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Marines conducting EABO in austere locations need high-bandwidth, low-latency, low earth orbit (LEO) constellation satellite internet to immediately request and transact logistics support using logistics C2 platforms. While military SATCOM has been available for over two decades, it was scarce due to the technological limitations of the time. The newest SATCOM project is widely available low earth orbit constellation satellite internet that can provide persistent, high bandwidth low latency internet anywhere on earth, including EABs with no infrastructure. LEO constellation satellite internet should be the Marine Corps' solution to the otherwise impossible use of its logistics C2 platforms in EABO.

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MASTER OF MILITARY STUDIES

**LOGISTICS COMMAND AND CONTROL (C2)
IN EXPEDITIONARY ADVANCED BASE OPERATIONS (EABO):
LOGISTICS C2 PLATFORMS NEED PERSISTENT SATELLITE INTERNET**

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

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AY 2020-21

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Executive Summary

Title: Logistics Command and Control (C2) in Expeditionary Advanced Base Operations (EABO): Logistics C2 Platforms Need Persistent Internet

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Thesis: Marines conducting EABO in austere locations need high-bandwidth, low-latency, low earth orbit (LEO) constellation satellite internet to immediately request and transact logistics support using logistics C2 platforms.

Discussion: The Marine Corps redesigned its forces to be most lethal against a peer adversary by conducting EABO inside the adversary's Weapons Engagement Zone (WEZ). The corresponding logistics C2 model is that the smallest-sized Marine units in the middle of nowhere and without infrastructure must be able to immediately coordinate with supporting units located as far as the other side of the world. Immediacy in coordination requires internet connectivity to both supported and supporting units. The primary Marine Corps logistics C2 platform that connects to supported and supporting units is Global Combat Service Support-Marine (GCSS-MC). GCSS-MC consumes so much of the Marine Corps' encrypted network and internet bandwidth that it will not work in scarce-internet environments such as an EAB. The root problem is that reliable internet is not available in austere locations to communicate logistics requests in the first place. Currently fielded military satellite communications is insufficient for GCSS-MC connectivity in EABO. Low earth orbit (LEO) constellation satellite internet is the best option for logistics C2 platforms in EABO. The DoD is already investing in LEO satellite constellations, and the Marine Corps should quickly become a consumer.

Conclusion: While military SATCOM has been available for over two decades, it was scarce due to the technological limitations of the time. The newest SATCOM projects such as SpaceX's Starlink is widely available low earth orbit constellation satellite internet that can provide persistent, high bandwidth low latency internet anywhere on earth, including EABs with no infrastructure. LEO constellation satellite internet should be the Marine Corps' solution to the otherwise impossible use of its logistics C2 platforms in EABO.

DISCLAIMER

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LIST OF ACRONYMS

AFNET - Air Force Intranet
C2 - Command and Control
CLC2S - Common Logistics Command & Control System
DEUCSI - Defense Experimentation Using Commercial Space Internet
DISA - Defense Information Systems Agency
DMO - Distributed Maritime Operations
EAB - Expeditionary Advanced Base
EABO - Expeditionary Advanced Base Operations
IMLCI - Item Master Logistics Capability Initiative
ISR - Intelligence, Surveillance, and Reconnaissance
JIE - Joint Information Environment
LAAB - Littoral Anti-Air Battalion
LCT - Littoral Combat Team
LEO - low earth orbit
LLB - Littoral Logistics Battalion
LOCE - Littoral Operations in a Contested Environment
FOC - fully operating capability
GCSS-MC - Global Combat Service Support-Marine Corps
GEO - geosynchronous earth orbit
MARCORLOGCOM - Marine Corps Logistics Command
MCEN - Marine Corps Enterprise Network
MCTSS - Marine Corps Tactical Systems Support
MEB - Marine Expeditionary Brigade
MEF - Marine Expeditionary Force
MLG - Marine Logistics Group
MLR - Marine Littoral Regiment
MPF - Maritime Prepositioning Forces
MPSRON - Maritime Pre-positioning Ship Squadron
MUOS - Mobile User Objective System
NETCOM - Army's Network Enterprise Technology Command
NMCI - Navy Marine Corps Intranet
NOBLE - Naval Operational Business Logistics Enterprise
NOSS - Naval Operational Supply System
OCS – Operational Contract Support
pLEO - proliferation of low earth orbit
SATCOM – Satellite Communication
TCPT - Transportation Capacity Planning Tool
USTRANSCOM - US Transportation Command
WEZ - Weapons Engagement Zone

Preface

This research topic is sponsored by the Marine Corps Warfighting Laboratory in Quantico, VA. The sponsored question is: “How will Logistics C2 Platforms like Global Combat Support System-Marine Corps (GCSS), Combat Logistics Command and Control System (CLC2S), and Transportation Capacity Planning Tool (TCPT) work in EABO?” This question is a part of the larger research about how to conduct logistics in support of the Marine Corps Force Design 2030.

Introduction

Even the most prepared and self-sustaining hikers will run into unplanned logistics requirements when they go camping in austere locations. For example, if their tents are attacked by enemy fires, the hikers will need to order tent-repair supplies from Amazon.com, a retail platform. If they need to move their campsite to hide their location from the enemy, they will need to order transportation out of the woods from their smartphone's Uber application, a ride-hailing platform. But as anyone who camps knows, there is little to no internet connectivity in austere locations. Without internet connectivity, the most easy-to-use smartphone applications are useless. These smartphone applications are analogous to command and control (C2) platforms that Marines use to manage and coordinate logistics support to operating forces.

In Expeditionary Advanced Base Operations (EABO), Marines establish temporary campsites with missiles at austere locations such as uninhabited islands. Marines in EABO face the same logistics predicament as hikers sans internet: no communications connectivity. The problem is that Marines cannot effectively use Marine Corps logistics C2 platforms to coordinate logistics support to and from Expeditionary Advanced Bases (EABs). Marines conducting EABO in austere locations need high-bandwidth, low-latency, low earth orbit (LEO) constellation satellite internet to immediately request and transact logistics support using logistics C2 platforms.

Marine Corps Force Design Context

Marine Corps logistics is modernizing to support the Marine Corps' Force Design 2030. Secretary of the Navy Kenneth Braithwaite and the service chiefs of the Navy, Marine Corps, and Coast Guard published their Tri-Service Strategy in December 2020 which explains America's strategy for naval warfare in modern great power competition against China and Russia.¹ Instead of conventional naval warfare from WWII and prior wars where ships faced off in battles at sea or forces landed on an objective inland from the sea, the modern strategy combines new concepts which requires new technology and tactics. Naval forces now fight in Distributed Maritime Operations (DMO) by way of the related Littoral Operations in a Contested Environment (LOCE) and Expeditionary Advance Base Operations (EABO). DMO, LOCE, and EABO together "combine the effects of sea-based and land-based fires, enabling our forces to mass combat power at times and places of our choosing."² The Tri-Service strategy's goal is for America's military forces to be a credible deterrence against peer competitors that preserves its advantage at sea.³

The Marine Corps' contribution to the Tri-service Strategy is primarily in EABO. Three months after the Tri-Service Strategy was released, the Marine Corps published its *Tentative Manual for Expeditionary Based Operations*. In it, EABO's definition is to operate in "austere, temporary locations ashore or inshore within a contested or potentially contested maritime area in order to conduct sea denial, support sea control, or enable fleet sustainment."⁴ The following depiction of EABO is an arrangement where the "stand-in force" is located inside the Weapons Engagement Zone (WEZ).

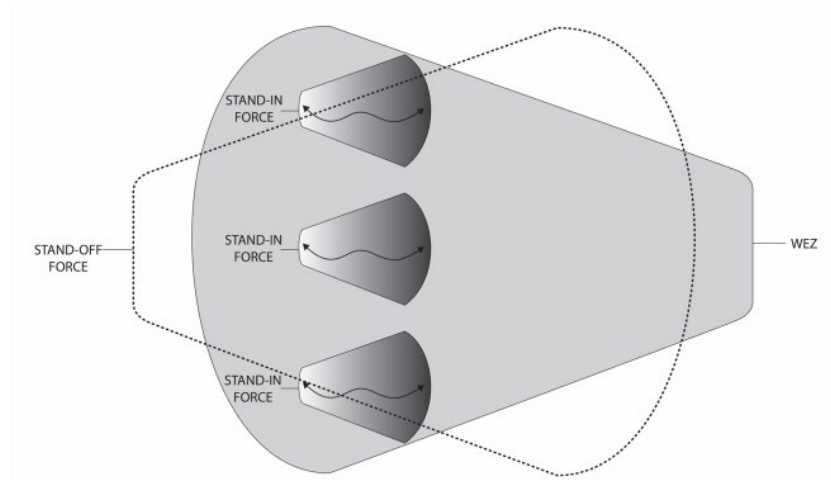


Figure 1: Idealized Conceptual Depiction of Stand-Off and Stand in Engagement⁵

A WEZ is a weapon system’s bubble of space in which it can effectively hit a target. A modern peer competitor's long-range weapons located near Taiwan can range well past Japan and the Philippines, all countries that are inside the peer competitor’s WEZ. Inside the WEZ is where the adversary could use a long-range missile and layer multiple forms of Intelligence, Surveillance, and Reconnaissance (ISR) and mass fires. An EAB is a dispersed, hard-to-target forward base inside an adversary’s WEZ.⁶ An EAB will have low-signature infrastructure, possibly at austere locations like sparsely inhabited islands within weapons range of the adversary.⁷ A unit operating "inside" and "outside" the WEZ is specific to the EABO concept which defines capability, not distance.

A unit that can get close enough to do local sea-denial will have to operate in that WEZ. The Marine Corps redesigned its force in 2020 called “Force Design 2030” to be more lethal against a peer adversary by operating inside the adversary’s WEZ.⁸ The new unit in the Force

Design 2030 that is supposed to operate inside the WEZ is called the Marine Littoral Regiment (MLR).⁹

Marine Corps forces located in Japan, in the EABO context, is not close enough to the adversary to project a sea denial effect inside the WEZ. Instead, small teams of Marines can deploy from Japan and land on remote dispersed islands well-inside the adversary's weapons range and be close enough to conduct temporary local sea denial in support of a naval campaign. This construct of deployable small teams is the cornerstone of the MLR's structure; the MLR's subordinate units are the Littoral Combat Team (LCT) that sends small teams to EABs to conduct local sea-denial, a Littoral Anti-Air Battalion (LAAB) that sends small teams for local air control, and a Littoral Logistics Battalion (LLB) that provides tactical logistics support to the LCT and LAAB. The LLB is the MLR's organic logistics coordinator and provider for the small teams on remote dispersed islands.¹⁰

The Littoral Logistics Battalion (LLB) strives to sustain combat forces inside an adversary's weapons reach, as military logistics always have in conventional wars fought before and during the Global War on Terrorism. However, the LLB's sustainment of the MLR's operations in an EAB comes with its own set of problems. The *Tentative Manual for EABO* identifies that effective sustainment to EABO "extends operational reach" and enables persistence of "decentralized forces throughout the littorals."¹¹ EABO logistics is different than conventional warfare logistics in several ways. First, EABO logistics elements would need to support the constant yet unpredictable relocation of forces from one maritime EAB to another. Second, tactical logistics support must be inside key maritime terrain to austere islands with minimal local infrastructure. Third, the resupply operations will be conducted with a new focus on survivability inside the adversary's WEZ, so resupply operations will likely be by air drops,

submarines, unmanned delivery vessels, smaller-sized naval vessels such as Light Amphibious Warships (LAWs), and foraging (such as using local merchant boats for delivery). Sustainment operations inside an adversary's WEZ are not survivable if they are as slow and as predictable as sustainment operations in conventional wars. Furthermore, conventional supply points and cache sites are vulnerable and require their own security forces. If EABO had supply points and cache sites, they cannot have their own security forces because forces operating in EABO cannot remain in the same locations. To support these MLR-specific requirements, the LLB's command and control (C2) of its organic capabilities and with other reinforcements needs to be faster than ever before.

The MLR's composition and mission require the Littoral Logistics Battalion (LLB) to adopt a form of command and control that is more responsive than conventional command and control currently structured for conventional forces, where a support request must go through several layers of coordination before reaching the support provider. To be immediately responsive, the LLB's command and control must be adaptable and flexible enough to allow subordinate units to operate independently of higher headquarters, but also be secure and reliable enough for changes to the mission to be communicated quickly and effectively. It must also be resilient and sustainable inside an adversary's WEZ and across a variety of missions and the great distances over which the MLR will be operating. The *Tentative Manual for EABO* also suggests that to be resilient and sustainable, both supported and supporting forces must be lighter.¹² To lighten the load, forces must pack light enough of just only bare necessities and without prepositioning stockpiles, which inversely increases the requirement for resupply missions to sustain these forces for longer than a few days. For resupply missions to be immediate yet unpredictable, the speed of support request transactions must be fast enough to

enable on-demand delivery. Commercial on-demand services like car-hailing through the Uber application and grocery delivery through the Amazon Now application can be tracked in real-time when users are enabled by 4G internet connectivity. In contrast, the Marine Corps logistics services currently cannot be on demand nor in real-time through their C2 platforms for lack of constant internet connectivity.

Logistics support command and control in EABO is different than in conventional wars. Support for future EABO needs C2 to coordinate faster and through fewer layers of bureaucracy between supplier and end user. The effectiveness of the currently available logistics C2 platforms such as Global Combat Service Support-Marine Corps (GCSS-MC) in deployed environments depends on the user's internet reliability; GCSS-MC loads slowly or does not load at all if the internet is high latency (slow) or intermittent (breaks in connectivity). New space satellites technology makes deployments possible to have constant high-bandwidth low-latency internet in places that do not have any infrastructure, like in the middle of the ocean, for example. GCSS-MC works well when connected to reliable internet such as the high-bandwidth and low-latency satellite internet.

In EABO, the LLB's command/support relationships require immediate connectivity to both supported and supporting units. The LLB's C2 with supported units down to the LCT small team level must be able to communicate unpredictable sustainment or transportation requests from austere environments to coordinate immediate movement control plans, resupply, and maintenance. Although the LLB is designed with enough capabilities and supplies to organically support the MLR in most operations, the rest of the Marine Corps provides additional support. Like Amazon.com draws from its own network of warehouses and contracted companies for its

ultrafast delivery anywhere in America, the Marine Corps' own logistics network is a web of mutually supporting Marine units around the world.ⁱ

In practice, the LLB would need dependable communication with supporting units of its higher commands, such as the Marine Expeditionary Brigade (MEB) and Marine Expeditionary Force (MEF), tactical-level logistics providers already at sea such as Marine Expeditionary Units (MEUs) and other Marine Air Ground Task Forces, and operational-level global logistics from Marine Corps Logistics Command (MARCORLOGCOM). An example of how the LLB would need support from the MEF is that the LLB does not have organic transportation structure yet that can conduct beach landings.ⁱⁱ The nearest Landing Support Battalion which is a part of the MEF can employ beach landings for the LLB if coordinated through the MEF. LLB would need to establish and maintain stable C2 with the MEF to quickly coordinate beach landing support for unpredictable movements in the littorals.

The LLB will also need to communicate with external sources of support, most of which are operating outside of the adversary's WEZ. Using the description of Amazon.com again, when a customer orders an item that is not in any of Amazon's own warehouses, the item is sourced from one of its external sources that are already linked to Amazon.com's website and delivered by contracted delivery services.ⁱⁱⁱ The MLR's operations are in support of fleet

ⁱ Selyukh, Alina, *Optimized Prime: How AI And Anticipation Power Amazon's 1-Hour Deliveries* (November, 21, 2018), <https://www.npr.org/2018/11/21/660168325/optimized-prime-how-ai-and-anticipation-power-amazons-1-hour-deliveries>. Amazon.com uses artificial intelligence to identify the nearest location of a purchased item from the buyer, move the item robotically in the warehouse to shipping, and coordinate contracted drivers to deliver the item in under an hour.

ⁱⁱ Fuentes, Gidget, *'Red Patch' is Back As Reactivated Landing Support Battalions Rejoin Fleet Marine Forces* (October 23, 2020), <https://news.usni.org/2020/10/23/red-patch-is-back-as-reactivated-landing-support-battalions-rejoin-fleet-marine-forces>; Winthrop, *Force Design 101*. The LLB is designed from the structure of a Combat Logistics Battalion (CLB), made up of companies of bulk fuel, engineering, food service, heavy equipment, maintenance, motor transport, and landing support. However, the Landing Support Battalions recently reactivated in late 2020 which absorbed landing support companies from CLBs. As a result, beach landing support resources are pooled together and can in general support to a more variety of Marine Corps units, including the LLB.

ⁱⁱⁱ Stone, Brad, *The Everything Store: Jeff Bezos and the age of Amazon* (New York: Little, Brown and Company, 2013), 82. Amazon.com's business model evolved where the company bought or contracted with those outside

campaigns, so they are inextricably linked to fleet forces. The LLB will have to tap into the Navy logistics enterprise more than it does now because of the MLR's operational relationship with the Fleet. The highest echelon in support of fleet forces include the Maritime Prepositioning Forces (MPF) which supports all Joint forces.¹³ The MPF are ships forward deployed with all classes of supply coordinated by US Transportation Command (USTRANSCOM) in support of the Combatant Commander. An example of the coordination that starts at the MLR requesting support from a Maritime Pre-positioning Ship Squadron (MPSRON) is a long chain that is reliant on the speed of connectivity: The MLR in Japan submits a request for specialized medical supplies from III MEF in Japan, who forwards it to PACFLEET in Hawaii, who forwards it to INDOPACOM in Hawaii, who then coordinates with USTRANSCOM in Illinois, who directs the MPSRON at sea in the Pacific Ocean to deliver the specialized medical supplies to the MLR. Such a coordination chain is so long that for the MLR to receive external support from the MPSRON within a few days, its request to the MPSRON would need it processed nearly immediately at every level.

The *Tentative Manual for EABO* envisions that “the littoral force’s concept of support should aim to flatten the logistic and sustainment networks as much as possible, with logistics assets at the operational level providing logistics directly to end users when feasible.”¹⁴ The tangible requirement to flatten the sustainment network is the physical ability for operational-level provider (at the Combatant Command level) and the end user (the LLB) to communicate directly with each other. Having unbroken fast internet and automated supply sourcing would enable immediate processing of logistics requests even outside of the Marine Corps.

companies such as Toys-R-Us, Zappos.com, Whole Foods, and now hundreds of other companies, so that the purchase is directly through Amazon.com but delivered by the contracted companies.

Other external logistics are the civilian industrial base, partners and allies, host nation organizations, and local markets. The *Tentative Manual for EABO* considers “a foraging skillset enabled by micropurchases” by way of operational contract support (OCS) as a way for the lowest level of operators to sustain themselves.¹⁵ To facilitate OCS at the lowest unit level, the LLB would have to pre-screen suppliers, arrange for legal methods of payment, and otherwise pre-coordinate all steps for micropurchases on behalf of the lowest operational unit. Such local non-DoD and non-U.S. sources of support rely on mutually accessible platforms and networks for coordination.

The Marine Corps must use unclassified information systems to coordinate with non-DoD and non-U.S. suppliers, as they do not have access to the DoD Information Network. In conventional wars, logistics functions such as supply, deployment and distribution, and contract support were heavily coordinated across unclassified networks (e.g., commercial air/sealift, Class I-IX requirements, contracts in support of Joint force requirements). Ideally, in future wars, the source of stable internet to transmit logistics coordination in EABO can host both classified and unclassified communications so that all sources of support can feasibly connect while still complying with cybersecurity requirements.

The EABO Logistics Problem

Marine Corps logistics is coordinated on web-based platforms that require internet connectivity; but in EABO, there is currently little to no internet connectivity. The primary Marine Corps logistics C2 platform that connects to supported and supporting units is Global Combat Service Support-Marine Corps (GCSS-MC). A logistics C2 platform is the communication medium and database between the supported and the supporting units. GCSS-

MC is an Oracle web-based logistics C2 platform used on unclassified networks.¹⁶ Marines—commanders, end users, and combat service support personnel—all use GCSS-MC as a platform like private citizens use the commercial websites and applications like eBay.com and target.com to communicate transactions and track available supply stockage in their stores. Every piece of Marine Corps military supply is coordinated and tracked through GCSS-MC. Marines must use GCSS-MC to request (like a purchase transaction), track (e.g., location, maintenance status), and return supplies (e.g., redistribution, upgrade, or disposal).

Even more than commercial platforms, GSS-MC is also the platform where maintainers record every maintenance and usage action for every piece of supply. GCSS-MC, as repository of maintenance information, can encapsulate material readiness statistics of each unit. There are other Marine Corps logistics C2 platforms such as Common Logistics Command & Control System (CLC2S, a logistics support requests tracker), the Transportation Capacity Planning Tool (TCPT, for transportation management), and good old-fashioned Microsoft Outlook email that are much smaller in scale than GCSS-MC.¹⁷ Because these platforms have the same infrastructure requirements as GCSS-MC, the same connectivity issues and solutions apply to them as well; for this analysis about logistics C2 platforms connectivity, this case of GCSS-MC can substitute any logistics C2 platform.

The infrastructure required for GCSS-MC and other C2 platforms are 1) laptops to host the platforms and 2) high-bandwidth low-latency internet connectivity to exchange information with supported and supporting units. Internet usage is limited by how much bandwidth can be processed and travel from one place to another. C2 platforms such as websites vary in bandwidth requirements, which affects their feasibility in austere environments where bandwidth is rationed and prioritized. GCSS-MC's bandwidth requirement is exceptionally large because

the system hosts a large amount of information while having security protocols that limit access to registered users.¹⁸

In the variances of internet connectivity in garrison, afloat, and in austere on-land locations, use of logistics platforms like GCSS-MC is constrained by internet connectivity. When in garrison, Marines use GCSS-MC over the Marine Corps Enterprise Network (MCEN) internet, which is secure internet over fiberoptic cable.¹⁹ Due to MCEN's limits in bandwidth, Marines who regularly use GCSS-MC must arrive before and stay after normal working hours in order to take advantage of available bandwidth.²⁰ When afloat, Marines use GCSS-MC over shipboard satellites.²¹ When ashore but not in garrison, such as during a field exercise, Marines use satellite communications such as very small aperture terminal (VSAT) and Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T).²² In all cases, Marines have to adapt to limited internet bandwidth to use GCSS-MC.

Oracle has created GCSS-MC to be a complete repository of information, which consumes so much of MCEN's internet bandwidth that it will not work in low-internet environments such as an EAB. According to multiple after-action reviews by Marine Corps organizations that have used GCSS-MC, GCSS-MC does not work in limited network bandwidth environments (anywhere not connected to fiberoptic cable internet). Users cannot log into GCSS-MC nor can they conduct transactions and order mission essential repair parts.²³

In 2018-2019, Marine Corps Tactical Systems Support (MCTSS) conducted a comprehensive study of how Marines used GCSS-MC when deployed at sea with MEU on the Navy's Ships compared with use in garrison. This study found that on while afloat, Marines had difficulty using GCSS-MC because they lacked persistent internet connection. MCTSS's summary of findings reports that poor internet connectivity "doubles the interaction time with

the system, greatly reducing the efficiency of the user experience.”²⁴ The three cases used for the study are the 15th MEU, 26th MEU, and at 1st Marine Logistics Group (MLG).

At the 15th MEU, GCSS-MC did not work when afloat because of a “complex network infrastructure” that provides “insufficient data.”²⁵ At the 26th MEU, the ship’s communications officer “invested in grooming the network to provide an optimal environment for GCSS-MC traffic” which was why GCSS-MC on the 26th MEU was able to work at an acceptable level.²⁶ Grooming the network is an industry term for artificially increasing bandwidth by adding cables, partitioning frequency channels, or assigning usage time slots.²⁷ GCSS-MC on the 26th MEU otherwise still had login and latency problems. These MEUs’ collective experience is evidence that the GCSS-MC will not work in EABO for lack of reliable internet.

While scarcity of satellite internet degraded GCSS-MC usage on ships, GCSS-MC usage also degraded when connected to fiberoptic cable internet during high traffic hours. MCTSS’s study of 1st MLG in garrison using fiberoptic cable shows that GCSS-MC was not easier to use than on a ship. MCTSS concluded that 1st MLG needed to find ways to reduce bandwidth usage or use GCSS-MC during off-peak hours.²⁸ As of this writing, the only solution to improve the user experience is Oracle upgrading the platform to have an offline module. This offline module will allow users to input data into GCSS-MC while disconnected from the internet, and the transactions in the queue will be processed when GCSS-MC is connected to internet again.²⁹ This offline solution is insufficient because it is simply conceding that there is no internet and logistics coordination cannot happen when deployed at sea. If the low internet bandwidth problem cannot be solved by changing the logistics C2 platform, then the solution must be to increase internet bandwidth and connectivity.

Solution

The most reliable source of internet connectivity in an EAB would be Low Earth Orbit constellation satellite internet. If not satellite internet, all other sources of internet require infrastructure tied to fiberoptic cables. For example, the wireless “4G” internet accessible by smartphones are radio waves transmitted from cellphone towers. The cellphone towers are connected by fiberoptic cable to an internet hub in a building, which are connected to more internet hub buildings by more fiberoptic cables so that all the internet infrastructure is physically connected. Even internet hubs connecting transoceanic countries transmit information through fiberoptic cables are under the ocean.³⁰ In EABO, Marines would not build infrastructure since operations are meant to be temporary and austere. Without infrastructure for fiberoptic cables at an EAB, like on MEUs afloat, the only alternative for internet connectivity must be from satellites.

Currently fielded Mobile User Objective System (MUOS) Satellite Communication (SATCOM) is insufficient for GCSS-MC connectivity in EABO. Because legacy SATCOM has limited bandwidth, commanders have the burden of prioritizing this scarce resource to fires and intelligence operations, leaving other requirements like logistics and administration without it. The Marine Corps has been upgrading its legacy SATCOM with the MUOS, which is the latest SATCOM technology that is tested in Marine Corps field exercises for internet in austere environments.³¹ MUOS is fielded by the Navy and used by the Marine Corps.³² According to the Lockheed Martin MUOS website, it is a satellite constellation of five satellites.³³ It works well for the USMC because it is built to be compatible with legacy communication assets.³⁴ Unfortunately, although MUOS is operational, it is still limited in bandwidth capacity and suffers from high latency when tested in field exercises.³⁵ Because MUOS does not provide persistent

internet for logistics on a MEU or in the field, it is not sufficient for GCSS-MC connectivity in EABO.

Like the value of technology devalues with time and advent of new technology, MUOS is now considered usable but slow, much like “3G” cellular service. MUOS is a geosynchronous earth orbit (GEO) satellite, which is far from earth compared to a low earth orbit (LEO) satellite. LEO satellites are closer to the ground so connectivity to ground-based receivers is more stable than it is for further away GEO satellites, just as it intuitively sounds.

The proliferation of LEO satellites since 2019 has introduced credible capabilities of space-based broadband communications that is only available from LEO for being close enough to the ground, and not from GEO where MUOS orbits.³⁶ Compared to MUOS, LEO constellation satellite internet is faster and more stable “5G” cellular service. Additionally, most current military satellite systems in GEO or further orbits are comprised of just a few satellites orbiting around earth. MUOS, for example, is only five satellites.³⁷ LEO constellation satellites are planned for hundreds to tens of thousands of satellites that will ensure constant worldwide low-latency internet.³⁸

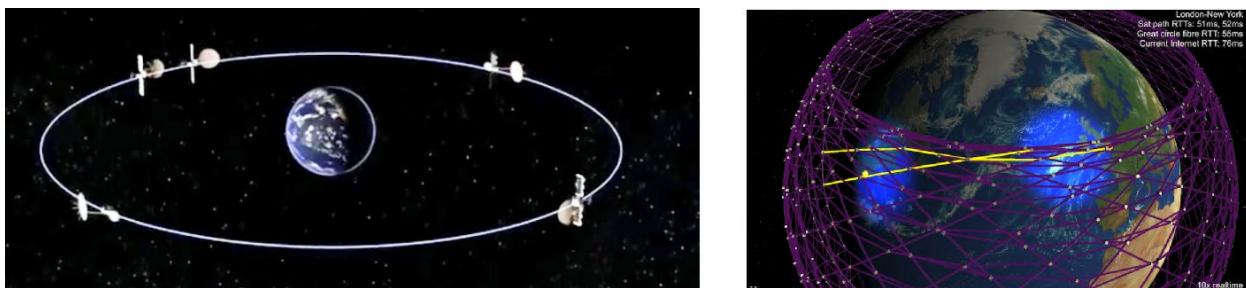


Figure 2: Artists' renderings of the five MUOS satellites in Geostationary Orbit (left), compared to Starlink's thousands of satellites much closer to the ground in Low Earth Orbit (right).³⁹

LEO constellation satellite internet is also higher redundancy, higher survivability, and is more readily available commercially than MUOS; LEO constellation satellite internet the best option for logistics C2 platforms in EABO. A LEO constellation of satellites will have high

redundancy because it is comprised of so many satellites that it can withstand losing a few before it loses capacity.⁴⁰ If China or Russia attacks a U.S. constellation that has tens of thousands of satellites with kinetic antisatellite weapons that they are currently developing, they would “require hundreds of costly weapons to destroy satellites that would be relatively inexpensive to replace.”⁴¹ LEO constellations have high survivability, a valuable trait in a contested EAB environment. Marines located at an EAB will need at minimum the high-bandwidth low-latency uninterrupted internet that only the LEO constellation satellite communications can provide to use logistics C2 platforms.

The Department of Defense is already investing in LEO satellite constellations, and the Marine Corps can quickly become a consumer. Among the several constellation companies competing for DoD contracts, Starlink is the primary awardee.⁴² Starlink is a commercial space internet constellation and is intended to “provide internet all over the globe, particularly in remote or rural areas where connectivity is limited or completely unavailable,” according to the Starlink informational website.⁴³ As of this writing, there are about 800 Starlink satellites in orbit. The DoD’s investment in LEO satellites is a healthy indication that even more LEO capabilities will be fielded to the Joint forces soon.⁴⁴ The U.S.’s competitors are also deeply invested in LEO constellation satellites. China, for example, is reportedly underway with launching 13,000 of their own such satellites.⁴⁵ A single integrated SATCOM access for all U.S. forces to use reliable internet provided by LEO satellites would benefit even the most austere military operations.

Ideally, the DoD would be able to field LEO constellation satellites sby companies such as Starlink to the Joint Services as fast as these companies are able to launch their satellites. The Navy and Marine Corps spent 15 years developing MUOS with Lockheed Martin until it reached

“fully operating capability” (FOC) and by now that technology is stale compared to LEO constellation satellites.⁴⁶ The Air Force Space Command, who is the DoD’s lead for procurement of commercial satellite communications, has been much faster experimenting with LEO constellation satellites than the Navy was with MUOS. Just over a year ago, the Air Force’s Defense Experimentation Using Commercial Space Internet (DEUSCI) program awarded Starlink \$28 million to connect military platforms such as aircraft and ground terminals, and awarded smaller contracts to Iridium, Telesat and O3B to experiment with LEO broadband internet.⁴⁷ Since then, Starlink’s LEO satellites have surpassed all of the DEUSCI program’s expectations; it is so user-friendly that a user can “plug it in and plant where it is: that’s how automatic it is.”⁴⁸ The Marine Corps already has LEO constellation satellite program managers at Marine Corps Combat Development Command and is participating in the DEUSCI testing. By investing in constellation satellite internet to enable logistics C2 platforms, the Marine Corps would create incentives to accelerate realization.

LEO constellation satellite internet is also secure enough to prevent an adversary from discovering military requirements on its networks. A security problem in logistics coordination is the inherent nature of supply chains, where operational-level logistics enablers and suppliers consist of the commercial industry and local small businesses across the U.S. and in partner/ally nations. Using these commercial sources of support necessarily exposes military requirements on unclassified networks because they lack access to classified networks. The adversary can aggregate logistics information across these unclassified networks and learn of friendly military actions and intentions. Leveraging Space Operations to communicate on unclassified networks may help enhance information security compared to using fiberoptic cable internet. The *Tentative Manual for EABO* directs planners to execute space operations for EABO with

consideration of adversary actions in the electromagnetic spectrum and cyberspace. Such space operations include commercial SATCOM currently managed by U.S. Strategic Command which augments additional bandwidth to insufficient military SATCOM resources to support ongoing operations. Informed SATCOM users can recognize signs of electromagnetic interference, understand SATCOM threats, and employ mitigation measures to make the electronic line of communication more secure than fiberoptic cable.⁴⁹ Even if commercial LEO constellation satellite internet services are not secure enough for classified military operations like targeting or ISR, such internet services are secure enough for military logistics C2 platforms like unclassified GCSS-MC.

An additional benefit of using a single source of Joint-service internet is that it may help enable stronger logistics synchronization to share logistics resources in Joint operations. Joint Publication 4-0 *Joint Logistics* idealizes “the coordinated use, synchronization, and often sharing of two or more combatant commands (CCMDs) or Military Departments’ logistics resources to support the joint force.”⁵⁰ If the DoD can implement this new space technology as a primary source of internet shared by the Joint forces, then the Joint forces may share the same network and become as interoperable as needed for direct-to-consumer logistics coordination. In EABO, the LLB will need more supporting relationships with Joint services and allies and partners for operational reach inside the WEZ.

If the DoD can establish LEO constellation SATCOM for all Joint Services, then it can potentially overhaul internet infrastructure for a single network for all Joint services. A computer network is a group of interconnected computers, laptops, tablets, and other devices which send and receive data within the group.⁵¹ Right now, each service has its own .mil network (e.g., usmc.mil, army.mil, navy.mil, af.mil). Each service’s logistics platforms reside exclusively on

their own .mil network. GCSS-MC can be accessed remotely only on a government computer with Virtual Private Network (VPN) for encryption security and a usmc.mil network connection. Other services' logistics C2 platforms have the same requirements for remote access; for example, GCSS-Army can only be accessed on army.mil network connection.⁵² If the DoD can establish one joint service network where all separate services' logistics C2 platforms can migrate into this joint service network, then the services can access each other's logistics C2 platforms for coordination.

The LLB will need the ability to coordinate support from other services in EABO, but the Joint services' logistics C2 platforms are not yet consolidated to a single joint platform for joint coordination. Although the platforms are different, sharing a joint DoD network can help enable cross-communication. The Defense Information Systems Agency's (DISA) Joint Information Environment (JIE) that launched in 2014 demonstrates the need for "a single joint enterprise IT platform that can be leveraged for all DoD missions."⁵³ JIE attempts to solve the problem where different networks have "differing systems, policies, and lack of trust between networks" which adversely impacts "the warfighter's ability to execute joint global military operations" and increases service costs to the DoD for redundant internet infrastructure.⁵⁴ Yet even now, most of the Marine Corps' communication platforms, including Logistics C2 platforms, are not running on JIE. But even if the platforms were on the JIE, JIE connectivity is unlikely accessible without satellite internet in EABO.

The new U.S. Space Force, established in 2019, is likely to be the future administrator of all the Joint Force's space assets including SATCOM. By being the central administrator of Joint SATCOM, the Space Force can enable JIE connectivity. The U.S. Space Force's SATCOM Vision Paper envisions managing "a single, integrated enterprise [that] will deliver

unparalleled options to joint warfighters,” so satellite internet can be managed for the Joint force by the Space Force.⁵⁵ By using the same LEO constellation satellite internet provided to the Joint services, the Marine Corps can remove the barriers for effective communication to coordinate logistics support from other services in an EABO.

Joint logistics coordination between the Marine Corps and the Navy is even closer to realization than with other services because both already share non-satellite Navy Marine Corps Intranet (NMCI) for connectivity. The Marine Corps’ logistics C2 platforms can integrate with the Navy’s platforms on NMCI. The Navy’s upcoming logistics C2 platform for their Naval Operational Supply System (NOSS) is the Naval Operational Business Logistics Enterprise (NOBLE), a platform developed by the commercial provider One Network Enterprises which will replace all previous systems. It is a multi-party platform that consolidates all classes of Supply, from ammunition to food to retail so that there is only one platform for all logistics operations.⁵⁶ Through NOBLE, the Marine Corps is supposed to be able to even request Navy support like sea route security, explosive ordnance detonation capabilities, and shipping.⁵⁷ If the Marine Corps communications can be on the same internet network as the Navy, and have uninterrupted internet service, then its logistics C2 platforms can be integrated with the Navy’s platforms for expanded EABO support. LEO constellation satellite internet like Starlink could expand the Marine Corps’ interoperability with the Navy to be interoperable with the rest of the Joint force.

If the Marine Corps can be on the same internet network as the rest of the services, then it is possible for service specific C2 platforms to communicate with each other. The U.S. Army, like the Marine Corps, is using the GCSS platform by Oracle, called GCSS-Army. Even when both the Army and the Marine Corps are using the same C2 platform (GCSS) by the same

company (Oracle), they cannot cross-coordinate because they are on different .mil networks. The Army's Network Enterprise Technology Command (NETCOM) manages several sources of intranet and internet connectivity, none of which is compatible with Navy or Marine Corps logistics C2 platforms.⁵⁸ The U.S. Air Force logistics platform is just as incompatible. The Air Force contracted the same company that created the Navy's NOBLE platform, One Network Enterprises, to build its own version of a multi-party platform that consolidates all supply classes to one "modern global network platform" called the Item Master Logistics Capability Initiative (IMLCI).⁵⁹ Again, even though the Air Force uses the same multi-party platform by the same company as the Navy, the Air Force-wide internet platform is the Air Force Intranet (AFNET) which is incompatible for Navy and Marine Corps use. For the Marine Corps to coordinate logistics directly with the Army or the Navy, all C2 platforms need to be accessible on a single joint network on secure broadband internet provided by LEO constellation SATCOM. The Joint Forces' ideal of sharing logistics can be enabled starting with sharing a joint network to communicate logistics coordination.

Conclusion

EABO logistics operations needs LEO constellation satellite internet to effectively transmit logistics coordination over existing web-based platforms from austere locations. Unlike MEUs afloat, which are designed to be self-sustaining, the MLR is not self-sustaining and instead is nested in the much larger Joint operations logistics schematic. The new logistics C2 scenario in Force Design 2030 is that the MLR's smallest units in the middle of nowhere and without infrastructure must be able to immediately coordinate with supporting units as close as the LLB, and immediately coordinate with combatant commands as far as USTRANSCOM,

while using Marine Corps-specific logistics C2 platforms, for resupply of ammunition or amphibious transportation back to base.

The root problem of why logistics coordination cannot be immediate is not for lack of technical expertise, lack of ready suppliers, or lack of anyone's effort. As proven by the Marine Corps' use of GCSS-MC and other logistics C2 platforms in both garrison and at sea, the platforms themselves are expertly built, connected to ready suppliers, and heavily used. The root problem is that reliable internet is currently not available in austere locations to even communicate in the first place. Even in garrison where internet fiberoptic cable is well-emplaced in infrastructure, platforms like GCSS-MC become slow, cumbersome, and user-unfriendly when the NMCI network stresses the internet bandwidth capacity. When deployed at sea where logistics functions are considered low priority for limited SATCOM use, Marines have the option of an "offline mode" for GCSS-MC until they land ashore with access to internet. If the root of the problem is scarcity of internet, then the solution is to get more internet.

The only way to get internet in the middle of nowhere is from SATCOM. While military SATCOM has been available for over two decades, it was scarce due to the technological limitations of the time. Scarce SATCOM was primarily available to high-priority capabilities such as targeting and intelligence and less so for supporting functions like logistics. Opportunely, the proliferation of LEO constellation satellite internet technology is in tandem with the advent of the Marine Corps' redesigned force. As recently as just two years ago the DoD began investing in the newest SATCOM projects that provide LEO constellation satellite internet. Commercial LEO constellation satellite internet technology such as SpaceX's Starlink promises to be available to millions of people located in places without fiberoptic cable infrastructure. LEO constellation satellite internet should be the Marine Corps' solution to the

otherwise impossible use of its logistics C2 platforms in EABO. When Marines on uninhabited islands need to transact their logistics requests with far-away support assets immediately and any time, then can effectively be *alone and unafraid* because they have internet to do it.

The next generation of Marines in the new paradigm of naval warfare will be operating with the most modern technology. A scenario that traces a modern logistics chain supporting a platoon-sized team inside the WEZ looks nothing like when Combat Logistics Battalions sent up-armored truck convoys to resupply forward operating bases (FOBs) during Operation Iraqi Freedom just a decade ago. Instead, the scenario would have new technologies. In such a hypothetical, a platoon from the Littoral Combat Team needs to extend its time occupying an uninhabited island as an expeditionary base near a contested coast and needs to immediately change the sustainment plan.

Here is a scenario that demonstrates what LEO constellation satellite internet connectivity, and hence logistics, would look like: In just a few fast steps, a Marine on an austere island can transact a support request across earth. The Marine's first step would be to open her miniature satellite receiver dish. Then she would turn on her wifi-enabled government tablet and connect it to the low-earth-orbit constellation satellite internet assigned to her unit. Next, she would log into the CLC2S, GCSS-MC, and TCPT applications on the laptop. Lastly, she would transact a request in CLC2S for resupply of food and fuel, update weapons maintenance requirements in GCSS-MC, and coordinate transportation to pick up the platoon in TCPT. These requests would automatically transact at the Littoral Logistics Battalion's operations center, where supply and maintenance statuses are tracked as efficiently as the most modern commercial warehouse. The operations center then assigns each request to actionable subordinate units. The maintenance office 3-D prints the requested maintenance parts and airdrops them by an Army-

operated unmanned delivery vehicle to the EAB within five hours of receiving the request. The logistics coordination office would order food and fuel from the nearest local economy to be delivered by merchant boat. And the transportation office would deconflict the Light Amphibious Warships schedule to pick up the platoon from the EAB at the updated time. Meanwhile, the status of each request is tracked in real-time by the Marine at the EAB with the tablet because the LEO satellite constellation provides her uninterrupted, encrypted, high-bandwidth internet. Given the possibilities of secure constant connectivity, current logistics C2 platforms can work well for Marine Littoral Regiment to coordinate sustainment of Expeditionary Advanced Base Operations.

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