

**REPORT DOCUMENTATION PAGE**

Form Approved  
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.  
**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

<b>1. REPORT DATE</b> (DD-MM-YYYY) 28-03-2020	<b>2. REPORT TYPE</b> Master of Military Studies (MMS) thesis	<b>3. DATES COVERED</b> (From - To) AY 2019-2020
--	--	---

<b>4. TITLE AND SUBTITLE</b> Traversing the Invisible: How to Prepare the Ground Combat Element for Maneuver Warfare in the Electromagnetic Spectrum	<b>5a. CONTRACT NUMBER</b> N/A
	<b>5b. GRANT NUMBER</b> N/A
	<b>5c. PROGRAM ELEMENT NUMBER</b> N/A

<b>6. AUTHOR(S)</b> Bahk, Charlie S.	<b>5d. PROJECT NUMBER</b> N/A
	<b>5e. TASK NUMBER</b> N/A
	<b>5f. WORK UNIT NUMBER</b> N/A

<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068	<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b> N/A
--	--

<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> N/A	<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>
	<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b> N/A

**12. DISTRIBUTION/AVAILABILITY STATEMENT**  
Approved for public release, distribution unlimited.

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**  
Peer adversaries' electronic warfare (EW) capabilities are growing and advancing, providing their forces with an asymmetric advantage over US forces. In order to compete, counter, and prevail in maneuver warfare in a contested EW environment, the Ground Combat Element (GCE) of the Marine Air-Ground Task Force (MAGTF) urgently requires training, technology, and tactics at all echelons. Marine ground maneuver operations are centered on maneuver warfare doctrine. The Army's Asymmetric Warfare Group points out that maneuver warfare depends on communication and synchronization of assets. All modern communications assets rely on the Electromagnetic Spectrum (EMS) in some manner to operate. Great power competitors' electronic warfare (EW) capabilities continue to outmatch the US and pose a significant security risk to forward deployed forces. Russia and China have been developing respective doctrine, operating concepts, technologies, and force composition in this area for years. The ability to effectively traverse the invisible domain of the EMS is critical to success in the future security environment.

**15. SUBJECT TERMS**

<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b> USMC Command and Staff College
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			<b>19b. TELEPHONE NUMBER</b> (Include area code) (703) 784-3330 (Admin Office)
Unclass	Unclass	Unclass	UU		

United States Marine Corps  
Command and Staff College  
Marine Corps University  
2076 South Street  
Marine Corps Combat Development Command  
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

---

---

**TITLE:** Traversing the Invisible: How to Prepare the Ground Combat Element for Maneuver Warfare in  
the Electromagnetic Spectrum

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

**AUTHOR:**

Major Charlie S. Bahk  
United States Marine Corps

AY 2019-20

---

---

Mentor and Oral Defense Committee Member: J.W. Gordon  
Approved: [Signature]  
Date: 3/27/20

Oral Defense Committee Member: Lt Col R.J. Rega  
Approved: [Signature]  
Date: 27 March 2020

*United States Marine Corps  
Command and Staff College  
Marine Corps University  
2076 South Street  
Marine Corps Combat Development Command  
Quantico, Virginia 22134-5068*

MASTER OF MILITARY STUDIES

---

---

**TITLE:** Traversing the Invisible: How to Prepare the Ground Combat Element for Maneuver Warfare in  
the Electromagnetic Spectrum

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

**AUTHOR:**

Major Charlie S. Bahk  
United States Marine Corps

AY 2019-20

---

---

Mentor and Oral Defense Committee Member: \_\_\_\_\_

Approved: \_\_\_\_\_

Date:

Oral Defense Committee Member: \_\_\_\_\_

Approved:

Date:

## Table of Contents

<b>DISCLAIMER .....</b>	<b>II</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>III</b>
<b>INTRODUCTION .....</b>	<b>1</b>
<b>BACKGROUND .....</b>	<b>4</b>
<b>THE RUSSIAN THREAT .....</b>	<b>4</b>
<b>THE CHINESE THREAT .....</b>	<b>5</b>
<b>DEFINITIONS .....</b>	<b>7</b>
<b>THE MARINE CORPS' SERVICE-LEVEL RESPONSE.....</b>	<b>9</b>
<b>THE TACTICAL-LEVEL'S (INSUFFICIENT) RESPONSE .....</b>	<b>10</b>
<b>THE OPERATIONAL LEVEL RESPONSE.....</b>	<b>12</b>
<b>RECOMMENDED NEAR-TERM SOLUTIONS.....</b>	<b>14</b>
<b>1) OPERATOR-LEVEL TRAINING AND EQUIPMENT.....</b>	<b>14</b>
<b>2) THREAT SYSTEMS MANAGEMENT OFFICE.....</b>	<b>16</b>
<b>3) EW TRAINING VENUES .....</b>	<b>18</b>
<b>4) ADVOCACY FOR CURRENT BOTTOM-UP SOLUTIONS .....</b>	<b>19</b>
<b>CONCLUSION .....</b>	<b>22</b>

## **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.

QUOTATION FROM, ABSTRACTION FROM, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE.

## EXECUTIVE SUMMARY

**Title:** Traversing the Invisible: Training the Ground Combat Element for Maneuver Warfare in the Electromagnetic Spectrum

**Author:** Major Charlie S. Bahk, United States Marine Corps

**Thesis:** Peer adversaries' electronic warfare (EW) capabilities are growing and advancing, providing their forces with an asymmetric advantage over US forces. In order to compete, counter, and prevail in maneuver warfare in a contested EW environment, the Ground Combat Element (GCE) of the Marine Air-Ground Task Force (MAGTF) urgently requires training, technology, and tactics at all echelons.

**Discussion:** Marine ground maneuver operations are centered on maneuver warfare doctrine. The Army's Asymmetric Warfare Group points out that maneuver warfare depends on communication and synchronization of assets. All modern communications assets rely on the Electromagnetic Spectrum (EMS) in some manner to operate. Great power competitors' electronic warfare (EW) capabilities continue to outmatch the US and pose a significant security risk to forward deployed forces. Russia and China have been developing respective doctrine, operating concepts, technologies, and force composition in this area for years. The ability to effectively traverse the invisible domain of the EMS is critical to success in the future security environment. "Often the first reaction of [troops] is to blame faulty equipment, or a bad communicator, then spend time trying to troubleshoot and fix problems that are actually created by the adversary."

**Conclusion:** The GCE requires operator-level training, local training venues such as EW ranges and an EW Center of Excellence, augmented support from external entities such as the Threat Systems Management Office, and deliberate integration of EW considerations from the unit commander across the staff. These solutions would create substantial depth in Electromagnetic Spectrum Operations (EMSO) confidence and proficiency, thus, directly supporting operational planning and decision-making cycles necessary to operate in contested EW environments. The Marine Corps is paid to be ready. The solutions recommended in this paper need to be enacted with urgency.

**This page intentionally left blank.**

## Introduction

*“I’m certainly questioning my original premise that the fundamental nature of war will not change. You’ve got to question that now. I just don’t have the answers yet.”*

- USMC Gen (ret.) James Mattis, Former U.S. Secretary of Defense

*“If ignorant both of your enemy and of yourself, you are certain in every battle to be in peril.”*

- Sun Tzu

For the last several decades, the US Marine Corps has dominated warfighting domains in which it operated: sea, air, and land. Particularly, during the past two decades, the Marine Corps has enjoyed a relatively uncontested airspace and operated unmolested in the electromagnetic spectrum against disadvantaged opponents with less-sophisticated capabilities. The electronic warfare (EW) capabilities of peer adversaries are growing and advancing, providing their forces with an asymmetric advantage over US forces. The Ground Combat Element (GCE) of the Marine Air-Ground Task Force (MAGTF) urgently requires training, technology, and tactics at all echelons to compete, counter, and prevail in maneuver warfare in a contested EW environment.<sup>i</sup> This paper will begin by introducing the atmospherics surrounding the Joint Force’s acknowledgement of the EW threat. Then, a contextual overview of Russian and Chinese EW capabilities employment concepts will be provided. Further, this analysis will explore how the Marine Corps has responded in light of these emerging threats in the security environment and how the GCE has been inadequately addressed. Finally, this paper will present recommended solutions that can be implemented now vice years from now as a part of a major service-driven force structure and capabilities initiative.

---

<sup>i</sup> Maneuver warfare is a warfighting philosophy that seeks to shatter the enemy's cohesion through a variety of rapid, focused, and unexpected actions which create a turbulent and rapidly deteriorating situation with which the enemy cannot cope. (MCDP-1)

According to the 2017 National Security Strategy (NSS), the 2018 National Defense Strategy (NDS) Summary, and 2019 Commandant's Planning Guidance (CPG), America's advantages are rapidly shrinking as major power competitors, such as China, Russia, Iran, and North Korea, continue to modernize and develop their capabilities. J.R. Wilson of Military and Aerospace Electronics notes that this is "the first time in some six decades that the United States has not been the unquestioned military technology leader."<sup>1</sup> Rapid development and proliferation of technology have facilitated asymmetric warfare and have substantially complicated the battlefield. The MAGTF Information Environment Operations Concept of Employment recognizes, "With the pervasiveness of the internet and wireless communications, the far-reaching impact of social media, and the increasing use of these and other information capabilities by adversaries, today's information environment (IE) poses new and complex challenges and opportunities for the Marine Air Ground Task Force (MAGTF)."<sup>2</sup>

The Marine Corps is not the first to acknowledge the pervasiveness of the information environment. The Joint Force has recognized the significance of conducting operations in the Information Environment and has slowly elevated the criticality of information superiority across the joint force. In early 2019, the Marine Corps established, via Marine Corps Bulletin 5400, Information as the seventh warfighting function in order to address the rise in significance of the role of information on the battlefield.

Manipulation of technology transcends its role in increasing lethality of kinetic weapon systems and permeates throughout the cyber domain, space, and most importantly, the electromagnetic spectrum (EMS). In order to traverse the physical domains, to include space, one must understand the invisible maneuver space that is ubiquitous between all the physical domains: the electromagnetic spectrum. The US Army's field manual on cyberspace and

electronic warfare operations stresses, “Superiority in cyberspace and the electromagnetic spectrum (EMS) provides a decisive advantage to commanders at all levels in modern combat.”<sup>3</sup> The guiding coalition to expand awareness and readiness of EMS Operations (EMSO) is slowly growing.

In 2016, the Joint Force embraced the need to be superior in the EMS and authored Joint Doctrine Note 3-16, Joint Electromagnetic Spectrum Operations. Further, despite the emphasis on the “battle of signatures” being written into the Marine Corps Operating Concept in 2016, Marines and their commanders have been very slow in comprehending the problem and training for readiness in this domain. Much of the ground combat units across the Marine Corps stood still in a perpetual state of admiring the problem, leading to training constructs with superficial additives to meet minimum expectations with little to no advancement in substantive understanding of EMS. The Army’s Asymmetric Warfare Group identifies, “Often the first reaction of [troops] is to blame faulty equipment, or a bad communicator, then spend time trying to troubleshoot and fix problems that are actually created by the adversary.”<sup>4</sup> The slow adoption of considerations for new threats is not new. Mark Moyar, author of *A Question of Command*, describes the excruciatingly slow adoption of counterinsurgency as a problem confronting the United States’ national security. Rare conferences were attended by few Vietnam veterans and “counterinsurgency specialists were generally viewed as purveyors of eight-track tapes in an age of digital music.”<sup>5</sup> Certainly, parallels can be drawn in the context of the EW/EMS discussion. The urgency of fielding EW solutions and relevancy of EW considerations during planning phases have been slow until recently. The discussions currently are live and abundant on how to address the lack of EMS proficiency at all levels with the exception of the ground tactical level. Operational level objectives risk failure without effective employment at the tactical level.

Bryan Clark at the Center for Strategic and Budgetary Assessments astutely argues that the Department of Defense should focus its concept and capability development on the highest leverage opportunities to reduce the confidence of great power militaries that an act of aggression will be successful.<sup>6</sup> Currently, the highest leverage opportunity lies with the Marines that will be operating at the at the ground tactical level in support of operating concepts such as Stand-In Forces and Distributed Operations (DO).

## **Background**

### **The Russian Threat**

Following nearly two decades focused on counterinsurgency operations in the Middle East, the Marine Corps' institutional spark of interest in electronic warfare can be traced back to the start of the Russo-Ukrainian war in 2014. The beginning months of the Russo-Ukrainian war was the first overt demonstration of a major power competitor's, Russian, electronic warfare capabilities. Throughout the war-torn plains and plateaus of eastern Ukraine, Russian electronic warfare tactics continue to permeate combat operations against Ukraine's pro-European forces. Further, the eastern-Ukrainian battlefield has served as a training and testing ground for Russian armed forces. With an eye on operations in Syria and informed by the United States' lessons learned from Iraq and Afghanistan, Russia has been cleverly taking advantage of the opportunity in Ukraine to test, validate, and rehearse EW assets and operating concepts with great success. Codified into their doctrine, Russians have honed their ability to target their adversaries based entirely on their electronic signature.<sup>7</sup> The US Army's Asymmetric Warfare Group reports in their Russian New Generation Warfare Handbook, "A Ukrainian army unit was broadcasting a radio message when it received accurate artillery fire, sustaining multiple casualties."<sup>8</sup> The

targeted Ukrainian unit then received text messages on their cell phones from the Russian Led Separatist commander asking “how they liked the artillery.”<sup>9</sup>

Russian EW tactics transcended the Donbass region and has recently affected US operations in Syria, earning notice and concern by US Special Operations Command (USSOCOM). Then-Commanding General of USSOCOM, General Raymond Thomas, noted in 2017 that Syria was “the most aggressive EW environment on the planet from our adversaries.” Russia’s capabilities were proven effective as they “knocked down [US] communications” and disabled EC-130 gunships. Further, there were reports of an infantry unit that has encountered difficulty employing GPS-guided weapons on Syrian ground, well-covered by Russian EW capabilities. Additionally, according to Clark, Russian ground forces are receiving new EW equipment down to the company-level and are continuing to perform effectively against US and allied forces in Syria. It is obvious “the Russian military seeks to create a comprehensive EW system of systems (SoS)...designed to comprehensively defeat the US military’s C4ISR networks.”<sup>10</sup>

### **The Chinese Threat**

In contrast to Russia’s EW capabilities employment noted above, tangible examples of how the Chinese Peoples’ Liberation Army (PLA) is employing their EW capabilities are much more scarce. However, it is prudent to become familiar with the PLA’s strategy for modern warfare. Jeffrey Engstrom outlines in his RAND Corporation study that Chinese military doctrine has adopted and heavily integrated two interrelated lines of thinking; systems confrontation and system destruction warfare.<sup>11</sup> These schools of thought are informed by the US’s activities during the 1991 Gulf War and the 1999 Kosovo War, where the US forged victories with stealth and precision-guided weaponry.<sup>12</sup> During these conflicts, the PLA recognized that the US had

rendered its opponents ineffective without being centrally focused on attrition warfare, but by precisely targeting operational systems to paralyze the enemy's momentum and will to fight. Therefore, these two conflicts were pivotal in the PLA deducing that annihilation of the enemy is no longer a requirement for victory.<sup>13</sup> Due to widespread proliferation of technology, Engstrom argues that systems have proven to be practically central to a fighting organization's combat effectiveness. Therefore, targeting of systems and systems employment have become central tenets for the PLA's strategy for modern warfare.

Engstrom explains that systems confrontation is a conflict waged between adversarial operational systems.<sup>14</sup> Operational systems are believed to be the opponent's center of gravity. Further, systems confrontation is waged across all physical domains, land, sea, air, and space as well as non-physical domains of cyberspace and EMS. Therefore, success in conducting systems confrontation requires dominance across multiple domains and is executed as an integrated joint function.

Secondly, Engstrom describes PLA's theory of victory as being predicated on successfully waging system destruction warfare.<sup>15</sup> System destruction warfare is waged by kinetic attacks, non-kinetic attacks, or a combination thereof in order to destroy or degrade the adversary's operational system.<sup>16</sup> The desired effect of system destruction warfare is functional paralysis that inhibits the opponent's will and ability to resist. PLA literature explains functional paralysis as a weakened system's structure which leads to the breakdown of internal coordinating mechanisms and procedures.<sup>17</sup> The value of the targeted operational system relies on the amount of influence the system has over these mechanisms. The Marine Corps Planning Process equates these factors to center of gravity, high-value targets, and command and control. Simply put, the PLA considers the US's information systems to be high-value targets due to the over-reliance

American commanders have on information systems, particularly those that require the EMS for operation.

## **Definitions**

Widespread confusion over terminology and the nebulous boundaries of EMSO have caused the slow progress in the conversation of electronic warfare and has kept much of the force paralyzed in a state of “problem admiration.” During what is considered another “interwar period” following the Iraq and Afghanistan conflicts, multiple schools of thought surrounding multiple emerging threats have unearthed a myriad of terms that are often confused. Additionally, Joint publications, service guidance and manuals use certain terms interchangeably. Because this paper focuses on the education, training, and readiness of the GCE within the MAGTF, its source definitions will be largely derived from Marine Corps publications.

According to Marine Corps Bulletin 5400, all related terms such as cyberspace, electromagnetic spectrum, information operations, operations in the information environment, and electronic warfare, are subservient to the information warfighting function. To keep it as simple as possible, there are only four important terms and definitions that are relevant to this paper: electronic warfare, electromagnetic spectrum, electronic protection and electromagnetic spectrum operations. Understandably, these terms might sound very similar to the reader and cause confusion. First, the electromagnetic spectrum (EMS) is a highly regulated continuum of EM waves arranged according to frequency and wavelengths. The EMS includes the full range of all possible frequencies of EM radiation.<sup>18</sup> In other words, it is a medium upon which many US operational systems are designed to operate in order to share and disseminate information, from tactical radio communications to air delivered munitions precision-guided by the Global Positioning System (GPS) constellation. Usage of the EMS is arguably a critical vulnerability

and critical capability for all major power competitors. The EMS plays a foundationally elemental role that interconnects all other warfighting domains (See figure 1).

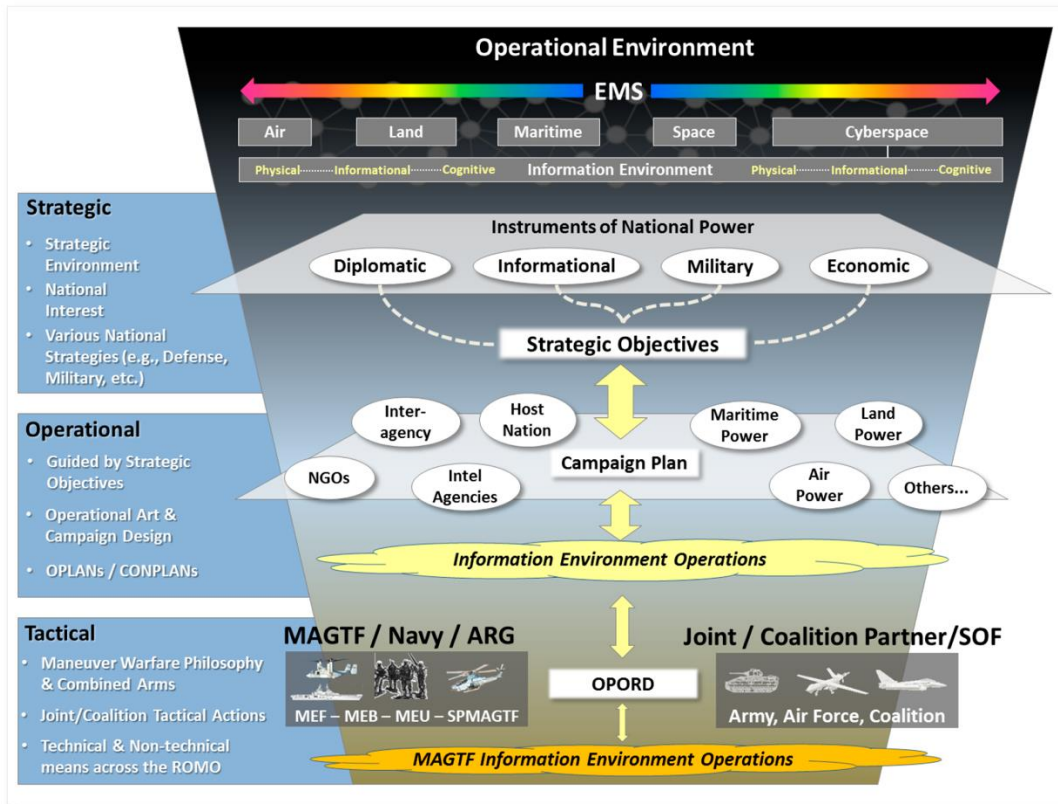


Figure 1. Operational Environment Conceptual Model

The term electronic warfare (EW) refers to military action involving the use of electromagnetic energy and directed energy (DE) to control the EMS or to attack the enemy.<sup>19</sup> It is an overarching joint term that encompasses multiple functions. EW consists of three [functions]: electronic attack (EA), electronic protection (EP), and electronic warfare support (ES). The recommended solutions presented later in this paper are foundationally tied to predominantly serve the EP function of EW. EP refers to the division of EW involving actions taken to protect personnel, facilities, and equipment from any effects of friendly, neutral, or enemy use of the EMS, as well as naturally occurring phenomena that degrade, neutralize, or

destroy friendly combat capability.<sup>20</sup> Finally, MAGTF electromagnetic spectrum operations (EMSO) are coordinated MAGTF actions to exploit, attack, protect, and manage the [EMS] in support of MAGTF objectives. MAGTF EMSO is principally important as an enabler of all other MAGTF Information Environment functions (See figure 2). From figure 2, by titles alone, one can see that EMSO is a critical enabler of the other five operations categories. Cyberspace, Space, Influence, Deception, and Information Operations heavily rely on the EMS to function.

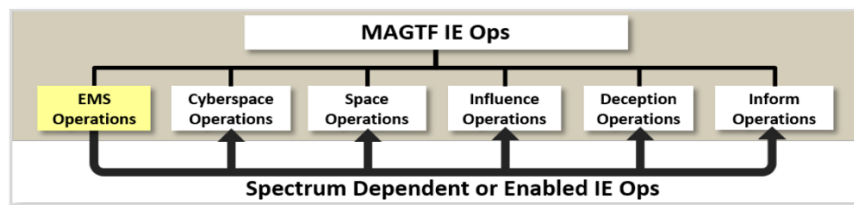


Figure 2. MAGTF Information Environment Operations with EMSO and Associated Capability Areas

### **The Marine Corps’ Service-Level Response**

Currently, the GCE is not conditioned to effectively operate within the landscape of a contested EMS. GCE commanders at all levels are concerned about combat effectiveness if the technologically advanced mediums of exercising command and control that were heavily depended upon during the recent two decades of counterinsurgency fighting in the Middle East are not available. In 2016, the 37th Commandant of the Marine Corps, General Robert Neller, warned that the “battle of signatures” will be a prevalent part of the future security environment.<sup>21</sup> He stated, “Tomorrow’s fights will involve conditions in which “to be detected is to be targeted is to be killed.”<sup>22</sup> The previously described Russian examples certainly validate General Neller’s concerns.

In the past three years, commanders across the Marine Corps have narrowly and slowly paid homage to this seemingly new threat. Today, particularly within the GCE community, concerns of being detected, targeted, and then killed are very real and alive. Considerations of

how to “hide” in the EMS have slowly wedged themselves into planning processes of training constructs and equipment design. Within the First Marine Division, a High Mobility Artillery Rocket System (HIMARS) unit continues to explore ways to swiftly insert themselves into firing positions, execute firing missions, and extract from the area without being detected. Infantry battalions are compelled to revisit the concept of “bounding” command posts as well as emphasize rapid establishment and disestablishment of communications nodes in an effort to remain mobile and difficult to target.

### **The Tactical-Level’s (Insufficient) Response**

Some commanders across the GCE are less informed on the specifics and effects of operating in the EMS, which impacts command decisions during training and planning. For example, the lack of awareness and education at the infantry battalion level produces consequences during a Marine Corps Combat Readiness Evaluation (MCCRE) exercise. MCCREs are service required formal evaluations of “units based on Marine Corps Training and Readiness (T&R) standards derived from core and/or assigned Mission Essential Tasks (METs) to ensure standardization and combat readiness in preparation for operational deployments.”<sup>23</sup> Within the First Marine Division, the infantry battalion is evaluated by a team of evaluators from a parent regiment, often primary and special staff officers, under the authority of the Marine Expeditionary Force (MEF) commander. As of 2017, the exercise design construct required minimal detailed planning for EW tactics. If the commander and staff showed evidence of some consideration for EW threats, how it would affect the unit, and how the unit would address it, the exercise would proceed onto items of greater interest such as reconnaissance, maneuver, and kinetic fires.

There are other consequences of making decisions lacking understanding on EW considerations. In addition to execution, the planning and preparation stages for the battalion staff are included

in the MCCRE evaluation. Evaluation of these stages is important for the battalion staff, particularly to be informed and trained on how to conduct operational planning in a tactical environment, consider all pertinent aspects of each staff function, and develop and disseminate orders across the battalion. Recently, this author has served as the senior communications evaluator for multiple infantry battalions' MCCREs. From the tactical communications perspective, there are two chief capabilities that the battalion communications staff section (S-6) provide – radio and data communications. Each Marine infantry battalion is allocated a portable, two-way satellite communications terminal named Very Small Aperture Terminal – Small (VSAT-S). These terminals provide the battalion commander data services in austere environments where data connectivity is not accessible or does not previously exist by accessing satellites in geosynchronous orbit.

Out of concern for emitting an excessive electromagnetic footprint, the commander made the decision to not utilize the VSAT-S during the MCCRE. What is less commonly known is that the beam emitted by the VSAT-S to communicate with the satellite is incredible narrow – a diameter comparable to a common soft drink can – and very difficult to be intercepted by nefarious actors. The benefits of capitalizing on the VSAT-S's technology far outweigh the potential to be targeted in the EMS. Requisite education would illuminate that the undisciplined use of tactical radios utilizing high frequency (HF), very high frequency (VHF), ultra-high frequency (UHF), and the Joint Battle Command Platform (JBC-P), the next generation of Force XXI Battle Command Brigade and Below/Blue Force Tracking (FBCB2/BFT) system, pose greater vulnerabilities to adversarial targeting and attack. A classified analysis on signal propagation of each system and waveform is available upon request. This lack of awareness and understanding at the tactical is alarming, particularly if the tactical level is to be charged with

operating as Stand-In Forces and in support of Distributed Operations (DO) across the Pacific in accordance with the 38th Commandant's Planning Guidance.

### **The Operational Level Response**

In mid-2017, I MEF Headquarters Group was redesigned and transitioned to I MEF Information Group (MIG). The MIG's mission is to synchronize and coordinate efforts across the MAGTF's information domain. It is comprised of units across multiple disciplines (intelligence, communications, signal intelligence, air-naval gunfire liaison and law enforcement) in order to provide capabilities to operate effectively in a multi-domain battle. The MIG is a MEF-level asset. The preponderance of the MIG's efforts are summoned in support of MEF-level operations. The MIG has three key pertinent assets for EMSO: the Electromagnetic Spectrum Operations Cell (EMSOC), Electronics Warfare Support Teams (EWST), and Electronic Warfare Red Teams (EWRT). The EMSOC coordinates and deconflicts EMSO in support of the MEF by processing, analyzing, and sharing EMS data and information across MEF-level and major subordinate command (MSC)-level staff sections. This level of coordination should "enhance the integration of and the capabilities associated with spectrum-dependent systems applicable to all warfighting functions and MEF objectives."<sup>24</sup>

The tangible benefits of this function are yet to be seen. Exercise Pacific Blitz 2019, a large-scale, joint exercise with the US Navy, was designed to validate operating concepts such as Expeditionary Advanced Base Operations (EABO) in support of a naval fleet commander. From the ground combat element perspective, the relationship between the forward-deployed EWST and ground force commander through the joint task force to the MIG was disjointed. Reports of EW activity from the forward line of troops often went unanswered from the MEF level. The EMSOC support construct described above requires additional time and further evaluation of

how to be effectively implemented. With further implementation of EMSOC counterparts on each MSC staff, the EMSOC support construct has promise for the operational and tactical levels.

Further, the EWST and EWRT are, in part, promising concepts to support the tactical level. EWSTs are small teams of signals intelligence Marines trained and equipped by radio battalions to be attached to supported units, primarily infantry battalions, across the MEF. EWSTs are tasked with providing gaining units support by planning EW missions, integration of EW capabilities to bolster tactical situational awareness and contribute pertinent EW data to fires plans.

The two major shortcomings with the EWST concept is that centralized control and tasking of EWSTs put responsive support to the gaining unit at risk and hinder integration with the supported battalion and its staff. Further, merely layering a small team of experts on top of the capability gap is insufficient. The widespread lack of education and understanding looms amongst the GCE Marines. Heightened awareness and education among the GCE Marines would result in a more combat effective unit with the corporate knowledge required to maneuver in the EMS. The concept of EWRTs suffers similar limitations. Being mostly enemy-focused, EWRTs conduct ground and airborne electronic attacks in support of the gaining unit. EWRTs' singular contribution to EP for friendly forces is maintaining currency on friendly and enemy EW capabilities and tactics. The MIG's capabilities should be supplementary to organic GCE capabilities. In an organization where kinetic actions command most planning efforts, a seismic cultural shift is required in order to operate effectively in the EMS with capabilities such as the MIG's. Decentralized technical expertise and corporate resources for training and battlefield

employment will ensure a more proficient and agile ground force to operate as Stand-In Forces in a distributed manner.

### **Recommended Near-Term Solutions**

The four recommended solutions that follow will address what can be done from the infantry battalion level to a major service-level training exercise such as Integrated Training Exercise (ITX) at Marine Corps Air-Ground Combat Center (MCAGCC) in Twentynine Palms, California. These solutions would empower the GCE with enough awareness and technical knowledge to conduct internal training, codify standard operating procedures, and routinely integrate EW considerations into operational planning. Freedom of maneuver within the EMS is essential to successfully operating in the current and future security environments. The current solutions implemented across the force, while necessary, remain inadequate for the GCE. They should be supplementary to the following solutions.

#### **1) Operator-level Training and Equipment**

First, GCE Marines should be trained on radio frequency (RF) propagation patterns and waveform behaviors with respect to terrain for systems that are organic to the infantry battalion. In 2018, Lieutenant Colonel Clifford Magee, the previous senior Communications Officer for the First Marine Division stated, “Detection is the first indication and warning for the [commander] that the enemy is preparing to fight; and early detection pushes [his] decision timeline to the left.” In other words, early detection of adversarial EW activity on the battlefield will maximize maneuver space for the commander’s decision-making cycle. Chief Warrant Officer-3 (CWO-3) Emedin Rivera, the current Space and Waveform Integration Officer for the First Marine Division argues, “There is no better sensor in the Marine Corps than a Marine with some incidental training.” At a minimum, the knowledge gained among incidental radio operators

should permeate throughout all ranks and occupational specialties. There is tremendous opportunity with utilizing the individual Marine on patrol, in a defensive posture, or serving as a member of the combat operations center (COC) as an EW sensor. For example, during Exercise Steel Knight in 2018, the First Marine Division deployed to MCAGCC with over twenty combat arms and logistics units. During all phases of the operation, the senior communications coordination center (hosted at the Division-level), maintains the responsibility of ensuring all the division's units are able to communicate. In order to track the progress of establishing positive communications with each unit, a tracker is used to inform the commanding general of the overall status (See figure 3). The benefit of utilizing a trained radio operator, complemented with the tracker in figure 3, is identification of trends. From figure 3, it can be deduced that there existed a problem with widespread impacts rather than the chances of faulty equipment or operator error at the unit-level.

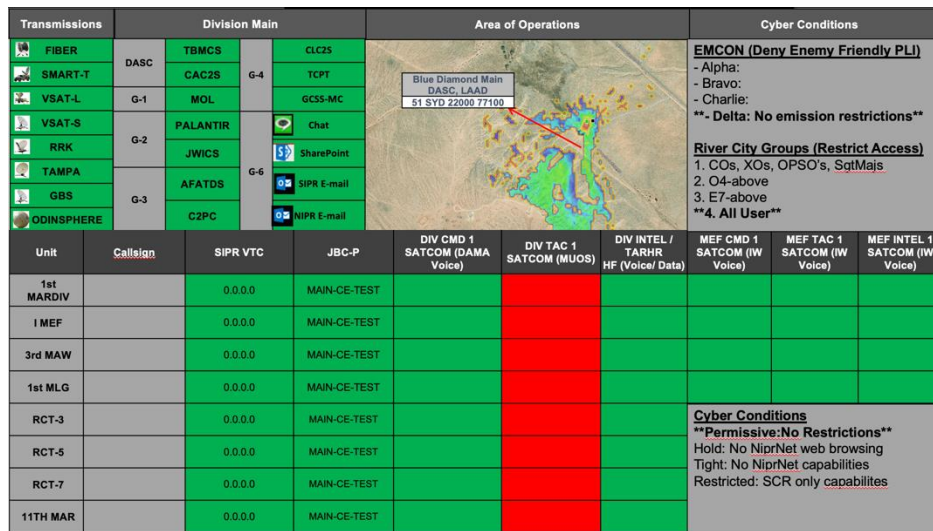


Figure 3. First Marine Division G-6's Communications Tracker

Further, complementary to training incidental operators, a visualization tool, much like a spectrum analyzer, should be provided to each COC within the GCE. Currently, spectrum analyzers are only available to communications-electronics maintenance technicians, who serve

at the regimental-level and beyond. CWO3 Rivera argues that the spectrum analyzer is “no longer a maintainer’s tool, but a tactician’s tool.” These tools would help streamline and visualize EW activity for the commander to quickly assess adversarial activity and react (See figure 4). The screenshots in figure 4 illustrate the difference in spectrum activity when a frequency is operating in its normal state and when it is under electronic attack. The “spike” (black line) depicted in each visualization is the “noise floor” of the examined frequency. The visualization of an electronic attack (right) demonstrates that the noise floor is being saturated and overpowered with other noise, preventing anything decipherable to be heard by the recipient. The ability to use this type of visualization allows the operator to rapidly determine whether the radio net is under electronic attack or if it is due to equipment malfunction, incorrect cryptographic keying material, or operator error.

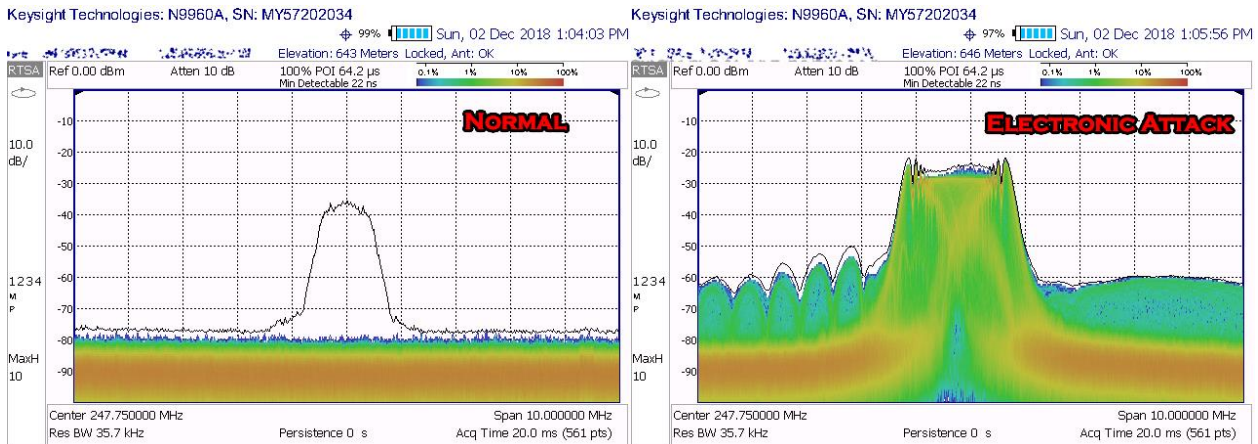


Figure 4. Electronic Attack Screenshots from Spectrum Analyzer

## 2) Threat Systems Management Office

The 38th Commandant of the Marine Corps, General David Berger stresses the importance of training decision-making against a free-thinking enemy. Further, in his planning guidance, he

makes note that “careless and unmanaged signatures will invite destruction.”<sup>25</sup> The Threat Systems Management Office (TSMO) has proven its potential to assist the Marine Corps with this problem. TSMO is a sub-organization under the Army’s program portfolio for instrumentation, targets and threat simulators, and special operations training systems. TSMO’s greatest value is their fleet of vehicular, airborne, and hand-held EW assets. These assets were modeled after real adversarial threats from great power competitors which were validated by the US Intelligence Community. Additionally, TSMO personnel operate these assets in training environments nation-wide with current adversarial tactics, techniques, and procedures (TTPs). In support of the Army, TSMO provides support to an average of nine training iterations at the National Training Center (NTC). In late 2018, the First Marine Division employed TSMO in order to gather empirical EMS data on a cross-section of combat arms units across the division, including infantry, artillery, light-armored reconnaissance, and a division-level headquarters command post. The resultant data was alarming to all commanders and staff across the division and was subsequently briefed to the quarterly Ground Combat Element Conference. Figure 5 is a sanitized example of the resulting products briefed at the executive level. These simple examples breathe relevancy into the ground maneuver warfare conversation as a critical topic to consider during planning.

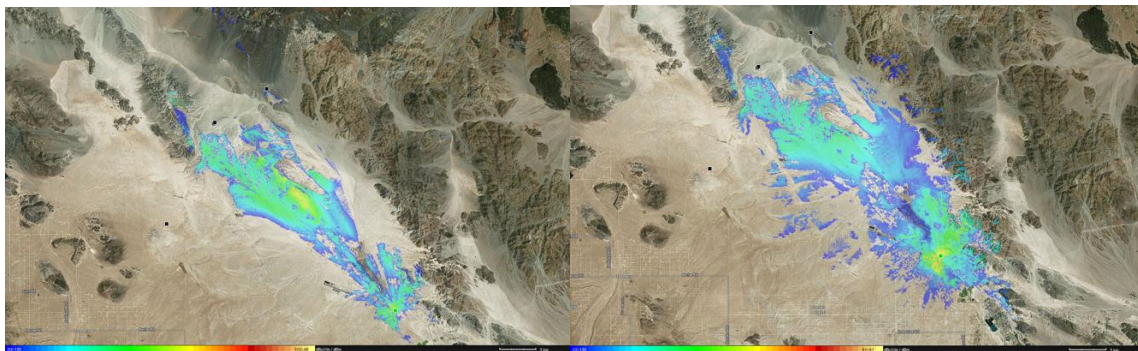


Figure 5. EMS Survey Screenshots from TSMO

Beyond gathering EMS data for awareness, TSMO is capable of targeting friendly forces with the accuracy of their EMS analyses. Among the TSMO asset fleet, the Integrated Threat Force (ITF) provides an integrated and scalable command and control node that ties all sensors and a “free thinking” enemy of hired operators together. The Army considers it an “integrated, realistic threat force under one live, virtual, and constructive umbrella.” An amalgamation of TSMO assets and the opposing force (OPFOR) of training exercises satisfies the Commandant’s plea for realistic training against a “free thinking” enemy in a force-on-force construct.

### **3) EW Training Venues**

In addition to operator- and staff-level training at the battalion, local training venues that are easily accessible, as well as establishing a Center of Excellence, are required to building onto the training continuum for the exercise force. During Operations Iraqi Freedom and Enduring Freedom, the adversary’s use of improved explosive devices (IED) became an unforeseen and prevalent threat that commanded significant attention. Originally the Army’s Counter-IED Task Force, the escalating IED threat incentivized the Joint Staff to create Joint IED Defeat Organization (JIEDDO) in early 2006. As a result, JIEDDO established training detachments for each service; specifically, the Marine JIEDDO detachment was born at MCAGCC, Twentynine Palms, CA. The Marine JIEDDO detachment worked very closely with MCAGCC’s tenant commands to provide a “training lane” that reinforced TTPs on targeting the IED network and defeating a myriad of IED variants in an environment which focused on repetitious training. Similar to the JIEDDO detachment aboard MCAGCC, an EW Center of Excellence (CoE) would provide tremendous benefit to each exercise force attending ITXs as well as other training events in Twentynine Palms. With standing approvals to conduct EMSO aboard the base, the EW Center of Excellence would provide instruction on a multitude of EW tactics and considerations

such as how to operate in a GPS-denied environment, terrain masking, direction-finding, and counter-unmanned aerial surveillance (UAS) operations. Further, the EW CoE would be heavily integrated with Tactical Training Exercise Control Group (TTECG) in order to provide an accurately capable OPFOR as well as advisement on EP for friendly forces.

Marine Corps installations that host operational GCE units should have standing EW ranges in order to conveniently facilitate practical training for combat units. Similar to the EW CoE, installation EW ranges would have standing approvals to employ EW equipment, both adversarial and friendly. TSMO would prove beneficial in providing the enemy threat environment aboard these ranges. TSMO's deep experience in providing education and awareness to commanders via EMS visualization, establishment of enemy threat capabilities and how to defeat or traverse around them are natural solutions for such proposed ranges. The persistent threat environment that is easily accessible to the unit in training provides ample opportunities for the unit to be further educated as well as develop, validate, and refine TTPs. From a Deliberate Universal Need Statement (D-UNS) submitted in the summer of 2019, Chief Warrant Officer-5 Keith Marine, the First Marine Division Gunner states, "It is highly anticipated that this training will allow Marines to gain a knowledge advantage that will facilitate operating concepts in the future security environment."<sup>26</sup> These EW training venues directly satisfy the concerns outlined within the commandant's planning guidance: operating as Stand-In Forces and Distributed Operations within weapons engagement zones.

#### **4) Advocacy for Current Bottom-Up Solutions**

The operating forces are not waiting for service-level solutions. Substantial work continues to be done at all levels of the GCE following advocacy rhetoric from all Marine division commanders. As previously mentioned, in 2017, a HIMARs rocket artillery unit within First Marine Division

aggressively explored ways to deploy, render itself fires-capable, execute fire missions, and extract from with miscellaneous weapons engagement zones while maintaining a low to invisible EMS footprint. The pending success of the validation of this employment concept will confirm Marine HIMARs units' utility as a strategic-level firing asset. In 2018, the First Marine Division heavily integrated TSMO into Exercise Steel Knight-19 in order to analyze the EMS signatures of all types of combat arms units. During the analysis, a draft emissions control (EMCON) posture of communication systems were studied at the division headquarters. A test script was drafted by the G-6 directorate and implemented to analyze the division headquarters while all communications systems were utilized versus the CP operating in EMCON status (See figure 6). In a contributing effort during the exercise, the First Tank Battalion fabricated an antenna cover for the FBCB2/BFT system (See figure 7). The cover was intended to focus EMS emissions in an upward direction in order to mitigate its lateral electronic footprint. Some tactical-level units are more aggressive than others in pursuit of solutions to understand and train against the EW threat. Continued innovation and sharing of information across the GCE community is necessary in order to provide learned lessons and best practices.



## UNCLASSIFIED//FOUO Normal vs EMCON (HQ, 1st Marine Division)

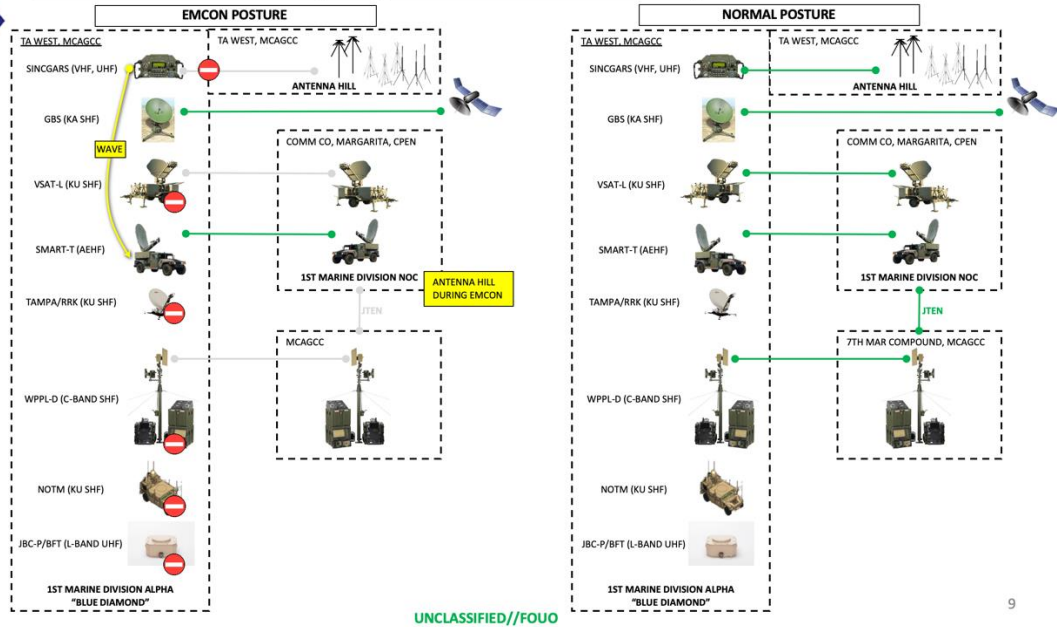


Figure 6. Presentation Slide Depicting Communications Equipment in Normal Posture Versus EMCON Posture



Figure 7. Photo by author of FBCB2/BFT Antenna Cover Fabricated by First Tank Battalion

In 2018, the Fourth Marine Regiment became the first MAGTF headquarters to deliberately plan for EW considerations during ITX events. This is significant because this is arguably the first demonstration of a full MAGTF's devotion to training and exercising realistic EMCON procedures. In early 2019, the First Marine Regiment successfully innovated ways to direction-find adversarial electronic signals using a spectrum analyzer during their ITX iteration. Later in 2019, the First Marine Division successfully mitigated its electronic footprint to mimic a single

Marine with a satellite communications radio. This was possible due to Division G-6 Marines finding ways to direct all data networking traffic over a single satellite communications radio. All critical warfighting applications remained available to the division commander. These examples signify tremendous initiative and urgency at the ground tactical level. If “bottom-up” initiatives such as these were supplemented with the aforementioned recommended solutions, the GCE would be a formidable force and a valuable maneuver asset in the future security environment.

### **Conclusion**

Marine ground maneuver operations are centered on maneuver warfare doctrine. The Army’s Asymmetric Warfare Group points out that maneuver warfare depends on communication and synchronization of assets.<sup>27</sup> All modern communications assets rely on the EMS in some manner to operate. Great power competitors’ EW capabilities continue to outmatch the US and pose a significant security risk to forward deployed forces. Russia and China have been developing respective doctrine, operating concepts, technologies, and force composition in this area for years. The ability to effectively traverse the invisible domain of the EMS is critical to success in the future security environment. Further, the lack of understanding of EMS has led to the inability to discern between being electronically attacked, operator error, or employing faulty equipment. The GCE requires operator-level training, local training venues such as EW ranges and an EW Center of Excellence, and augmented support from external entities such as the Threat Systems Management Office. These solutions would create substantial depth in EMSO confidence and proficiency, thus, directly supporting operational planning and decision-making cycles necessary to operate in contested EW environments. The Marine Corps is paid to be ready. The solutions recommended in this paper need to be enacted with urgency.



## Endnotes

---

<sup>1</sup> J. R. Wilson, "Electronic Warfare on the Ground," Military and Aerospace Electronics, last modified Feb 1, 2019,

<https://www.militaryaerospace.com/home/article/16709607/electronic-warfare-on-the-ground>.

<sup>2</sup> Headquarters, US Marine Corps, "Marine Air Ground Task Force Information Environment Operations Concept of Employment," (Washington, DC: Deputy Commandant for Combat Development and Integration, 2017), 1.

<sup>3</sup> US Army Chief of Staff, *Cyberspace and Electronic Warfare Operations*, FM 3-12 (Washington, DC, 2017), 1-1.

<sup>4</sup> Asymmetric Warfare Group, *Russian New Generation Warfare Handbook*, Staff Study, 2016, 47.

<sup>5</sup> Mark Moyar, *A Question of Command: Counterinsurgency from the Civil War to Iraq*, (New Haven, CT: Yale University Press, 2009), 1.

<sup>6</sup> Bryan Clark, et al, *Winning the Invisible War: Gaining an Enduring U.S. Advantage in the Electromagnetic Spectrum*, Center for Strategic and Budgetary Assessments, (Washington, DC: CSBA, 2019), 9.

<sup>7</sup> Asymmetric Warfare Group, *Russian Handbook*, 47.

<sup>8</sup> Asymmetric Warfare Group, *Russian Handbook*, 48.

<sup>9</sup> Asymmetric Warfare Group, *Russian Handbook*, 48.

<sup>10</sup> Clark, *Winning the Invisible War*, CSBA, 15.

<sup>11</sup> Jeffrey Engstrom, *Systems Confrontation and System Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare*, RAND Corporation, (Santa Monica, CA: RAND Corporation, 2018), 28.

- 
- <sup>12</sup> Engstrom, *Systems Confrontation*, 26.
- <sup>13</sup> Engstrom, *Systems Confrontation*, 26.
- <sup>14</sup> Engstrom, *Systems Confrontation*, 27.
- <sup>15</sup> Engstrom, *Systems Confrontation*, 31.
- <sup>16</sup> Engstrom, *Systems Confrontation*, 31.
- <sup>17</sup> Engstrom, *Systems Confrontation*, 32.
- <sup>18</sup> Joint Chiefs of Staff, *Electronic Warfare*, Joint Publication 3-13.1 (Washington, DC: Joint Chiefs of Staff, February 8, 2012), I-1.
- <sup>19</sup> Joint Chiefs of Staff, *Electronic Warfare*, JP 3-13.1, (Washington, DC: Joint Staff, 8 February 2012), I-4.
- <sup>20</sup> Joint Chiefs of Staff, *Joint Electromagnetic Spectrum Operations*, JDN 3-16, (Washington, DC: Joint Staff, 20 October 2018), I-8.
- <sup>21</sup> Headquarters US Marine Corps, *Marine Corps Operating Concept: How the Expeditionary Force Operates in the 21st Century*, (Washington DC: Headquarters US Marine Corps, September 2016), 10.
- <sup>22</sup> HQMC, *Marine Corps Operating Concept*, 10.
- <sup>23</sup> Commandant of the Marine Corps, *Marine Corps Combat Readiness Evaluation (MCCRE)*, MCO 3501.1D, October 17, 2014, 1.
- <sup>24</sup> Maj Katherine James, "I Marine Expeditionary Force Electromagnetic Spectrum Operations," information paper, August 22, 2019, 3.
- <sup>25</sup> Gen David Berger, *Commandant's Planning Guidance: 38th Commandant of the Marine Corps*, (Washington DC: Headquarters US Marine Corps), 2019, 20.
- <sup>26</sup> CWO5 Keith Marine, *Deliberate Universal Needs Statement*, 2.

---

<sup>27</sup> Asymmetric Warfare Group, *Russian Handbook*, 22.

---

## Bibliography

38th Commandant of the Marine Corps. *Commandants Planning Guidance 2019*. Washington, DC: 2019.

Bonner, E. Lincoln. "Defending our Satellites: The Need for Electronic Warfare Education and Training." *Air & Space Power Journal* 29, no. 6 (Nov 1, 2015).

Boot, Max. *War Made New: Technology, Warfare, and the Course of History: 1500 to Today*. New York: Gotham Books, 2006.

Clark, Bryan, Whitney McNamara, and Timothy Walton. *Winning the Invisible War*. Washington, DC: Center for Strategic and Budgetary Assessments, 2019.

Coffey Jr., William T., Joan Rousseau, and Scott Mudge. *Tactical Staff Considerations for Winning in a Denied, Degraded, and Disrupted Space Operational Environment* Center for Army Lessons Learned, 2019.

George, Jonathan M. "Spectrum Warfare Integration." *Marine Corps Gazette* (May, 2019).

Gray, Colin S. *Another Bloody Century: Future Warfare*. California: Phoenix Press, 2006.

Headquarters, US Marine Corps. "Marine Air Ground Task Force Information Environment Operations Concept of Employment." Washington, DC: Deputy Commandant for Combat Development and Integration, 2017.

Headquarters, US Marine Corps. *Marine Corps Bulletin 5400: Establishment of Information as the Seventh Marine Corps Warfighting Function*. Washington, DC: US Marine Corps, 2019.

Headquarters, US Marine Corps. *MCRP 3-32.1D: Electronic Warfare*. Washington, DC: Headquarters, US Marine Corps, 1998.

Hess, Charlotte. "Mapping the New Commons." Syracuse University, 2008.

---

Hoehn, John R. *Ground Electronic Warfare: Background and*

*Issues for Congress*. Washington, DC: Congressional Research Service, 2019.

Joint Chiefs of Staff. *Joint Doctrine Note 3-16: Joint Electromagnetic Spectrum Operations*.

Washington, DC: Joint Chiefs of Staff, 2016.

Keller, Jared. "After Experiencing Russian Jamming Up Close in Syria, the Pentagon is

Scrambling to Catch Up." *Business Insider*, Jun, 2019.

Marine, Keith A. *Deliberate Universal Needs Statement*. Camp Pendleton, CA: 1st Marine

Division, 2019.

Matthews, Lloyd J. "Challenging the United States Symmetrically and Asymmetrically: Can

America be Defeated?" US Army War College, 1998.

Musey, J. Armand and E. Barlow Keener. *The Spectrum Handbook 2018*. New York, NY:

Summit Ridge Group, 2018.

Secretary of Defense. *Department of Defense Strategy for Operations in the Information*

*Environment*. Washington, D.C.: Department of Defense, 2016.

Secretary of Defense. *Summary of the 2018 National Defense Strategy of the United States of*

*America: Sharpening the American Military's Competitive Edge*. Washington, DC: US

Department of Defense, 2018.

Seligman, Lara. "Russian Jamming Poses a Growing Threat to U.S. Troops in Syria." *Foreign*

*Policy* (1997).

Stebbins, Scott F. *Electromagnetic Spectrum: Critical Capability, Critical Vulnerability, Or*

*Both*. Charles Town, WV: American Public University,.

The White House. *The National Security Strategy of the United States of America*. Washington,

DC, 2017.

---

US Army Chief of Staff. *FM 3-12: Cyberspace and Electronic Warfare Operations*.

Washington, DC, 2017.

Whitney, Adam and Anthony Link. *Electromagnetic Spectrum Ops*. Twentynine Palms, CA:  
Marine Corps Tactical Operations Group, 2019.