground sensors to provide targeting data and distribute it to kinetic and non-kinetic weapons systems and inform decisionmakers in the operating environment.<sup>69</sup>

The TITAN system utilizes space-based and airborne ISR and integrates the data with AI and machine learning to provide timely intelligence products directly to forces in the operational environment. If the Marines had a system like Titan, it would have direct downlink capability, enabling them to leverage more imagery and ISR data and more efficiently close the kill chain.<sup>70</sup> TITAN will receive data, process it into targeting data, and feed it directly to fires in a short amount of time.

## **Recommendations and Conclusion**

As China continues to develop warfighting capabilities to effectively disable opposing forces’ abilities in the INDOPACOM region, Marines and joint military and interagency partners must develop a comprehensive and robust OIE capability to counter them. A critical requirement exists to increase space and advanced ISR skill sets, not only in analysis and reporting of adversary operations but also in using new and emerging U.S. and space and ISR systems to their

full capabilities. Marines are not prepared to provide a sufficient level of support in conducting OIE, lacking understanding of the space domain and its crucial role in supporting operations, and in particular, ISR. In today's information-rich environment, the Corps must counter A2/AD in future conflicts by incorporating space into their training and operations.

### **Integration of Space Capabilities to support OIE**

With information as relatively new warfighting function and the subsequent requirements assigned to the Corps, Marines must prioritize integration of space capabilities to support OIE, synchronizing space-based systems and robust ISR capabilities. If Marines and the joint forces are to achieve the information advantage necessary to dominate the environment, this network-centric approach will need to provide data at machine speed, using artificial intelligence and cloud computing to accelerate the processes that overwhelm competitors with an attack from all domains.<sup>71</sup> If Marines and the joint forces are to achieve the information advantage necessary to dominate the environment, this network-centric approach will need to provide data at machine speed, using artificial intelligence and cloud computing to accelerate the processes that overwhelm competitors with an attack from all domains.<sup>72</sup>

The Marines should absolutely conduct operational exercises to test their ability to continue operations in a degraded, disrupted, or denied space environment in preparation for Chinese hostile actions.<sup>73</sup> These imperatives require competent and adequate personnel though, and a culture shift that integrates the space domain into training, education, planning, and operations at all levels.

The NSP provides a list of activities for the Intelligence Community, many of which Marine Corps Intelligence Activity (MCIA) could conduct, such as integration of intelligence

that documents foreign space capabilities to produce products supporting space domain awareness.<sup>74</sup> Marines need to integrate capabilities to support an all-domain operating environment and adopt modernized ISR technology to counter the A2/AD attempts by near-peer opponents like China. A more modernized approach that integrates tactical ISR and communications systems with space-based assets would equip Marines with a competitive and informational edge over adversaries. In a conflict, this paradigm shift would also lead to a more effective and efficient kill chain.

Marines both in the Fleet and in rear echelons will require artificial intelligence/machine learning (AI/ML) systems such as activity-based intelligence and automatic target recognition to manage the volumes of data that will be available from pLEO. Advancements in machine-speed exploitation using AI/ML will alleviate some of the exploitation both in CONUS and in theater. However, the Corps need to proactively communicate its unique maritime and expeditionary requirements as these capabilities develop and evolve. If the Marines acquire a tactical system with sensor tasking and direct-downlink capabilities, they will have not only have more executive control over collection of ISR data required for operations, but also ability to exploit the data in theater, thus reducing the time to the end user. The Corps could leverage the assistance of machine-speed exploitation with appropriately skilled analysts, leading to more rapid execution of the TCPED process. It is crucial the Marines publish policy, doctrine, and directives leveraging space systems and associated AI/ML tools for an ever-advancing and time-sensitive environment.

The Marines also require a “system of systems” that incorporates the integration of ISR&T capabilities, deep sensing, and AI, all while keeping humans in the loop to validate the

targets. Such systems should provide direct tasking and downlink of ISR data to warfighters in theater and integrate the resulting data into sensor-to-shooter operations.

### **Collaboration with the Joint Forces and Intelligence Community**

As U.S. adversaries continue to develop offensive space capabilities, the U.S. military recognizes the need to increase its offensive and defensive space capabilities within the Department of Defense, each respective service, and the intelligence community, beyond just one-way data sharing and space situational awareness. These interagency partnerships must increase in operating, training, exercising, wargaming, and developing capabilities together to develop increased capability and capacity.<sup>75</sup>

Training programs require a great deal of resources to develop, but member of the Intelligence Community such as NGA, NSA, and NRO have developed robust training programs on classified domains that address advanced geospatial-intelligence analysis and exploitation, electronic warfare, and space situational awareness. The Marines would benefit from creating and establishing long-term partnerships with these agencies to cross-train their space cadre and integrate operations with intelligence operations.

The fact that Marines do not possess space assets of their own, but leverage others for Corps requirements, does not negate the potential for future acquisitions. In joint operations the Marines will undoubtedly benefit from the Army's participation in future ISR assets, and systems like TITAN, but the Army's expeditionary operations have a more terrestrial focus, while Marines are more maritime in nature. The Marine Corps would gain even more benefit if it also established such partnerships with NRO and NGA so that it may communicate its unique

expeditionary requirements to the development process of TITAN or a system like it that is also interoperable, thus additionally supporting joint operability.

New constellations of space-based systems and associated equipment are under development to support tactical and expeditionary operations in the information environment, which could benefit the Fleet Marine Forces if they acquire them, utilize them, and incorporate them into future planning processes. The Corps must collaborate with the developers of these systems, other branches of the Armed Forces, and intelligence agencies to ensure that these new systems support the Corps' unique capabilities.

### **Force Development**

As tensions increase in the South China Sea and China continues to advance its A2/AD and space/counter-space capabilities, Marines need to have the training and education to leverage space systems and identify, communicate, and define requirements for future systems design and capabilities. Having a robust workforce competent in space operations only furthers the objectives of the Marine Corps.

The list of training and education opportunities in MCIA's proposal mentions partnerships with other organizations, but it doesn't list which organizations with which to partner. It would further benefit from partnerships with the NRO, the government agency responsible for designing, building, launching, and maintaining U.S. intelligence satellites. Partnerships with the NRO would provide analysts with training and education on the space domain and space operations as they apply to ISR and OIE.

The NRO offers training curricula on several of its tools to analyze ISR data derived from space systems, including Bodhi, MIST, and OMAR. The list of tools described in this



section is not comprehensive as most of the tools reside on classified networks. Bodhi is a web-based visualization tool developed by NRO where users can create and establish situational awareness and enables collaboration and data sharing.<sup>76</sup> The Multi-Intelligence Spatial-Temporal Toolsuite (MIST) provides battlespace awareness. MIST takes large volumes of time-sensitive, complex data and uses artificial intelligence and machine learning to recognize anomalies and patterns, leading to activity-based intelligence for situational awareness in real-time or near-real-time.<sup>77</sup> Ossim Mapping and Archiving (OMAR) is a web-based tool designed for the purpose of retrieving, archiving, and disseminating geospatial products. OMAR provides rapid access to ortho-rectified imagery where users can generate products through a web-based interface.<sup>78</sup> It would benefit the MCISRE to send its analytic and FMF cadre to receive this training. Many of the tools are web-based and would benefit not only intelligence analysts but anyone involved in expeditionary operations that has connectivity to a network that hosts these tools and the data from NRO space systems.

Marine Corps GEOINT analysts would benefit from NRO training for several reasons. It would be advantageous to have a general understanding of orbital mechanics and orbital properties of the numerous space-based assets available to them and their effect on satisfying collection requirements. They should have this knowledge at the tactical level and rear support echelons from the developmental or entry-level. However, in its present state, even some of the most senior GEOINT analysts at the service level lack this fundamental awareness. This deficiency affects their ability to task sensors efficiently and appropriately, leading to insufficient or inaccurate analysis of GEOINT products, thus affecting the warfighters they support.

Even with expanded training of the existing 8866 and 0540 MOSs, an expansion of billets for highly trained personnel and associated talent management supporting these concepts is required for the Corps with an additional need to provide introductory training and education across all occupational fields. The Marines need to establish a comprehensive training plan that matches discipline, training requirements, and training fulfillment.

Little emphasis exists on developing Marine expeditionary forces' analytic capabilities or even equipping them with an awareness of the capabilities available to them – systems that could provide situational awareness, counter jamming, counter A2/AD, or even close the kill chain. The MCISRE needs more robust education and awareness of ISR systems, capabilities, advanced analysis of the data, and training and education on how to access and leverage information from the space layer.

The concept of space as a warfighting domain is relatively unfamiliar to the Corps. In many cases, the forces at all levels lack awareness of just how much their job roles depend upon space-based assets. A requirement for greater emphasis throughout the Fleet Marine Force's careers exists for training, better enabling them to leverage the utility of space.

MCIA should utilize their IO cadre to share technical knowledge and expertise with operational forces. In the short-term, these IO cadre should provide informal training courses and deskside on-the-job training to Marines while stationed at MCIA to equip Marines returning to the fleet on their next assignment with the necessary knowledge and skills to support OIE in the future operating environment. In the long-term, MCIA should create a formalized training team and provide more IO-related training to the FMF.

Increasing training and education on space operations, concepts, and policy and creating an organic cadre of dedicated space professionals in dedicated, billeted positions would benefit the Marine Corps. Specialists in their respective fields already understand their unique tactical, strategic, or operational role, so adding space-focused training and education to their professional military education and initial MOS training would add value to the knowledge and skills already inherent to their field, putting space on parity with other warfighting domains.

The future of the Marine Corps and United States' readiness in future conflicts and competition will depend on dominating the information environment and space domain. The Marine Corps lacks readiness in both, leaving it unprepared to support US status as a Great Power and Naval efforts to preserve US freedom of navigation in the South China Sea. The Corps must increase its stake and involvement in OIE and space capabilities to maintain relevance and lethality by developing the force, integrating space capabilities to support OIE, and collaborating with the Joint Forces and Intelligence Community. While many objections exist against the Corps' need to incorporate more space-based ISR data into expeditionary operations, recent advances have mitigated the identified flaws in those arguments. Although there has been some progress in improving the Marine Corps' readiness in the information and space environments, the current effort and future plans are missing concepts to bring the fight into the 21<sup>st</sup> century.

Space operations are crucial to successful Marine operations. Marines have relied heavily upon space-based systems and assets and may not even realize how important they are in day-to-day operations. For the MCISRE to fully operationalize the information domain, the enterprise will need to shift its cultural mindset beyond the current paradigm of physical power to include OIE. To accomplish this objective, the MCISRE will need to modernize force development. It

must adopt training and education that focuses on the combined role of cyberspace, EW, space, and ISR capabilities, and acquire the associated support equipment. As Marines become increasingly dependent on cyber networks and space assets, they will need to devise new strategies to integrate these two relatively new domains with the three traditional land, sea, and air domains. The more awareness Marines have of just how much they rely on these capabilities, the more effectively they can take advantage of these systems to conduct successful operations.

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