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14. ABSTRACT

The Marine Corps must shift its conceptualization and understanding of communications to facilitate command and control in a contested communications environment. Fighting for communication pathways inside and outside of the electromagnetic spectrum will require predicting the information needed to make operation decisions during intermittent communications. The Tactical Air Command Center (TACC) should become a low-observable, small and mobile, networked with joint interoperability, C3 node that operates within the adversary's weapon engagement zone. By making these changes, the TACC will become a resilient, conditional forward Naval Air Operations Center (AOC) in line with the Marine Corps' EABO concept and will provide significant C3 capabilities for the Navy-Marine Corps team and the joint force.

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Changes to Marine Aviation Command and Control:
Fighting Contested Communications within an Adversary's Weapon Engagement Zone

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Executive Summary

Title: Changes to Marine Aviation Command and Control: Fighting Contested Communications Within an Adversary's Weapon Engagement Zone

Author: Maj Stephanie A. Mafrici, United States Marine Corps

Thesis: Marine aviation command and control must change to support joint operations decision-making within a contested communications environment.

Discussion: The rise of adversary competition against US supremacy in space, cyberspace, and the electromagnetic spectrum demands changes for Marine Corps command, control, and communications (C3). The Tactical Air Command Center (TACC) is the most critical C3 node in the Marine Corps and will not survive as currently employed in a contested communications environment under the Marine Corps' Expeditionary Advanced Base Operations (EABO) concept.

Conclusion: The Marine Corps must shift its conceptualization and understanding of communications to facilitate command and control in a contested communications environment. Fighting for communication pathways inside and outside of the electromagnetic spectrum will require predicting the information needed to make operational decisions during intermittent communications. The TACC should become a low-observable, small and mobile, networked with joint interoperability, C3 node that operates within the adversary's weapon engagement zone. By making these changes, the TACC will become a resilient, conditional forward Naval Air Operations Center (AOC) in line with the Marine Corps' EABO concept and will provide significant C3 capabilities for the Navy-Marine Corps team and the joint force.

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I would like to dedicate this paper to the officers and Marines of Marine Wing Communications Squadron 18 who served with me from 2015 to 2019. You all were my inspiration for this paper. I was constantly humbled by your tireless dedication and stellar performance in a complex communications environment. I would not be the officer I am today without you all. This paper is a small effort to still contribute to your fight.

Lastly, I'd like to thank my husband. Any success I experience is directly attributed to his support of me.

Introduction

The US military no longer has supremacy in space and the electromagnetic spectrum, which changes its long-held assumptions about communications. While the US focused on training, manning, and equipping a military focused on counterinsurgency without considering the risk of contested communications, peer adversaries focused on developing ways to disrupt the military's extensive communications networks. Adversaries seek to contest communications, denying commanders the ability to synthesize information and facilitate decision-making, inhibiting the joint force to effectively command and control (C2). For instance, the People's Republic of China changed its approach to the space and cyberspace domains, and electromagnetic spectrum over the course of thirty years based on two lessons learned from America's dominance in the Gulf War. First, Chinese civilian and military leaders realized information technology provided the military a significant advantage in warfare. Second, the Chinese recognized the vulnerability associated with US reliance on these technologies[1] and, as such, spent the next three decades evolving its Strategic Support Force to exploit these vulnerabilities in space, cyber, and the electromagnetic spectrum.[2]

Without an effective command and control system, the joint force will struggle to provide integrated air power within a peer adversary's weapon engagement zone (WEZ). Aviation platforms that conduct C2 are scarce, high value assets that require protection. And although the maturation of unmanned aerial systems (UAS) technology increases time on station, the nature for most aviation C2 platforms today requires them to land to conduct any maintenance, refueling, or crew rotation. A ground-based aviation C2 capability within the WEZ compliments aviation platform C2 assets by providing this capability without the same degree of risk of loss of manned aviation C2 platforms. Additionally, ground based C2 platforms can more easily be

resupplied without interrupting operations. Islands throughout the Pacific Ocean provide opportunities for ground-based, non-satellite-based communications to enable aviation C2 for the joint force.

If the joint force only uses aviation-based platforms, it increases the chance of disruption in its communications pathways. Loss of communications affects the joint force's ability to shape initial actions or gain situational awareness to make decisions across a dispersed operational area. Aviation assets provide fast moving, long reaching warfighting capabilities, which require the most complex C2 structures to synchronize operations. Internally, Marine Corps aviation C2 is the critical integrator between the Marine Corps aviation and ground units forward deployed in key maritime terrain. Externally, Marine aviation C2 connects the Marine Corps to other joint command nodes such as the Navy Maritime Operations Center (MOC) and the Air Force Air Operations Center (AOC). Marine aviation C2 must change to support joint operations decision-making within a contested communications environment in today's information age.

Prior to discussing the required changes for Marine C2, this paper develops an understanding of how the Marine Corps came to the current problem of an ineffective command and control structure. Then, it discusses the mindset changes for planning and operating in a contested communication environment against a peer adversary. Next, this paper describes the latest Navy and Marine Corps warfighting concepts and provides a new theory of communications. Additionally, this paper advocates for changes to the training and equipment of command and control structures needed for the Marine Corps to have personnel and equipment ready to field an effective communications system for joint aviation command and control. Finally, this paper demonstrates that Marine Corps aviation C2 must change to support the

Marine Corps' role as the forward-deployed ground component of the Navy-Marine Corps team and the joint force ready to engage peer adversaries in the Indo-Pacific Command area of responsibility.

The Contested Communications Environment

The assumption of a permissive communications environment created problems for today's command and control systems. US supremacy in space, cyberspace, and the electromagnetic spectrum resulted in military communication practices that ignore concerns of enemy electronic warfare capabilities, as well as equipment optimized to provide as much information as possible. Over time, the Marine Corps established headquarters that capitalized on the advantages of constant communications under the assumption of a continually permissive communications environment. Based on the Marine Corps model of power projection and its focus on counter-insurgency operations, these large command posts were positioned in a place safely outside of an enemy's weapon range, providing command and control and higher echelon support to forward deployed forces. This created large, static, constantly emitting, and highly observable command posts.

The Marine Tactical Air Command Center (TACC) exemplifies this problematic model as the largest and most complex command post in the Marine Corps. The TACC is a large, static, node which constantly emits across several different pathways of the electromagnetic spectrum to provide a real-time common air picture. The TACC's communications are not flexible enough to fight against jamming, satellite destruction, network intrusion, or the destruction and manipulation of its data. Its communications emissions, lack of mobility, and large size makes the C2 node easily located in time and space.[3] Additionally, the TACC is designed to be stationed outside of key maritime terrain[4] where it organizes forces safely outside enemy weapon

range. It cannot move rapidly and is not designed with redundancy if it is destroyed; instead a different Marine Air Command and Control System (MACCS) agency fills its role in a limited capability. Additionally, as with all Marine C2 nodes, the TACC functions separately from joint C2 nodes with equipment that is not easily interoperable across different systems and platforms.

Mindset Changes

Communications Superiority

Whoever first achieves superiority in air, land, sea, space, or cyberspace, must plan for contested superiority with a fleeting advantage. A paradigm shift regarding how to fight for communications is needed now that the US no longer has space or cyber supremacy. Just as there is a difference in how to fight when the US has air supremacy versus air superiority, there is a difference in how to fight when the US has communications supremacy vs communications superiority. If an adversary has an air force, the US military responds by deploying fighter planes and anti-air missiles, contesting the air domain and gaining air superiority for periods of time to fly bombers against key enemy targets. The US military may not dominate space, cyberspace, and the electromagnetic spectrum in the present and future, but the US military must learn how to protect, maneuver, and fight for moments of superiority while concurrently fighting in the air, land, and sea domains. If the US military cedes space, cyberspace, and the electromagnetic spectrum in a moment in time and space, it could result in negative consequences to US forces. The most effective use of a contested domain is to combine arms to achieve an advantage at a moment in time.

The Marine Corps' long history of being forward deployed in austere conditions makes the service the perfect selection to become the joint force's experts in sensing and communicating in a denied and degraded environment within the enemy's WEZ. To compete

against an enemy seeking to deny the Navy's situational awareness and targeting capabilities, the Marine Corps must learn to fight for communications inside and outside of the electromagnetic spectrum. It may do so by leveraging technology such as passive sensors, free space optic technology, high frequency radio waves, and communications balloons to replace targeted satellite communications pathways. In this manner, the Marine Corps could serve as the littoral eyes and ears for the Navy in contested maritime waterways, fighting for communications superiority and integrating joint force multi-domain capabilities.

Decentralized Control and Push Information Flow

The proliferation of constantly connected communications technology in the commercial sector biased the military's understanding and expectation regarding what is feasible in military operations in a contested communications environment. The expectation of constantly being tactically connected formed biases that created centrally controlled Marine Corps C2 nodes. Over time as headquarters became more robust, decentralized control became devalued as the demand for information provided to higher echelons increased across the joint force. Technology that enabled the general staffs to watch actions on objection in real-time down to platoon-level, and the assumption that this technology cannot be disrupted, undermined practices that enable decentralized control.

This large demand for information created by a centralized organization allows the enemy to easily detect interconnected, forward deployed C2 nodes that emit constantly. To survive in this contested space, the Marine Corps must change its processes for decision-making and information flow, in a way that accounts for intermittent connectivity while exercising disciplined emissions control. If the Marine Corps maintains constant, predictable, static connectivity, adversaries will be more likely to identify and disrupt those communication links.

If adversaries maintain communications capabilities while disrupting US communications in an operational area, they can take advantage of their communications superiority to make rapid, accurate operational decisions. To communicate in this environment, the decision-making process must be decentralized, and senior commanders must trust subordinates to push required information for higher headquarters action.

Information management theory outlines two ways of initiating communications. *Supply-push* communications trusts subordinates at the forward edge to push information when necessary.[5] In contrast, *demand-pull* communications, requires subordinates to answer information requests from higher headquarters. Current Marine Corps communications procedures reflect the *demand-pull* model of information management. This model does not require decision-makers to anticipate what information they may need; instead, they will demand the information when they need it. This model may not work in a contested communications environment, for when the decision-maker demands the information, communications with the forward deployed C2 node may reveal that node's position. By changing to a *supply-push* model for information management, Marine Corps and joint force decision-makers need to recognize the minimum information required to make decisions and communicate those information requirements to the forward deployed C2 node in advance. Then decision-makers must trust forward deployed C2 nodes to "push" the information to them when able.[6]

The *supply-push* model of information management requires decision-makers to accept uncertainty and make decisions with incomplete and imprecise information, as the only way to manage information in a contested communications environment without potentially compromising the forward deployed C2 node. Once the Marine Corps changes its information management process to a *supply-push* model it must change its conceptualization of information

sharing. Instead of a linear hierarchy in which headquarters demand information, information management instead must reflect a networked organization, which pushes critical information across the webbed network.

Goodbye Service Linear Hierarchy, Hello Joint Webbed Networks

Marine Corps C2 nodes default to the *demand-pull* model due to two major concerns with the *supply-push* model. The first concern is that the model is more difficult, requires more planning in advance, and incurs more risk of making decisions in uncertainty.[7] There may be times where decision-makers do not have the required information to make a decision or emergent requirements based on enemy action were not anticipated. With the *supply-push* model, higher headquarters will need to trust that they gave appropriate information requirements to the forward deployed C2 node, and that the forward node can adapt to the changing enemy situation. There is also the risk a forward deployed unit may take bias for action and rapidly make decisions without synchronization from higher headquarters and waste limited resources. This legitimate concern cannot be solved by simply providing commander's intent and hoping for the best. Harmonizing actions throughout the organization is necessary to maintain the system.[8] A known, rehearsed information management process with expected, standardized information requirements must occur between C2 nodes during intermittent communications.

The organizational norms must change within the Marine Corps to ensure C2 nodes within the WEZ effectively communicate despite enemy actions to target and deny communications capabilities.[9] Instead of viewing the organizational chart as a block diagram with lines running vertical to depict command and control, the Marine Corps must view its nodes as a web, interconnected with other joint force webs. This concept of networked information flow is described as "shared consciousness" in Stanley McChrystal's *Team of Teams*.[10] Viewing

Marine Corps C2 nodes as a web with information flowing by *supply-push* will provide the best situational awareness with the most resiliency for the network. It is important to understand that the push of information is not just from the "bottom up" or "top down" but throughout the organization as a whole. This means that the entire joint force must move away from the *demand-pull* model of information sharing and manage its information in a planned way so those units closest to the adversary are passive receivers of "shared consciousness" transmitted in "windows of opportunity" to minimize their observability across domains. Unlike when McChrystal created this network through high-bandwidth video-teleconference to fight an adversary without advanced technology, this web must exist in a contested communications environment.

Doctrinally, the TACC espouses centralized command for planning and decentralized control to "generate the tempo of operations required to cope with the uncertainty of combat operations"[11] but this mindset must change from a linear hierarchy to a fluid information sharing network. Centralized planning for air operations to coordinate efforts makes sense in the paradigm of limited warfare power projection, but this type of planning will be detrimental during uncertainty of operations within a peer adversary's WEZ. The Marine Corps TACC Handbook recognizes this change, noting that its agency must create "decentralized networks instead of relying on a linear, centralized information hub for the distribution of a common operational picture, common tactical picture, air picture, and status of air missions."[12]

"Garrison Communications" No More

Over the past 30 years, the Marine Corps has treated space, cyberspace, and the electromagnetic spectrum as uncontested environments and focused its training on land-, air-, and sea-based maneuver problems. This view of the electromagnetic spectrum as an uncontested

environment is evident in joint doctrine where the extent of its management revolves around preventing interference from civilian host nation telecommunication pathways.[13] Garrison networks maintained by organizations outside those units using them create a disconnect between those operating on the network and those defending it. The prioritized acquisition of communications technology reliant on satellites to communicate anywhere in the world ignores concerns of adversary competition in space.

During joint training, spectrum conflict is especially noticeable when the US and host nation countries' spectrum restrictions do not allow Marine Corps communication equipment to function. Often, training events are so short that if the scenario "tactical" communications pathways are disrupted or denied, the Marines can continue on with the singular event without any communications until the end of the exercise. The length of most training events is somewhere between a few hours, for a single maneuver attack, up to a week of continuous operations in a field exercise; it is simple for the commanders to administratively pause or restart communications, or for information to be shared across separate instructor or evaluator communications pathways. Communication pathways are an afterthought to schemes of maneuver developed, and enemy templates are devoid of specifics on electronic or cyber warfare. Training in a contested spectrum environment where dynamic communications pathways are created, detected, jammed, and reconnected, is not rehearsed in conjunction with operations. Often the fear of the loss of training value in the physical maneuver event takes a higher priority, ignoring the threat today's adversaries bring to the communication environment.

As physical maneuver is prioritized, when communications are interrupted, communications pathways become assured through "garrison" commercial means like personal cell phones, or by decreasing the complexity of the use of tactical means, like talking over plain

text. Spectrum conflict within US or host nations training grounds is routinely solved with unsecured or unrealistic networks and simulations. This creates a mindset of using artificial communication paths to pass required information during the conduct of training, pathways which will not exist in real world scenarios. Marine Corps networks are often considered tactical in the field where Marines have permissions to install, operate, and maintain such networks. If Marines in the unit are qualified, they also have the ability to assist in local defense of the network. Conversely, in the office, Marine workstations are connected to the "garrison" network where the unit's communications Marines have little to no ability to manage the network or identify network intrusions or data manipulation.

To compete with peer adversaries in a contested communications environment, Marine leaders must stop viewing communications in garrison differently from a field training environment. "Garrison" cyberspace networks have been subject to constant attack for almost 30 years. All networks are vulnerable and should be thought of holistically. China's development of the Strategic Support Force allows for ease of transition of operations from peacetime to wartime for the related domains of space, cyber, and the electromagnetic spectrum.[14] The Marine Corps cannot train with constant communications and then hope to fight effectively against a peer threat when denied communications altogether. The Marine Corps must "train as we fight."[15] Marines use different equipment to communicate in garrison (commercial cell phones), in the field (tactical UHF/VHF radios), or on deployment (high demand satellites). The only similarity between these different paths is the assumption Marines make about their communications—that they are secured and will be available for use at any time, or if they do not work it will be inconsequential to mission accomplishment. This assumption is not only false but will be detrimental to the Marine Corps winning future battles.

Distributed Maritime Operations and Expeditionary Advanced Base Operations

As the world becomes more interconnected, the US military recognizes the requirement to operate in a distributed environment. The Navy recognizes the importance of Distributed Maritime Operations (DMO) in today's operational environment. DMO aligns with the maritime strategy of Julian Corbett, who described a method of disputing command at sea through "a fleet in being." He describes this idea as a mobile defense, prepared to "dispute the control by harassing operations, to exercise control at any place and at any moment as we saw a chance, and to prevent the enemy exercising control in spite of his superiority by continually occupying his attention."[16] Although DMO states it is offensive, it is more accurately described as something similar to how Corbett described the "fleet-in-being" as constantly counter-attacking. Corbett identified the naval forces needed to constantly harass, counter-attack, and fight aggressively, targeting both enemy forces and maritime communications.[17] DMO seeks to improve the Navy's lethality in contested maritime environments by distributing its forces but maintaining its ability to mass effects through integration.[18]

The Marine Corps continues to develop a concept in line with the Navy's Distributed Maritime Operations (DMO) concept called Expeditionary Advanced Base Operations (EABO). The general idea of EABO is for the Marine Corps to provide forces to control key maritime terrain in a region of maritime competition to support the Navy conducting DMO. The definition of "key maritime terrain" is an essential element of understanding the EABO concept. Key maritime terrain is defined as "any landward portion of the littoral that affords a force controlling it the ability to significantly influence events seaward."[19] By exploiting the opportunities afforded by key maritime terrain, EABO concept seeks to posture forces to gain an advantage

within an enemy's weapon engagement zone, enable sea control, and provide credible deterrence to a *fait accompli*.[20]

A Communications Concept for EABO

The DMO concept requires decentralized command and control[21] and the EABO subordinate concept calls for a low-signature force.[22] Nevertheless, neither concept discusses addresses how the naval force should resolve the simultaneous problems of contested communications within the contested maritime domain. Currently, the Department of Defense (DOD) identified the cyber and space domains as separate warfighting domains and the responsibility of US Cyber Command and US Space Command, respectively. Forward deployed commanders must understand that in a contested maritime environment, local communications pathways will be contested and the joint force unable to rely on those known, targetable, communication pathways.

A contested electromagnetic spectrum and space environment means the Marine Corps must plan for communications under two assumptions. First, the adversary seeks to identify C2 nodes through the electromagnetic spectrum for collection, jamming, and targeting. Second, the adversary will target known satellite constellations to deny their use. The Marine Corps should seek options to communicate using space-based pathways from the troposphere to the thermosphere layers of the atmosphere and change the expectations of how C2 nodes communicate.

Building a C2 node under the assumption the adversary is looking for you means the node should focus on passive methods of communication, radiate minimally, and create distance from the node and the transceivers. The C2 node should endeavor to hide within the ambient electromagnetic spectrum of its environment to minimize risk of detection. In this environment,

C2 nodes must be small, mobile, and camouflaged to make visual identification more difficult if the node is found through its signature. Marine Reconnaissance units, skilled in communications deception at long ranges away from headquarters elements, developed the tools required to pass information in a communications contested environment. Some tools include establishing communication windows, brevity codes, and mission type orders, and integrating these tools throughout joint and coalition forces. All Marine Corps C2 nodes must develop the mindset of a reconnaissance unit inside the enemy WEZ and plan for intermittent communications driven by the contested communications environment. Adjusting to a *supply-push* model of receiving information then allows nodes to go silent for longer periods of time to avoid detection.

Deceiving the adversary to prevent identification of the C2 node is another critical component of communications planning in this new environment. A historic example of successful military deception is Operation Quicksilver, a World War II operation using radio signals, instead of troop formations, as an integral part of the plan to deceive the Germans of the Allied troop landing for D-Day.[23] Instead of simply trying to hide all the C2 nodes on the battlefield, a method of deception includes introducing decoys to complicate the adversary's identification process. Additionally, C2 nodes would need to pre-plan ways to establish communication pathways in new areas of the electromagnetic spectrum to avoid using the same spectrum for long periods of time and provide options to adjust once compromised. The concept of swarming seeks to overwhelm the adversary's targeting ability by creating constantly moving C2 nodes that dynamically connect.[24] Regardless of whether the nodes are static or aerial movers, operate individually or within a swarm, there must be deliberate measures taken to deceive the adversary into misidentifying the C2 nodes.

Another method to increase the survivability of those C2 nodes within the WEZ is to identify key "communications maritime terrain." This terrain is defined as land that affords a force controlling it the ability to communicate to distributed forces in the maritime environment through low-signature, terrestrial communications pathways. Doing so with present-day technology is similar to how communications retransmission sites were used to extend the range of Very High Frequency (VHF) communications links, these nodes located on key communications terrain must relay messages and support multiple links at one location. These nodes should be mobile, equipped to communicate over multiple pathways in a dynamic fashion, and prepared to adjust to communication windows of opportunity. Identifying and deploying Marines to these key communications maritime locations provides flexibility in transmitting or receiving key information from the joint force in a contested communications environment. Doing so, moreover, nests within the EABO concept. Fluid communication pathways and intermittent communications seek to promote decentralized command and control, identify the minimum information requirements for a commander's decisions, and most importantly maintain the advantage of information against an adversary.

C2 nodes within line of sight, or within 30 miles of each other, should use communications pathways that reduce or eliminate the electronic signature. An example of such a pathway is free space optics (FSO), which uses the visible light portion of the electromagnetic spectrum to establish communications links instead of VHF or UHF radio waves (see Appendix 1). FSO is an example of communicating outside the known military frequencies of the electromagnetic spectrum to reduce the likelihood of detection.

Key communications terrain may be located beyond the line of sight of C2 nodes within the WEZ, but the Marine Corps should use satellite-based communications systems to

communicate over the horizon with caution. Current satellite systems are easily identifiable due to their high-power output and require use of limited satellite assets not under USMC control that are routinely provided to higher priority DOD missions. Instead of satellite communications, the Marine Corps should invest in beyond line of sight communications methods that do not require the use of satellites, such as methods used by ham radio operators, troposcatter links, communications balloons, and unmanned aerial platforms. A major concern with these methods today is their intermittent nature; however, intermittent communications must be expected and planned for in a contested communications environment. By planning the times these communications pathways are established in advance, adversaries will be less likely to intercept and identify these C2 nodes which, from the adversary's perspective, seem to establish and disestablish links in an erratic manner.

Communicating beyond line of sight is important for aviation C2 because of the long distances covered by aircraft. While Marine Corps doctrine espouses that Deep Air Support (DAS), in particular Air Interdiction (AI), is designed to conduction missions with intermittent or no communications,[25] Joint doctrine on the subject requires communications for integrating joint operations at the macro-level.[26] The difference is scope in planning. Aviation operations for the joint force covers a much more significant distance where resource allocation and force flow are more important because they are less easily adjusted. If conducting offensive counterair operations against a peer adversary distributed across a wide area of operations without C2, opportunities can be missed to dynamically re-task and integrate Air Force or Naval air forces to take advantage of an opening in the WEZ. Having satellite-denied and degrade communication pathways are more critical when conducting these operations against a peer adversary because they are more capable of placing aircraft in positions where they cannot communicate.[27]

To sustain C2 nodes forward deployed in key maritime terrain, the Marine Corps must invest in less costly, unmanned technology to facilitate the transition to a smaller, more self-reliant force. The old paradigm of power projection caused a growth of expensive ground programs of record, which relied on technical experts and centralized control to operate. The Marine Corps should move away from these expensive systems that require strict accountability and protection from loss. To do so, the Marine Corps should experiment with inexpensive technology that lacks a maintenance trail to support its functionality. Integrating unmanned technology, such as unmanned aircraft systems which are smaller, less expensive, and pose less risk if lost than a manned aircraft used for aviation C2, will allow the Marines to be more agile and deadly when facing a surface threat.[28] Disposable equipment should be sought after, which can be bought, used, and discarded by junior leaders forward deployed in austere environments.

In addition to the large associated cost with the current equipment, Marine Corps procured equipment does not operate automatically with joint and allied partners. Instead of having its own acquisition process to advocate for service specific requirements, the Marine Corps should posture itself as the naval service's experimentation capability and coordinate its acquisitions through the joint force to ensure interoperability, reducing stove-piped equipment that does not communicate with Navy or Air Force aviation C2 systems. To be an effective part of the joint force, the TACC's equipment needs to be interoperable.

What can Marine Aviation C2 provide to Navy-Marine Corps Operations and the Joint Force?

Marine aviation C2 must change to support the Navy's DMO concept and the Marine Corps' EABO concept, but the Marine TACC must do more than just serve as the land-based aviation C2 node for the Marine Corps and the Navy. The Marine TACC should serve as the

forward deployed C2 node that integrates the Navy, Marine Corps, and Air Force in the distributed, maritime environment. Marine Tactical Air Command Squadron 38 (MTACS-38) demonstrated this capability during Air Force Exercise Red Flag 19-3.[29] The first time in the exercise's history where Marines were the lead Air Operations Center, integrating Air Force, Navy, Army, Marine, and Coalition aviation in a large-scale exercise. The Marines were widely praised by the Air Force evaluators and the MTACS-18 Commanding Officer, Lieutenant Colonel Grant Clester stated the exercise demonstrated "the Marine TACC is scalable and flexible enough to assume the responsibilities of a CAOC (Combined Air Operations Center) and enable a Joint Force Air Component Commander."[30]

The Air Force recognizes the need to conduct distributed operations in a contested environment and advocates for modifying its command and control system for more decentralized control of air operations.[31] This would change control from a single Joint Air Operations Center (JAOC) to multiple C2 nodes,[32] potentially dividing the operating area into multiple geographic sectors based on the risk of communications disruptions between the forward C2 nodes and the JAOC. [33,34] Former Commander of Air Combat Command, and former US Central Command CFACC, General Hostage III, advocates for decentralized control and implementing procedures for intermittent communications.[35] Pacific Air Force (PACAF) also considered delegating conditional authorities for air operations at the wing-level.[36] The Marine TACC is a wing-level C2 node, so the simple solution to these concerns from the Air Force would be to designate the Marine TACC as a wing-level C2 node with conditional AOC authorities and use the Marine TACC as a model for austere Air Force wing-level AOCs. Most notably, if the Marine TACC changes its current employment to operate within the Marine Corps' EABO concept and the contested communications principles discussed in this paper, the

Marine TACC will become an example of a resilient C2 node, forward deployed and operating in a contested communications environment.

The CJFACC should delegate to the TACC through the concept of distributed control, defined as the "conditional, adaptive delegation of assumptions of control activities through orders or protocols to synchronize operations, maintain initiative, and achieve commanders intent."[37] Although the Air Force's familiarity with the concept is typically single service centric, the same concept could be interservice where the CJFACC delegates AOC control activities to the TACC to support the CJMCC in key maritime domain within the enemy's WEZ. This would be done under conditions, such as the CJFACC or NTACC losing the ability to communicate. If the Marine Corps makes the changes addressed in this paper, the TACC would become something new, able to assist in the command and control of aviation operations against a peer competitor and allow for the naval force to understand the common air picture, despite the difficulties of doing so in the Pacific. This new, Evasive Naval AOC would be poised to serve as a forward-deployed C2 node that could provide command and control when larger, static, C2 nodes are targeted and denied the ability to communicate.

For the Marine TACC to serve as a forward AOC, while operating under the concept of EABO, the Marine Corps needs equipment that meets joint force interoperability requirements. Stove-piped legacy C2 systems[38] is one of the largest problems with equipment interoperability within the joint force today and is a high priority concern for all services.[39] The Air Force developed Open Mission Systems, a non-proprietary open system architecture meant to push acquisition and business models away from legacy stove-piped solutions for Unmanned Aircraft System (UAS) Command and Control Initiative (UCI) and the Common Mission Control Center (CMCC) program.[40] The Navy and Marine Corps should ensure interoperability with their UAS

and C2 systems on this common OMS architecture. Creating a common set of standards across the joint force, as the Air Force has attempted, and then requiring industry to have "conformance to the standard" will prevent the Marine TACC's Common Aviation Command and Control System (CAC2S), and newer technologies, from communicating only through extensive architecture changes by communication technicians. Marine Corps Aviation C2 systems must be "plug and play" interoperable with Air Force and Navy systems, and cannot require special cabling, data translation, or other methods of work arounds to get the systems to communicate with each other. To do this effectively, the Marine Corps must stop creating service specific systems that are interoperable with other joint systems[41] and instead require systems conform to a joint standard.

The benefits of having an Evasive Naval AOC acting as a forward AOC in key maritime terrain are critical to the Combined Joint Force Maritime Component Commander (CJFMCC) in the Pacific theater. As the Marine Corps specializes in littoral operations, adversary weapons would likely less target this ground-based capability compared to a naval ship or aviation C2 platforms. Being a mobile C2 node operating in an expeditionary environment provides the joint force flexibility in placement compared to the static, hardened AOCs currently in place by the Air Force. Although smaller in capacity than an Air Force AOC, the Evasive Naval AOC maintains the same standards of joint aviation command and control and as a Naval AOC has the added benefit of being integrated within the CJFMCC naval forces in the maritime theater.

Conclusion

The Marine Corps must change the way it views command and control in today's contested communications environment. Marine Corps C2 nodes must be intermittent, deceptive, networked, able to operate within the enemy's weapon engagement zone, and interoperable with

joint C2 nodes to provide specific information requirements to inform a commander's decision. Over the past few decades, an entire generation of officers and staff non-commissioned officers progressed through their careers with a mindset of communicating to whomever they needed to at any time and figuring out what information they need to make decisions when the information comes. This mindset change must start with the Marine TACC, which can become a forward, hidden, conditional AOC: The Evasive Naval AOC.

The Evasive Naval AOC must undergo many changes from today's TACC to survive in the contested communications environment. The Evasive Naval AOC should distribute its key elements outside of enemy weapon's effective casualty radius and connect them through technology such as free space optics to avoid producing detectable signatures. Additionally, it must practice passive methods of communication radiating minimally, seeking to deceive the adversary through decoys, and hiding within the ambient electromagnetic spectrum of its environment to avoid detection. By becoming small and more mobile it will provide the joint force a flexible AOC, less targeted than high value aerial C2 platforms or static, high-signature headquarters. By planning in advance ways to establish communication pathways in new areas of the electromagnetic spectrum to avoid using the same spectrum for long periods of time and provide options to adjust once compromised, the Evasive Naval AOC will effectively hide within the spectrum. By maintaining self-controlled options like balloon based communications the Evasive Naval AOC will maintain an aviation C2 capability in a satellite denied and degraded environment. The Evasive Naval AOC, as a contingent aviation command and control capability, provides increased flexibility in decision-making by creating a professional C2 node prepared to conduct aviation C2 under the most denied and degraded communications situation. This type of

capability is vital for the Navy and Marine Corps team if conducting aviation operations against a peer adversary within a WEZ.

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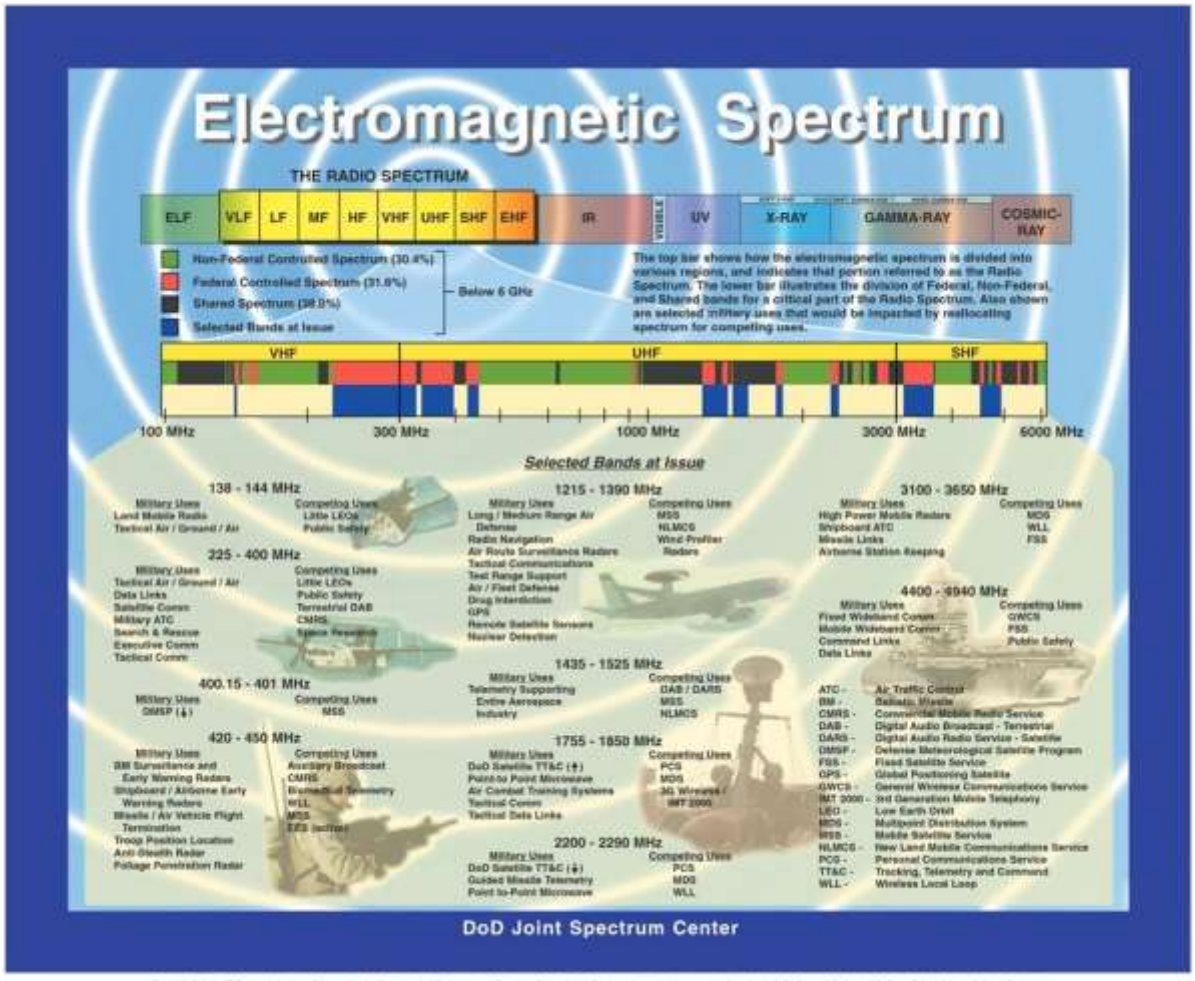
Appendix:

1. Typical military communications equipment operates within the radio spectrum, where free space optics operate within the visible light portion of the electromagnetic spectrum.



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