

**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) 07-05-2021	<b>2. REPORT TYPE</b> Master of Military Studies (MMS) thesis	<b>3. DATES COVERED</b> (From - To) AY 2020-2021
--	--	---

<b>4. TITLE AND SUBTITLE</b> Command and Control in a Denied and Degraded Environment: Preparing for the Next Global Conflict, Today	<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> Stepanoff, Dimitri (Major)	<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**  
The Armed Forces of the United States must be prepared to fight future battles. The past 20 years of conflict have seen a technologically inferior enemy fight effectively against the United States. When the time comes to battle an enemy of equal or greater technological advantage, the US Armed Forces must adapt and be prepared to fight and win those battles. As new strategies become apparent, the United States must achieve naval integration via EABO and LOCE. To be successful, the USMC must protect its C2 and ISR capabilities in the cloud, and be prepared to continue to function even in a degraded environment. Mission command orders, with an ability to continue to function without cloud access, is the key to winning the future fight. The US Armed Forces can and will win if given the proper training and capability to accomplish its mission.

**15. SUBJECT TERMS**  
C2D2E, EABO, LOCE, C2, ISR

<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>
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			USMC Command and Staff College
Unclass	Unclass	Unclass	UU	29	<b>19b. TELEPHONE NUMBER</b> (Include area code) (703) 784-3330 (Admin Office)

*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:**

Command and Control in a Denied and Degraded Environment:  
Preparing for the Next Global Conflict, Today

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

**AUTHOR:**

Maj Dimitri Stepanoff

AY 2020-21

---

MMS Mentor Team and Oral Defense Committee Member:

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

Date: \_\_\_\_\_

*MATTHEW FLYNN*  
*[Signature]* *5/7/21*

MMS Mentor Team and Oral Defense Committee Member:

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

Date: \_\_\_\_\_

*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:**

Command and Control in a Denied and Degraded Environment:  
Preparing for the Next Global Conflict, Today

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

**AUTHOR:**

Maj Dimitri Stepanoff

AY 2020-21

---

---

MMS Mentor Team and Oral Defense Committee Member:

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

Date: \_\_\_\_\_

MMS Mentor Team and Oral Defense Committee Member:

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

Date: \_\_\_\_\_

*Table of Contents*

Page

DISCLAIMER .....2

EXECUTIVE SUMMARY .....3

INTRODUCTION .....4

SOURCES..... 5

CONCLUSIONS.....22

BIBLIOGRAPHY.....25

CITATIONS AND FOOTNOTES .....27

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:** Command and Control in a Denied and Degraded Environment: Preparing for the Next Global Conflict, Today

**Author:** Major Dimitri Stepanoff, United States Marine Corps

**Thesis:** The US Armed Forces must be properly trained, equipped and prepared to fight and win in a command and control, denied and degraded environment.

**Discussion:** The Armed Forces of the United States must be prepared to fight future battles. The past 20 years of conflict have seen a technologically inferior enemy fight effectively against the United States. When the time comes to battle an enemy of equal or greater technological advantage, the US Armed Forces must adapt and be prepared to fight and win those battles. As new strategies become apparent, the United States must achieve naval integration via EABO and LOCE. To be successful, the USMC must protect its C2 and ISR capabilities in the cloud, and be prepared to continue to function even in a degraded environment. Mission command orders, with an ability to continue to function without cloud access, is the key to winning the future fight. The US Armed Forces can and will win if given the proper training and capability to accomplish its mission.

**Conclusion:** The United States can win and fight in a C2D2 environment if it adapts, trains, and prepares for that eventuality. In so doing, the US military ensures that technological reliance helps more than it hinders success on a battlefield.

## Introduction

Throughout the past 20 years, the United States Armed Forces has fought the Global War on Terror in various parts of the world. From major combat operations in Afghanistan and Iraq, to operating as a training and supporting force, the United States has enjoyed dominance in all domains against its adversaries. As technology evolves at a rapid pace, the United States has to accept the fact that future conflicts will be fought in a contested environment in all domains. Adversaries, both nation states and non-state actors, will develop tactics and buy technologies that will counter the dominance that the United States currently enjoys. The US Armed Forces have to understand how to fight in that arena and be prepared to Command and Control (C2) their forces in a Denied and Degraded Environment (D2E). The force has not had to deal with this problem set on a large scale in recent fighting. The US Armed Forces have started to adapt and understand the emerging threat of the cyber domain, but a new domain of battle in the electromagnetic spectrum could make or break battles in the future. Once the dominate force in cyberspace and the electromagnetic spectrum, that could quickly change, demanding adaptability and preparedness. Anything short of this readiness risks losing the next war, inviting a retrenchment of US interests globally. The US Armed Forces must be properly trained, equipped and prepared to fight and win in a Command and Control, Denied and Degraded Environment. There are new systems and concepts under discussion to try and cope with this problem, but the overall issue of degradation of communications has not been fully addressed. The most concerning is a worst-case scenario of complete isolation of dispersed, forward deployed units. Combat functionality is still expected, even when cohesion of effort is disrupted. Actions which empower mission command requires more focused thought on implementation to overcome atomization on the ground and help spell operational success. [good, thesis and significance]

## Sources

The United States Marine Corps has developed a new concept for future strategic deterrence called Expeditionary Advanced Base Operations (EABO). It has worked hand-in-hand with the US Navy and its new strategy called Littoral Operations in a Contested Environment (LOCE). These two concepts will bring new capabilities, strategy, and challenges to combat new threats.<sup>1</sup> These strategies are the baseline of what the current Commandant of the Marine Corps has outlined in his Planning Guidance.<sup>2</sup> This guidance outlines the threat in the Pacific and that the Marine Corps will adapt to those challenges. Since the force has been fighting a land war for the past 19 years, the Commandant has outlined his new area of focus but divesting of equipment to invest in new technologies and force laydown. In order for this to happen, the Commandant has instructed that the Marine Corps to change some forces to focus on this new operational construct. This plan is outlined within the Force Design report on which units will be redesigned and equipped to focus on this new mission. This construct will enable the Marine Corps to shape its force to address future warfare.

Future battles that will be fought will be very different from what the US Armed Forces are used to from the wars in Iraq and Afghanistan. During these wars, the US military dominated in every aspect of warfare to include cyber and the electromagnetic spectrum. The time of dominance is quickly eroding and the United States needs to start focusing on new technologies and procedures to ensure future battles are won. The use of cloud computing will have to be addressed and its dangers to the force mitigated by other new technologies. Each unit in the battlespace will need to have redundant systems in place to continue the fight when they

are cut off from the cloud network. The Marine Corps has started a study through its “Strategy for Assured Command and Control,” to determine what the best course of action will be, an approach requiring a need to decentralize its networks, ensure security in cyberspace, create and train to their PACE plans, and develop technologies that would mitigate this threat in the battlespace.<sup>3</sup>

The biggest hinderance to this new strategy is determining how to Command and Control (C2) forces that are distributed and in a contested environment. What needs to be determined is which elements need to communicate with whom in order to ensure mission success. What systems need to rely on each other to ensure proper targeting and intelligence information is passed to those units to win battles. The key construct is outlined within Joint Publication 1. These publications talk about Mission Command and how it should be implemented within the Joint Force. For example, Joint Publication 1 states: “Successful mission command demands that subordinate leaders at all echelons exercise disciplined initiative and act aggressively and independently to accomplish the mission.”<sup>4</sup> Doctrine has started to take the force in the right direction.

While we look at what doctrine states, LtCol Jim Lyle, in a blog titled, “Thoughts on C2 in Contested Environments, Some Fundamental Concepts of C2 in Contested Environments,” walks us through what C2 is and what is required for a unit to properly function.<sup>5</sup> There are many misconceptions on C2 and how to implement it, and this article clears up many of those. For example, C2 is really dependent on what the commander needs to control to accomplish the mission. This capability does not mean having to direct all units at the same time at all locations, but rather ensuring that your units understand their missions and enabling their success.

Targeting enemy forces has greatly evolved throughout the years. ISR assets have been the dominant force on the battlefield that brings the shooter the information necessary for accurate, precise fires. These systems have to be protected and require countermeasures to enable their use in a C2D2 Environment. William Tompkins, in a blog post titled, “Command & Control Of ISR in A Contested, Degraded, And Operationally Limited Environment: Ensuring Support To Unit Level Intelligence (Part 2),” reviews how the vital assets of ISR can and should be used in a degraded environment.<sup>6</sup> When the links become severed, multiple paths have to be established and practiced in order of us to be ready when this happens in real time. When the EABO construct becomes fully operational, ISR will be a vital tool enabling intelligence collection and fire coordination.

While the joint force looks to act on mission command orders, time and time and again, units are given these types of orders but constantly ask for updates and a report of where they are in their mission. Units and commanders have to train and trust their subordinate units and leaders to accomplish their orders without this too inclusive oversight. When EABO and LOCE are established and the communication nodes are cut off by an enemy, those lower-level commanders and leaders have to be entrusted with accomplishing their mission on their own. This concept is critical for future warfare in a C2D2 environment given the goal of fighting in disaggregated fashion in these future conflicts.

The US military has to be prepared to fight and win in any future conflict. This obvious need means it has to be prepared to fight in a C2D2 environment and be trained and equipped to do so. The United States Marine Corps has looked at this problem and came up with their new Force Design to meet the challenges of future conflict. All branches must accept and train to these standards so as not to be caught unaware when our communication networks are attacked.

The limited literature on this topic, whether from doctrine or experts in more open forums, stresses that we need to continue to evolve our thinking to ensure we continue to dominate all domains of warfare. That reality has overtaken the battlefield. To not have a more developed practice of enabling C2 in challenged environments is surprising and detrimental to the needed push for doctrine.

### **Expeditionary Advanced Base Operations**

The United States Marine Corps has identified the Indo-Pacific theater of operations as the next hot spot for potential conflict. In order to combat this threat, it has developed a new strategy via Force Design through the 38<sup>th</sup> Commandant's Planning Guidance. This new strategy replaces many legacy systems and places new technologies on the forefront of the battlelines throughout the Indo-Pacific area of operations. This goal is clearly stated in the Commandant's Planning guidance: "We must divest of legacy capabilities that do not meet our future requirements, regardless of their past operational efficacy. There is no piece of equipment or major defense acquisition program that defines us – not the AAV, ACV, LAV, M1A1, M777, AH-1, F/A-18, F-35, or any other program."<sup>7</sup> The Marine Corps recognizes that the wars of the past will be quite different from those in the future and will update its weapons for this future fight.

Keeping to the mindset of innovation and forging new strategies, the Marine Corps has developed a new strategy to go along with their updated equipment called Expeditionary Advanced Base Operations or EABO. This concept "meets the resiliency and forward presence requirements of the next paradigm of US Joint expeditionary operations. The concept is adversary-based, cost-informed, and advantage- focused."<sup>8</sup> This strategy looks for ways to make

the Marine Corps more lethal in future warfare by ensuring that it remains combat effective in the first stages of future conflict. The Marine Corps is looking to conduct EABO by offering,

...low-signature naval and joint forces with operationally relevant sea control and denial capabilities—in particular, the ability to offensively target and strike adversary naval and air platforms, and defensively form the nucleus of an active integrated maritime defense-in-depth. EABO is premised on the creation of an alternative forward force posture based on a more difficult [enemy] to target, low-signature, and dispersed forward-basing infrastructure. The lethal, yet resilient, combination of low-signature forces operating from a more amorphous forward-basing infrastructure will enable US naval and joint forces to persist, partner, and operate within range of adversary long-range precision fires—particularly ballistic and cruise missiles designed to attack critical joint, fixed, forward infrastructure, and large platforms.<sup>9</sup>

This entire strategy will be conducted in a contested environment throughout all domains of warfare. Combat units will be spread out in locations where command and control are vital for coordinated strikes and intelligence sharing. Without redundant and reliable systems in place, the Joint Force and partner forces will not be able to integrate with the Marine Corps and allow it to conduct its missions.

The plan for these Expeditionary Advanced Bases (EABs) is that they have a greater role to play, not only with the naval services, but in the Joint Environment, enabling a capability to gain the advantage in the opening stages of conflict. The emerging concept recommends that:

EABs will support forces ashore, afloat, airborne, sub-surface, and those designed to exploit the EMS. Most of these capabilities will be naval, but many will be joint. Consequently, EABs will require inter-service task organization. As new inside forces are developed and proliferated, new capabilities and requirements for support will be discerned, and new opportunities for creative and effective C2 will arise.<sup>10</sup>

Given the joint emphasis, C2 will clearly assume a priority. The Marine Corps understands the challenges that lie ahead in this new domain of warfare that it has enjoyed dominance in for so many years. With the EABs scattered wherever the Marine Corps deems appropriate, there is mutual understanding between the Marine Corps and the Navy that networks and capabilities have to interact with each other and be mutually supporting.

The Marine Corps wants this capability and understands that innovation has to happen in both equipment and tactics. This is evident by what is stated in the Force Design handbook:

Integral to the Fleet Tactical Grid must be a common C2 communications architecture that enables all systems to interoperate. This system should be network optional, and service agnostic. All inside force EABO systems and units must be interoperable and utilize low probability of detection and intercept communications. Emerging technologies, such as free-space optics, hold great promise of creating a new spectrum for secure, high bandwidth communications. New systems to ensure timely communications with sub-surface platforms will allow them to be integrated into the scheme of maneuver vice merely de-conflicted by battlespace.<sup>11</sup>

The writing is on the wall that the Marine Corps is looking to future technologies to integrate and solve the dilemma of countering adversary means to impair accepted Marine warfighting capabilities, which will enable continued dominance in future conflicts in a contested environment in all domains.

### **Littoral Operations in a Contested Environment**

The Navy could be considered a great example and leader on how to operate at an Emissions Control (EMCON) level to prevent the enemy from detecting your location and combat strength. Emission control means ensuring a unit avoids detection even while operating communications that may emit a signal that can be traced. It has practiced this with their surface fleets and rely on this premise for their subsurface fleet to conduct missions. The Navy has also seen that the future conflict will be in a contested environment that has to be won across all domains of warfare.

With this in mind, it developed a concept of Littoral Operations in a Contested Environment (LOCE). The Navy acknowledges that with current and future enemy capabilities such as land-based cruise missiles and advanced undersea capabilities, the enemy has a greater reach where they can influence and affect an area. The Navy has stated that times have changed and they need to adapt to these threats. The Navy sees this change as a return to a Cold War era of sea conflict with some distinct changes. With their new strategy of LOCE, it understands the challenges that it faces today are different from the past. The concept states this threat as follows: “In fact, the increasingly contested operating environment marks a return to the historic

norm, with the added challenge posed by 21st century sensors and weapons. Friendly naval forces now routinely face land-based and seabased threats employed by state and non-state actors who are implementing sea denial strategies.”<sup>12</sup> The Navy is looking to introduce ideas as to “how naval forces could be organized, trained and equipped to enhance their ability to operate in contested littoral environments.” Included among those ideas are:

...additional, versatile force options; a wider application of existing doctrine; and the more flexible employment of current, emerging, and some potential capabilities. To confirm their integral merit, the ideas put forth in this concept require further testing and refinement through detailed wargaming, experimentation, and exercises. It is expected that these activities will invigorate and advance naval operational art and stimulate creativity on how to exploit the inherent synergy of integrated Navy and Marine Corps capabilities.<sup>13</sup>

This concept has been in development since 2017 and has delivered much of what the Navy was asking for. The Navy is testing and wargaming these new ideas to ensure freedom of navigation of the seas in a contested battlefield.

This concept works hand in hand with the Marine Corps’ EABO concept as they are both mutually supporting and rely on each other to minimize the threat from the enemy. As stated in the Marine Corps EABO Handbook:

US naval forces share in the overall joint force challenges imposed by A2AD equipped adversaries, but there are appreciable and distinct differences in both threats and opportunities. As a naval concept, EABO is focused on how naval forces can counter adversary initiatives and invalidate adversary assumptions to restore advantage to the joint force. To do so, naval strategists must first understand how aggressive adversary A2AD initiatives have imperiled the conventional approach to naval operations.<sup>14</sup>

These challenges posed by the Marine Corps have been adapted in the understanding of the problem that the Naval Services face in LOCE. The Navy states:

Armed with increasingly formidable sea denial capabilities, future adversaries may be capable of controlling choke points, holding key maritime terrain, or denying freedom of action and maneuver within the littorals by imposing unacceptable risk to forces at ever increasing ranges. Additionally, some potential adversaries are attempting to expand their sea denial capabilities into the ability to achieve sea control. These conditions call for a paradigm shift and the reinvigoration of a unified naval approach that effectively integrates sea control and maritime power projection capabilities.<sup>15</sup>

Though the enemy has gotten more lethal in their ways of conducting war and deterring the United States, the naval services and the joint force understand the many challenges ahead and are working to solve these problems with new concepts of employment and technological advantages. LOCE has the same requirements for command and control as EABO. The Navy has to ensure that the joint forces and partner forces can share vital information for fires, defensive measures and intelligence. These systems will be vital to win future conflicts along with training and preparing for this fight.

### **Why EABO Might Fail**

When EABO was announced, many were appalled by what the Marine Corps was doing by divesting from many of the technologies that some argue were critical to win battle and wars of the past. The tank being the main staple of an urban fight, was mothballed in order to pave the way for new equipment and technology. Here was one of the most controversial aspect of this strategy. While dissecting this change in the Marine Corps, Jim Lacy, a professor at Marine Corps University, mentioned how this strategy could lead to its failure. When Marines were pushed forward throughout the battlespace, they were no longer a maneuvering force. Lacy wrote, “In short, by adopting EABO as its foundational warfighting, the Marine Corps was apparently turning its units into sitting ducks.”<sup>16</sup> Lacy stressed that this concept seems a repeat of the Japanese strategy during the Second World War, one that failed. As mentioned in the article:

[Japan] scattered small forces throughout its so-called co-prosperity sphere, hoping that stubborn defenses by each of the isolated units would wear down an American offensive and force the United States to sue for peace. It did not work out that way. Instead, the Marine Corps tore through the Japanese bastions in a remarkably short period of time during the Central Pacific Campaign.”<sup>17</sup>

Japanese garrisons at times could be quite large, but no matter the size, the location on the periphery of empire meant failure, a result that rhymed a bit too closely with EABO in Lacy's estimation.

The Marine Corps is not repeating history, however. A closer look again establishes EABO's greatest advantage. This concept allows the Navy and Joint Services to work in concert to accomplish their missions in the Pacific, something the Japanese never accomplished in World War II. Closing out the article, Lacy mentions how the Marine Corps is in fact not repeating the mistakes of the past and playing to its strengths by the EABO concept. He wrote:

The EABO concept, upon deeper examination, bears little resemblance to what Japan tried during World War II. EABO is not a stand-alone concept that would leave Marine units stranded and fighting for their lives on isolated islands. Rather, the Marine Corps and Navy are working to integrate their various weapons systems – existing and projected – into a mutually supporting fires complex, employing missiles and long-range artillery fires to dominate the maritime domain.<sup>18</sup>

Only time will tell if this concept is the right one and leads the United States to maintain peace and security by maintaining command of the sea while allowing freedom of navigation for all nations throughout the Indo-Pacific Region.

### **Communications in a C2D2 Environment**

Most US command and control systems for military operations require a few things to work properly. The most important is to have access to the outside world for connectivity. This can be done via a simple radio or a satellite dish. The Armed Forces has been utilizing centralized networks to ensure the information exchange requirements are being met at the level that is required. From satellite communications to server farms, these assets provide the necessary information to properly fight and win wars. Any user that logs into a network has to be authenticated, which requires the system to have that capability. To minimize the amount of gear and resources at the lower echelon, those units at the forward operating bases and EABs

will have to conduct a “reach back” into the cloud or central location to process that information. This functionality becomes an issue if a unit is cut off in a C2D2 environment. When the connection to the controlling network is lost, a unit cannot function to its full capability since it requires access to that central location to coordinate with other units to fully function. This coordination is a primary concern for the end user when they utilize a centralized and cloud network.

This problem set only gets more complex when adding mission partners and a Mission Partner Environment (MPE). Though the MPE makes coordinated efforts in combat more effective, units still invite the same risk of vulnerable communications when reaching back to these networks as stated above. The goal is to ensure MPE has the capability and access that is required to fight combat operations and win these battles. The problems mentioned above can be overcome with the proper equipment and training. The equipment that will be utilized for an EABO mission must be small, man portable and adaptable. These systems already exist in the inventory but are not widely utilized. Small form factor dishes such as the TAMPA system has been utilized by the Joint Force for years.<sup>19</sup> It can be carried in a backpack or small suitcase and can provide connectivity to services for small EABO units scattered throughout the battlespace. It can operate on different spectrums with a simple feed cone swap. This system can be the starting point to solve the problem of small form factor dishes that are required for this new concept. The legacy systems of the VSAT and SNAP family have become obsolete and too bulky for the future fight. It is time to give the warfighters on the edge of the battlefield a portable, modern, reliable, redundant and resilient system to conduct future operations.

The authentication issue for connectivity and verification of the end user is vital for any mission to take place. Without a connection to the internet, if a user is not cached on the system,

they will not be allowed to log in. However, there are systems that can be operated and adapted for the mission at hand that are being experimented with and utilized in the Joint Force. One of these systems is the PacStar suite of servers that can be slid in and out of a briefcase to adapt for what the mission calls for.<sup>20</sup> For example, it can integrate an email server or storage device if needed. An authentication server can be placed in this small stack to allow users access to their information with the proper authentication method being utilized. Another system that has been tested and utilized is the Klas.<sup>21</sup> It operates with the same concept as PacStar and offers some more capability such as tactical radio integration and ISR suites. Both products can be the starting point for the future of what our network services will look like in this new construct. As technology advances, the systems in place will need to be adaptable enough that they do not become obsolete in a few years. A plan for upgrades of hardware and software will allow the Joint Force to stay ahead of our enemies with our command-and-control systems. As stated before, KLAS and PacStar have this in mind when they design and build their products and can be adapted for military use.

The biggest asset that the Joint Force will have in the new fight are its people. Commanders will need to ensure that their Marines, Sailors, Soldiers and Airmen are properly trained with these systems. Personnel who are trained on these systems should be allocated the proper amount of time to become experts in their field. This might require longer times in school and quite possibly longer contracts, so they are not lost to the civilian sector once they learn all the skills necessary for these missions. These personnel will be essential in maintaining command and control systems and need to be given proper attention in order to allow them to ensure these capabilities allow and conduct battle in this new style of warfare.<sup>22</sup>

Most military personnel have an understanding of how to operate and conduct basic programming on a radio. This concept of incidental operators should be done at all levels of communications and not just radios. This is already being done with transport drivers in the military. The most common vehicles that are being utilized today have incidental operators that do not possess a motor transport MOS, but rather are taught the basics of operations, maintenance and basic troubleshooting. In today's technological age, service members have been around technology long enough to know how to operate computers and software at a basic user level. That knowledge should be taught with the systems at hand to ensure that if a communications operator is taken out of the fight, there is still some basic knowledge to ensure systems can be operational for the fight. Considering that units will be isolated and have to rely on each other to function, there should be a mindset that each member of that team knows each other's job just in case they get hurt or have to leave. The concept that the Marine Corps has of "Every Marine a rifleman" should be adapted to critical gear and a mindset of the "Every Marine is a Communicator."

### **The Fight in Every Domain Must be Won**

As one looks into the future of what warfare will bring, the US Armed Forces have to accept the fact that they will be contested in every domain. Whether it is space, cyberspace, or in the electromagnetic spectrum, every one of these fronts is a maneuver battlespace. The United States has to be prepared to fight and win in these domains. The mindset and procedures are starting to get into place to address these domains. For example, the United States has created the Space Force to address the future fight that will be had in space.<sup>23</sup> This is an often-overlooked domain that the US Armed Forces take for granted. The Department of Defense has also created Cyber Command to ensure we can protect our networks but also go on the offensive

if need be.<sup>24</sup> This command has shown us that we can take the fight to the enemy without ever setting foot in a combat zone. Another area of concern is the electromagnetic spectrum. Attacks here can deny many of the essential capabilities of a military.<sup>25</sup> Commanders and planners have to develop the necessary steps to ensure that in future conflicts a force can communicate enough to win the battles.

Many unseen battles will take place in future conflict contesting command and control. The way to address this threat is by planning, rehearsing, and developing technologies which can continue to function, even in these demanding environments. The first step is creating a PACE plan. This acronym stands for Primary, Alternate, Contingency, Emergency (PACE) as a catch phrase to offer a means to communicate.<sup>26</sup> These communication paths have to be over a different median to be effective. For example, you can start on a data system, move to just voice, then radio, and finally use a runner as an emergency. Once these plans are developed, you have to rehearse this concept. A way to train and rehearse this practice is to disconnect the primary communications systems that are being utilized and teach commanders and staff how to utilize alternate means to conduct business. This will change the way and methods that everyone is used to. Instead of sending a PowerPoint with the entire plan and conducting a VTC to brief the PowerPoint, the staff can send a Tactical Chat “TacChat” message over High Frequency radios with simple, short instructions. This needed adjustment will be painful at first, but through repetition and proper implementation, those that need to communicate will have the training to properly ensure that what needs to be relayed across the battlespace will in fact reach a distant end. The US Armed Forces has become heavily dependent on technology, but we have to be able to pull out a map and pen and listen passively to radio traffic to visualize the battle unfold. The idea that you will get all the information the instant that it happens is not a reality in conflict.

Commanders and their staff will have to operate through this friction by repetition and finding the will to communicate. They will have to become a resilient staff and function via redundant means available to them at the time so they get crucial information to those that require it.

Though planning and rehearsing these concepts are a great step forward, new and evolving technologies will play a part in achieving readiness. This does not mean the Armed Forces have to completely start from scratch, but rather they need to look at what is in the inventory first and see how this gear can be refined to operate in a C2D2 Environment as mentioned above. An overlooked asset that we can utilize in this PACE plane is to look at High Frequency (HF). This lost art can be utilized to send and receive voice and data communications over great distances. Though HF is reliable, it still has to be utilized properly in order to allow command and control in this environment. The communications community will push more power over a radio system to ensure that it reaches the intended end point. This is great for communications, but gives away your position very quickly to the enemy. Instead, we blend technical knowledge with the art of HF by utilizing directional antennas with minimum power to reach the distant end. Setting up the antenna around terrain features means the radio waves only emulate where you want them to go and therefore helps protect the user.<sup>27</sup>

There are many ways in which we can mask our presence to ensure survivability. This is something that can be taught and trained to today, to ensure communications survive this type of battle. The Marine Corps already teaches these concepts in the radio operators' course both at the school house and at the Mountain Communications Course at the Mountain Warfare Training Center.<sup>28</sup> This course teaches students the limitations of gear and how to utilize terrain to their advantage in communications and its capabilities and limitations. Through continued training,

refinement and repetition, HF can become a reliable means to communicate in a contested environment as we pull from our addiction of satellite communications.

As technology continues to develop and evolve at a rapid pace, there will be a time to rely on new gear that is less susceptible to electromagnetic interference. This technology will have to counter what we know the enemy will try to do to our communications network in battle. These counters are more than just encrypting traffic. These systems will have to work while being constantly attacked and be reliable enough to send the proper information in real time to forces in the battlespace. Though some of this technology is being tested, it is not fully developed and ready for use. The US Armed Forces must start training and preparing for the fight ahead while the technology quickly catches up to our tactics.

### **ISR in C2D2 Environment**

What has made the United States more lethal in its operations around the globe is its ISR assets, primarily its drones.<sup>29</sup> From their loiter time to the way they are utilized for targeting, they are vital to today's fight. Now imagine losing that capability to properly identify targets and get rounds down range. This is what has to be considered in a C2D2E battlespace. Tompkins again raises the warning by writing, "With the increased reliance on information superiority to ensure mission success, the ability to conduct global reach-back to enable ISR operations is currently challenged by near-peer adversaries. Our adversaries have invested heavily in technologies to deny us the superiority we have come to rely upon."<sup>30</sup> How will we control these assets when their links has been broken? Do we have to change the way these aircraft are controlled? One could argue that ISR needs to have a PACE plan associated with it to ensure continuity of operations. Tompkins writes about how different operational zones can

mitigate these issues and ensure that the aircraft completes its mission properly.<sup>31</sup> The intertwined network of radios and data links that join together to create a mesh network, and create a more robust way to operate ISR. If one part of the chain brakes, the other pieces pick up the slack and continue to allow that asset to be control and utilized properly. This concept has to be rehearsed and properly planned for just as any other contingency operation. From tabletop discussions to conducting live drills, if we do not practice this, we will be in for a rude awakening in future conflicts.

Other ways to mitigate the loss of a link to an ISR vehicle is to have equipment that is broad spectrum capable. If the enemy decides to jam or interfere with a certain frequency known for controlling a drone, the platform should be capable of adapting to this threat internally and re-establishing communications with its ground control station. There can be alternate pathways that connect the drone to its control station which can be different than what it was intended to operate on. For example, a drone could be connected via a satellite link and switch to a Line-of-Sight link and continue to function automatically. This is done a lot during the take-off and landing of drones and a handshake is created to pass from one type of control to another. The technology has to be more than this simple method of operations. Envision an integrated network that can adapt to changes utilizing Artificial Intelligence (AI) to defeat a threat. If an ISR platform has an on-board computer with AI, it can detect and automatically conduct counter measures that will allow it to switch spectrums and continue to provide vital data to the ground force and never be lost to the ground control station. This type of technology could one day allow the US Armed Forces to help solve the communication challenges to ISR.<sup>32</sup>

Since controlling the aircraft is only half the problem, we have to determine how to get a drone's Video Downlink (VDL) to the appropriate authority to ensure targets and intelligence get

to decision makers and target engagement authority so they can properly execute their missions. This link has to be solid and accurate to give those with authority the proper information in a timely manner so they can properly make tough decisions. Utilizing a Video Scout, ROVER or OSRVT like system which offer a local, line of sight connection to the aircraft's feed, a unit could have accurate, local VDL to ensure their portion of the battlespace has the necessary ISR support for their mission.<sup>33</sup> These units on the ground are not worried about controlling the ISR platform, but rather, allows a one-way feed to broadcast to those that are authorized to receive. This limits the enemy's detection of ground forces since they are not emitting to control that ISR platform. A Global Broadcast System can also be utilized to mitigate this problem.<sup>34</sup> As it is 'receive' only, it does pose a challenge when needed to execute a strike if there are not any communications with the firing aircraft if there needs to be changes made to the video that they are receiving. Each system and method has its limitations and advantages. Since ISR is vital, new resilient technologies will have to be developed and implemented if we are to utilize our assets to their full potential in this new style of warfare.

### **Mission Command**

When the US military fights in a C2D2 environment, the main way in which we will win these future conflicts will be with our most precious recourse, our people. Junior leaders at the lower echelons will be where the battles are won and lost. In an environment where their higher command will be cut off, they must issue mission command orders to satisfy a commander's intent. Joint Doctrine 1, Doctrine for the Armed Forces of the United States formally defines mission command as follows:

Mission command is the conduct of military operations through decentralized execution based upon mission-type orders. It empowers individuals to exercise judgment in how they carry out their assigned tasks and it exploits the human element in joint operations, emphasizing trust, force of will, initiative, judgment, and creativity. Successful mission command demands that

subordinate leaders at all echelons exercise disciplined initiative and act aggressively and independently to accomplish the mission.<sup>35</sup>

This view means commanders must trust those leaders at the tip of spear in battle and allow them to conduct their missions without higher getting involved. Give them the guidance as to what has to be done and you will be surprised how they accomplish that task.

This concept has to be practiced and trained too as much as possible. Through training evolutions, commanders and leaders have to give their subordinates the end state to the mission and allow them to accomplish that mission without any interference. Though there will be times where they fail or do not meet the mission requirements, each training evolution will allow them to grow and learn, which makes them a more efficient warfighter in the long run. This process, in the end, will build trust in the team for future operations. This type of trust and training has to be accomplished if we are to fight in the C2D2 environment. The Joint Force has to utilize every tool that is has in the inventory when it becomes engaged in a conflict. Since the most important resource and tool we have are people, we have to enable them to be successful in this future fight.

### **Recommendations and Example for Training Forces**

To build these future leaders and thinkers at the lower echelons, these are several recommendations for training those forces. First, there are Leadership Reaction Courses (LRCs) that must be tailored to train personnel in a very short amount of time correcting their unwieldy practice by taking a stressful situation and requiring that lower echelon leader to solve quickly without any support from higher. This improvement allows small unit leaders to make decisions and come up with a plan while under pressure and time constraints. Another training evolution which can be considered is to operate as normal in a regimental or battalion training event and at

a certain time, cut off all the primary links of communication to see how the staff and subordinate units react. This incorporates not only the PACE plan but also the Mission Command concept and allows training to occur in a real-world scenario. 2nd Marine Division conducted an exercise in October and November of 2019 which showcased many of the concepts mentioned above. The exercise was primed to emulate fighting a near peer enemy that has all the capabilities the Joint Force would have. The first couple of days, the friendly forces were at a disadvantage and had to operate in a C2D2 environment while still conducting command and control of all its forces located throughout the battlespace. Many methods were utilized to minimize the enemy threat such as directional HF, small form factor dishes, and new systems that had a smaller footprint than legacy systems. This is just one example of how a division worth of Marines planned, trained and executed a major training event in a C2D2E.<sup>36</sup> The Marine Corps Center for Lessons Learned is a great resource to find what others have done for training that will better prepare the Joint Force for the tough fight ahead. For example, one can look at how 2d Marine Division has incorporated this type of training into its exercises for the past few years. The emphasis of going away from large command posts to smaller, mobile command centers has allowed them to expand their understanding of this future fight. Also, 7th Marine Regiment has been in the desert of Twentynine Palms practicing the way to hide in the open while continuing to communicate across the battlespace.<sup>37</sup> The more that we practice and train to operate in a C2D2 environment, the better prepared we will be when it happens in a real-world conflict. The US Armed Forces cannot lose the edge in the new era of challenging multi-domain warfare.

The US Armed Forces have to be prepared to fight and win in any future conflict. We have to be prepared to fight in a C2D2 Environment and be trained and equipped to do so. The

US Marine Corps has looked at this problem and came up with their new Force Design to meet the challenges of future conflict with their Navy brethren. All the branches need to accept and train to such standards to enable similar continuity among the branches so we are not caught on our heels when our command and control networks are attacked. We need to continue to evolve our thinking to ensure we continue to dominate all domains of warfare to win the future fight. The US Armed Forces must be properly trained, equipped and prepared to fight and win in a Command and Control, Denied and Degraded Environment.

## Bibliography

- Coffey Jr., William T. “Denied, Degraded, Disrupted.” *Purview* (January-March 2018): 1-5.
- “Concepts & Programs Home.” U.S. Marine Corps Concepts & Programs. Accessed February 26, 2021. <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-2-Information-Operations/Part-21-Command-and-Control-C2/GBS/>.  
 “Government.” Klas, November 19, 2020. <https://www.klasgroup.com/government/>.
- Joint Publication 1, *Doctrine for the Armed Forces of the United States*, 2017.
- Joint Publication 6, *Joint Communications System*, 2015.
- Lacey, Jim. “The ‘Dumbest Concept Ever’ Just Might Win Wars.” *War on the Rocks*, July 28, 2019. <https://warontherocks.com/2019/07/the-dumbest-concept-ever-just-might-win-wars/>.
- Lyle, David. “Thoughts on C2 in Contested Environments: Some Fundamental Concepts of C2 in Contested Environments.” *Apan*, 2017. <https://community.apan.org/wg/aucoi/jadcc/b/weblog1/posts/thoughts-on-c2-in-contested-environments>.
- “Mountain Communications Course.” Marine Corps Mountain Warfare Training Center > Staff > S-3 Operations and Training > Chief Instructor > Mountain Warfare Formal Schools > Mountain Communications Course. Accessed February 20, 2021. <https://www.29palms.marines.mil/mcmwtc/Staff/S-3-Operations-and-Training/Chief-Instructor/Mountain-Warfare-Formal-Schools/Mountain-Communcations-Course/>.
- Marine Corps Center for Lessons Learned, MWX 1-19 After Action Report, 2020, <https://www.mccll.usmc.mil/>
- “OSRVT™.” One System® Remote Video Terminal (OSRVT™) | Textron Systems. Accessed February 20, 2021. <https://www.textronsystems.com/products/osrvt>.
- “PacStar Deployable Communications Solutions.” PacStar, January 26, 2021. <https://pacstar.com/products/deployable-communications/>.
- Raytheon Intelligence & Space. “How Artificial Intelligence and Machine Learning Will Make ISR Faster.” *Breaking Defense*. September 14, 2020. <https://breakingdefense.com/2020/09/how-artificial-intelligence-and-machine-learning-will-make-isr-faster/>.
- “TAMPA MICROWAVE Modular Solutions for Any Mission.” Tampa Microwave, November 30, 2017. <https://www.tampamicrowave.com/>.

Tompkins, William. "Command & Control of ISR in a Contested, Degraded, and Operationally Limited Environment: Ensuring Support to Unit Level Intelligence (Part 2)." *Over the Horizon*, December 12, 2018. <https://othjournal.com/2018/12/12/command-control-of-isr-in-a-contested-degraded-and-operationally-limited-environment-ensuring-support-to-unit-level-intelligence-part-2/>.

United States Cyber Command. "Mission and Vision." Accessed February 20, 2021, <https://www.cybercom.mil/About/Mission-and-Vision/>.

United States Marine Corps Publication. *Commandant of the Marine Corps Force Design Report Phase I and II*, 2020.

United States Marine Corps Publication. *Commandant's Planning Guidance: 38<sup>th</sup> Commandant of the Marine Corps*. Washington DC: Headquarters Marine Corps, 2019.

United States Marine Corps Publication. *Expeditionary Advanced Operating Base Handbook*, 2018.

United States Marine Corps Publication. *Strategy for Assured Command and Control: Enabling C2 for Tomorrow's Marine Corps, Today*, 2017.

United States Marine Corps Publication. *Tentative Manual for Expeditionary Advanced Base Operations*. Department of the Navy, Headquarters, United States Marine Corps, February 2021.

United States Marine Corps Reference Publication. *Radio Operators Handbook*, 2015

United States Navy Publication. *Littoral Operations in a Contested Environment*, 2017.

United States Space Force. "United States Space Force Mission." Accessed February 20, 2021, <https://www.spaceforce.mil/About-Us/About-Space-Force/Mission/>.

## Endnotes

- <sup>1</sup> *Expeditionary Advanced Base Operations*, 2018; *Littoral Operations in a Contested Environment*, 2017, 5.
- <sup>2</sup> *Commandants Planning Guidance*, 2019, 1.
- <sup>3</sup> *Strategy for Assured Command and Control, Enabling C2 for Tomorrow's Marine Corps, Today*, 2017, 1.
- <sup>4</sup> Joint Publication 1, *Doctrine for the Armed Forces*, 2017, 127.
- <sup>5</sup> David Lyle, *Thoughts on C2 in Contested Environments, Some Fundamental Concepts of C2 in Contested Environments*, APAN, 2017, <https://community.apan.org/wg/aucoi/jadcc/b/weblog1/posts/thoughts-on-c2-in-contested-environments..>
- <sup>6</sup> William Tompkins, "Command & Control Of ISR In A Contested, Degraded, And Operationally Limited Environment: Ensuring Support To Unit Level Intelligence (Part 2)," *Over the Horizon*, 2020, <https://othjournal.com/2018/12/12/command-control-of-isr-in-a-contested-degraded-and-operationally-limited-environment-ensuring-support-to-unit-level-intelligence-part-2/>>.
- <sup>7</sup> *Expeditionary Advanced Base Operations*, V1.1, 2018, 5
- <sup>8</sup> *Ibid.*, 5. *Expeditionary Advanced Base Operations V1.1*, 2018, 5.
- <sup>9</sup> *Ibid.*, 66.
- <sup>10</sup> *Ibid.*, 66.
- <sup>11</sup> *Ibid.*, 67.
- <sup>12</sup> *Littoral Operations in a Contested Environment*, 2017, 5.
- <sup>13</sup> *Ibid.*, 7.
- <sup>14</sup> *Expeditionary Advanced Base Operations*, V1.1, 2018, 18.
- <sup>15</sup> *Littoral Operations in a Contested Environment*, 5.
- <sup>16</sup> Jim Lacey, "The 'Dumbest Concept Ever' Just Might Win Wars," *War on the Rocks*, July 28, 2019, <https://warontherocks.com/2019/07/the-dumbest-concept-ever-just-might-win-wars/>.
- <sup>17</sup> *Ibid.*
- <sup>18</sup> *Ibid.*
- <sup>19</sup> "TAMPA MICROWAVE Modular Solutions for Any Mission," Tampa Microwave, November 30, 2017, <https://www.tampamicrowave.com/>.
- <sup>20</sup> "PacStar Deployable Communications Solutions," PacStar, January 26, 2021. <https://pacstar.com/products/deployable-communications/>.
- <sup>21</sup> "Government," Klas, November 19, 2020. <https://www.klasgroup.com/government/>.
- <sup>22</sup> Joint Publication 1, *Doctrine for the Armed Forces of the United States*, 2017, 63.
- <sup>23</sup> "United States Space Force Mission," accessed February 26, 2021, <https://www.spaceforce.mil/About-Us/About-Space-Force/Mission/>.
- <sup>24</sup> United States Cyber Command, "Mission and Vision," accessed February 20, 2021, <https://www.cybercom.mil/About/Mission-and-Vision/>.
- <sup>25</sup> Joint Publication 6, *Joint Communications System*, 2019, 25.
- <sup>26</sup> Tompkins, "Command & Control Of ISR In A Contested, Degraded, And Operationally Limited Environment: Ensuring Support To Unit Level Intelligence (Part 2)."
- <sup>27</sup> United States Marine Corps Reference Publication, *Radio Operators Handbook*, 2015, 41.
- <sup>28</sup> "Mountain Communications Course," Marine Corps Mountain Warfare Training Center, S-3 Operations and Training Chief Instructor; Mountain Warfare Formal Schools; Mountain Communications Course, accessed February 20, 2021, <https://www.29palms.marines.mil/mcmwtc/Staff/S-3-Operations-and-Training/Chief-Instructor/Mountain-Warfare-Formal-Schools/Mountain-Communications-Course/>.
- <sup>29</sup> Tompkins, "Command & Control Of ISR In A Contested, Degraded, And Operationally Limited Environment: Ensuring Support To Unit Level Intelligence (Part 2)."
- <sup>30</sup> *Ibid.*
- <sup>31</sup> *Ibid.*
- <sup>32</sup> Raytheon Intelligence & Space, "How Artificial Intelligence and Machine Learning Will Make ISR Faster," *Breaking Defense*, September 14, 2020, <https://breakingdefense.com/2020/09/how-artificial-intelligence-and-machine-learning-will-make-isr-faster/>.
- <sup>33</sup> "OSRVT™," One System® Remote Video Terminal(OSRVT™) |Textron Systems. Accessed February 20, 2021, <https://www.textronsystems.com/products/osrvt>.

---

<sup>34</sup>“Concepts & Programs Home,” U.S. Marine Corps Concepts & Programs, accessed February 26, 2021, <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-2-Information-Operations/Part-21-Command-and-Control-C2/GBS/>.

<sup>35</sup> Joint Publication 1, *Doctrine for the Armed Services of the United States*, 2017, 127.

<sup>36</sup>Marine Corps Center for Lessons Learned, MWX 1-19, After Action Report, 2020, <https://www.mcell.usmc.mil/>.

<sup>37</sup> Ibid.