NPS-LM-25-271

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Developing a Concept of Employment for Marine Corps ULS-A from a DOTmLPF-P Perspective

December 2024

Capt Timothy B. Beger, USMC

Thesis Advisors: Keith A. Hirschman, Professor
Dr. Robert F. Mortlock, Professor

Department of Defense Management

Naval Postgraduate School

The research presented in this report was supported by the Acquisition Research Program of the Department of Defense Management at the Naval Postgraduate School.
To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact the Acquisition Research Program (ARP) via email, arp@nps.edu or at 831-656-3793.

ABSTRACT

The U.S. Marine Corps is adapting to conduct operations in contested, littoral environments. The 38th Commandant's Planning Guidance and Force Design 2030 initiative call for deploying unmanned logistics capabilities to support Expeditionary Advance Base Operations (EABO) and Distributed Maritime Operations (DMO). As warfare rapidly evolves, successfully deploying and sustaining the operations of new weapon systems and technologies is critical, as traditional logistics methods become less viable. With logistics now considered the "pacing function" of warfare in this scenario, the inability to sustain operations in contested, littoral areas of operation will create a significant vulnerability for the Marine Corps if these new systems are not integrated into the force properly. This thesis examines the lessons learned from initial employment of the Tactical Resupply Unmanned Aerial System (TRUAS), Unmanned Logistics System – Air (ULS-A), and other unmanned aerial systems. It analyzes these lessons through the well-established lens of Doctrine, Organization, Training, materiel, Leadership and education, Personnel, Facilities, and Policy (DOTmLPF-P). Based on this analysis, the research offers recommendations for the Marine Corps' ULS-A programs, specifically the Medium Aerial Resupply Vehicle–Expeditionary Logistics (MARV-EL) and Aerial Logistics Connector (ALC) variants, focusing on their concepts of employment from the DOTmLPF-P perspective.

THIS PAGE INTENTIONALLY LEFT BLANK

ABOUT THE AUTHOR

Captain Timothy Beger graduated from James Madison University in May of 2015 with two Bachelor of Science degrees in Public Policy and Administration, and Public Health Education. He received his commission via Officer Candidate School in August 2019. In August 2019, 2ndLt Beger reported to The Basic School (TBS) aboard MCB Quantico, Virginia. After successfully completing TBS, 2ndLt Beger reported to Logistics Officer Course aboard Camp Lejeune, North Carolina where he was designated as a Logistics Officer (MOS 0402) upon completion of the course.

In July 2020, 2ndLt Beger reported to 1st Transportation Support Battalion, under Permissive Temporary Assigned Duty orders, and was assigned as a Motor Transport Platoon Commander for Alpha Company, 1st Transportation Support Battalion. During his tenure at 1st Transportation Support Battalion, he held the billets of Platoon Commander and Company Executive/Operations Officer. In April 2021, he reported to 1st Landing Support Battalion. 2ndLt Beger immediately reported to and completed U.S. Army Basic Airborne Course at Fort Moore, Georgia. Upon his return to 1st Landing Support Battalion, 2ndLt Beger was assigned as the Air Delivery Officer in Charge. In this role, he supported multiple Weapons and Tactics Instruction courses as the Air Delivery Liaison Officer between the Logistics Combat Element and Marine Aviation Weapons and Tactics Squadron One.

Throughout this timeframe, 1stLt Beger graduated from Schar School of Policy and Government, George Mason University, with a Master of Public Policy in May 2023.

In May 2023, 1stLt Beger reported to the Naval Postgraduate School, and in December 2024 graduated with a Master of Science in Defense Logistics Management. He also completed Expeditionary Warfare School during his time in Monterey, CA, and was promoted to his current rank of Captain.

His personal awards include the Navy and Marine Corps Commendation Medal.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

To my thesis advisor, Professor Keith Hirschman: Thank you for your invaluable feedback, guidance, and expertise throughout this process. Your mentorship has been instrumental in shaping this thesis, and your insights will continue to influence my growth beyond my time at the Naval Postgraduate School.

To the individuals who helped me develop a relevant research topic: Thank you for your support and for challenging me to push my research forward. I hope this work will contribute meaningfully to the future of the Marine Corps.

To all the professors and instructors I have had over the past eighteen months: Your mentorship and leadership have profoundly influenced my development as both a leader and a thinker. Thank you for inspiring me to grow.

Finally, to my family: To my wife, thank you for your unwavering love, support, and sacrifices. Caring for our two children while I dedicated myself to this research was no small task, and I am deeply grateful. Your encouragement keeps me moving forward each day. Thank you, and I love you!

THIS PAGE INTENTIONALLY LEFT BLANK

NPS-LM-25-271

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Developing a Concept of Employment for Marine Corps ULS-A from a DOTmLPF-P Perspective

December 2024

Capt Timothy B. Beger, USMC

Thesis Advisors: Keith A. Hirschman, Professor
Dr. Robert F. Mortlock, Professor

Department of Defense Management

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AAF	Adaptive Acquisition Framework
ACE	Aviation Combat Element
ARG	Amphibious Ready Group
ASD(A)	Assistant Secretary of Defense for Acquisition
BES	Budget Estimate Submission
C2	Command and Control
CAPE	Cost Assessment and Program Evaluation
CBS	Capabilities Based Assessment
CCDR	Combatant Commander
CD&I	Combat Development & Integration
CJCS	Chairman of the Joint Chiefs of Staff
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CMC	Commandant of the Marine Corps
CONEMP	Concept of Employment
CONOP	Concept of Operation
COTS	Commercial Off-the-Shelf
CPG	Commandants Planning Guidance
CPR	Capability Program Review
CUAS	Cargo Unmanned Aerial System
DAS	Defense Acquisition System
DC CD&I	Deputy Commandant of Combat Development & Integration
DCR	DOTmLPF-P Change Recommendation
DMO	Distributed Maritime Operations
DoD	Department of Defense
DoDI	Department of Defense Instruction
DON	Department of the Navy
DOTmLPF-P	Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy
DPG	Defense Planning Guidance
EABO	Expeditionary Advanced Base Operations
EMD	Engineering and Manufacturing Development

EW	Electronic Warfare
FAA	Federal Aviation Administration
FMOS	Free Military Operational Specialty
FSA	Functional Solutions Analysis
FYDP	Future Year Defense Program
GCE	Ground Combat Element
GWOT	Global War on Terror
HQMC	Headquarters Marine Corps
I&L	Installations & Logistics
ISR	Intelligence, Surveillance, and Reconnaissance
JCA	Joint Capability Area
JCIDS	Joint Capabilities Integration and Development System
JCS	Joint Chiefs of Staff
JROC	Joint Requirements Oversight Committee
KPP	Key Performance Parameter
KSA	Key System Attribute
LCE	Logistics Combat Element
LOCE	Littoral Operations in a Contested Environment
MAGTF	Marine Air Ground Task Force
MCCA	Marine Corps Capability Area
MCCL	Marine Corps Capability List
MCDP	Marine Corps Doctrinal Publication
MCFDS	Marine Corps Force Development System
MCGL	Marine Corps Gap List
MCO	Marine Corps Order
MCRP	Marine Corps Reference Publication
MCSCP	Marine Corps Service Campaign Plan
MCSDD	Marine Corps Solutions Development Directive
MCTP	Marine Corps Tactical Publication
MCWL	Marine Corps Warfighting Laboratory
MCWP	Marine Corps Warfighting Publication
MDA	Milestone Decision Authority
MEU	Marine Expeditionary Unit

MOS	Military Operational Specialty
MSA	Materiel Solutions Analysis
MTA	Middle Tier of Acquisition
MUX	Marine Air Ground Task Force Unmanned Aerial System Expeditionary
NDI	Non-Developmental Item
NDS	National Defense Strategy
NSS	National Security Strategy
OS	Operations and Sustainment
OSA	Other System Attribute
OSD	Office of the Secretary of Defense
OUSD(A&S)	Office of the Under Secretary of Defense for Acquisition and Sustainment
PD	Production and Deployment
POM	Program Objective Memorandum
PP&O	Plans, Policies, & Operations
PPBE	Planning, Programming, Budgeting, and Execution
RM	Requirements Memorandum
RMD	Resource Management Decision
TACP	Tactical Air Control Party
TALSA	Training and Logistics Support Activity
TMRR	Technology Maturation and Risk Reduction
TRL	Technology Readiness Level
TRUAS	Tactical Resupply Unmanned Aircraft System
TTP	Tactics, Techniques, and Procedures
UAS	Unmanned Aerial System
ULS-A	Unmanned Logistics System – Air
USD	Under Secretary of Defense
USMC	United States Marine Corps
VMU	Marine Unmanned Aerial Vehicle Squadron

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The Marine Corps is preparing for the future of warfare. As the character of war changes, the indoctrination of autonomy presents a plethora of opportunities but also poses many challenges. A way in which the Marine Corps is addressing the proliferation of autonomy is through the acquisition of unmanned aerial systems for logistical resupply. The Unmanned Logistics System – Air (ULS-A) portfolio looks to address a gap in current force capability by introducing a portfolio of autonomous vehicles, of various sizes and capabilities, to provide sustainment to forces in contested, littoral battlespaces. The portfolio of ULS-A, the Tactical Resupply Unmanned Aircraft System (TRUAS), Medium Aerial Resupply Vehicle-Expeditionary Logistics (MARV-EL), and Aerial Logistics Connector (ALC), is the Marine Corps bid for success in the future fight.

There is a current dilemma on how ULS-A will be employed within the force structure to support logistics operations in the future operating environment: "Is the system a logistics capability to be operated through the aviation element, or is it an aviation capability that logisticians will operate?" Although the three variants of ULS-A may be the capability that the Marine Corps needs to succeed, without the appropriate institutional support for their employment through Doctrine, Organization, Training, materiel, Leadership and education, Personnel, Facilities, and Policy (DOTmLPF-P), gaps will remain leading to failure.

The DOTmLPF-P framework was utilized to analyze the complex nature of the ULS-A portfolio and provide recommendations to the Marine Corps enabling the effective employment and sustainability of the ULS-A capability into the future. Aviation and logistics in military operations are inherently unique, and without informed and clear direction of each of the tenets of DOTmLPF-P, the ULS-A portfolio will fail in achieving the intended mission. Most crucially, this analysis provides valuable insight from the warfighter and key leadership to inform recommendations for fostering the effective employment and sustainment of the ULS-A in the Marine Corps.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

Logistics forms the backbone of any military operation, playing a vital role in projecting and sustaining combat power. The ability to rapidly deploy forces, maintain a constant flow of supplies and equipment, and provide essential services to troops in the field can often be the deciding factor in the outcome of campaigns. The criticality of logistics has shown its true worth throughout history, including the failure of Emperor Napoleon Bonaparte to address logistics considerations in his failed attempt to invade Russia in 1812 (Bennett, 2012).

Although the criticality of logistics has prevailed throughout time, the battlefield and conduct of logistics operations have changed drastically. Technological advances in ground, air, and sea mobility have greatly improved the capability of forces to sustain forces for longer durations across vast battlefields. As nations and their militaries progress technologically, no longer will allied forces, or enemy forces be constrained to long tactical convoys or manned air assets to conduct logistics operations. Even during the Global War on Terror, the United States utilized unmanned aerial systems (UAS) such as the KAMAN K-MAX to conduct resupply missions to remote locations throughout the battlespace from December 2011 through May 2014 (Haddick, 2016). Although U.S. and allied forces saw the relative success of such platforms in recent conflicts, demand for reliable supply routes will continue to increase. The current Russia–Ukraine conflict has shown the criticality of logistics operations to the success of the larger strategic mission, and such, their failures (Martin et al., 2023). As the United States prepares for the future and potential conflict with China, and the tyranny of distance throughout the region, as conveyed in the National Defense Strategy, innovative, survivable, and reliable logistics systems will be a key success factor (Department of Defense [DoD], 2022).

The 38th Commandant of the Marine Corps (CMC) Planning Guidance (Berger, 2019) and Force Design 2030 (United States Marine Corps [USMC], 2020) has paved the way for the United States Marine Corps (USMC) to evolve for the future battlespace. Expeditionary Advance Base Operations (EABO) and Distributed Maritime Operations

(DMO) are at the forefront of the USMC mission set, requiring equipment and technology to enable their success and sustainability in a contested environment. Notably, the 38th CMC, General David H. Berger, espoused that logistics is the pacing function for modernization and operational planning and requires improved technology for survivability to ensure the sustainment of forces (Center for Strategic and International Studies, 2021). Identifying this gap in capabilities has led the Marine Corps to accelerate investments in the acquisition of advanced technology to support logistics operations, such as the Unmanned Logistics System – Air (ULS-A), a portfolio of three variants of UAS to conduct sustainment operations (Figure 1).

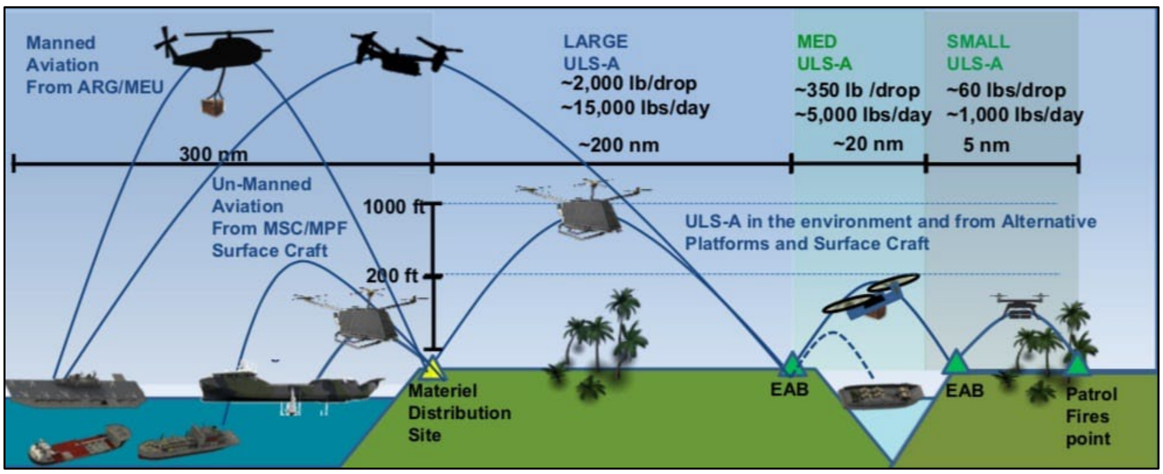

Figure 1. ULS-A Concept Graphic. Source: Head (2020).

As the warfare domains become increasingly contested, the development of robust unmanned logistics capabilities has the potential to provide a viable materiel solution to sustain forces, delivering supplies into contested environments with a reduction in the risk of personnel necessary to operate manned platforms. Although unmanned systems such as ULS-A may seem like an obvious solution to advancing logistics operations in contested environments, residual impacts on the force must be taken into consideration to enable their effective employment.

This research analyzes each of the tenets of Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P) as they relate to the ULS-A acquisition programs, considering the implications of such warfighting capabilities on each of these tenets. Those findings inform the development of a concept of employment of ULS-A as the USMC continues to acquire more unmanned systems to achieve the desired end state laid out in the 38th CMC Planning Guidance (Berger, 2019), *Force Design 2030* (USMC, 2020), and *Installations & Logistics (I&L) 2030* (USMC, 2023a).

A. PROBLEM IDENTIFICATION

The introduction of advanced technology through the Defense Acquisition System (DAS) poses challenges to the Department of Defense (DoD) and Services. Technology advances at a rapid rate, sometimes so much that the DAS is unable to keep pace at the speed of relevance. As requirements and capability gaps are identified, experimentation becomes the norm, and programs progress through the DAS, considerations surrounding DOTmLPF-P enable the successful implementation and support of 1) new technology and 2) changes in DOTmLPF-P. With the rapid growth and ever-changing developments in technology, the supporting tenets of DOTmLPF-P can be neglected to rapidly field a technology without the proper analysis from the requirements owner, the supporting mechanisms, and the appropriate force structure for it to succeed. As the USMC continues the acquisition of ULS-A, lessons can be learned from other UAS acquisition programs to ensure that the ULS-A program is employed effectively and sustained as a warfighting capability into the future.

B. RESEARCH QUESTIONS

This research addresses, generally, two research questions surrounding the Marine Corps ULS-A acquisition program:

1. Using a DOTmLPF-P framework, what are the potential concepts of employment and force structure of the ULS-A capability?
2. What are lessons learned from previous UAS acquisition programs to support the Marine Corps framework for DOTmLPF-P analysis of future ULS-A acquisitions?

C. RESEARCH OBJECTIVES

The objective of this research is to analyze the ULS-A acquisitions from a DOTmLPF-P framework to identify potential concepts of employment of the ULS-A capability while offering recommended courses of action to appropriately address each of the tenets of DOTmLPF-P.

D. RESEARCH APPROACH

This research consists of a comprehensive literature review and a comparative DOTmLPF-P analysis related to UAS programs. In addition to a detailed review of acquisition programs, the research consists of discussions and interviews with key personnel within the DAS.

E. ORGANIZATION OF REPORT

The first section of this research report, Chapter I, provides a brief introduction to the research topic, the purpose of the research, and the approach taken to conduct the research. Chapter II provides a background on the Marine Corps' impetus for investing in ULS-A, the DAS, Planning, Programming, Budgeting and Execution (PPBE), and Joint Capabilities Integration and Development System (JCIDS) processes, the Marine Corps Force Development System, the DOTmLPF-P analysis process, and an overview of ULS-A requirements to date. Chapter III is a comprehensive literature review of relevant acquisition policies and strategic publications with implication on the ULS-A portfolio. Chapter IV is an analysis of the background literature, as well as interviews conducted throughout the research, focusing on each of the DOTmLPF-P tenets, and presents key findings of the analysis and recommendations for the USMC to improve the concept of employment of ULS-A. The final section, Chapter V, summarizes the findings of the research, identifies the limitations of the research, and provides recommendations for future research.

II. BACKGROUND

The Marine Corps' decision to invest in the ULS-A program stems from the mentality of a lightweight, mobile, self-sustaining expeditionary force. Force Design 2030 laid the groundwork for the rebirth of the Marine Corps, a return to its naval roots, and preparations for the future operating environment. These developments relate to every warfighting function of the Marine Corps, specifically distancing logistics operations from the "iron mountain" (large stockpiles of supplies, which create a large physical and administrative signature) approach, which has been the status quo throughout recent conflicts. Although successful when threats are not as advanced as anticipated in future conflicts, this iron mountain concept of logistics support will impede the agility of the Marine Corps in EABO and DMO.

Several strategic imperatives have heightened the need for more autonomous and distributed logistics capabilities like ULS-A. The Marine Corps' focus on EABO and DMO calls for deploying low-signature, forward-positioned naval expeditionary forces able to operate independently in contested littorals (USMC, 2023d). DMO across island chains and remote land locations will place an increased onus on the flexibility and resiliency of logistics operations, to avoid enemy engagement in a contested area of operations. Additionally, the threat of long-range precision missile systems and China's abilities and presumed desires to target logistics capabilities have the potential to put logistical hubs at increased risk. ULS-A has the potential to reduce the risk of logistical operations by enabling unmanned delivery drones to enter and operate in environments where threats are present but may not engage smaller, unmanned assets. Reduced signatures, autonomous routing, and the ability to aerially resupply personnel enhance the agility of logistics operations while reducing the potential targeting of larger, manned logistical assets.

By investing in ULS-A, the Marine Corps aims to acquire and field a full suite of unmanned logistics capabilities that are expeditionary, autonomous, and resilient, and can enable and sustain EABO and DMO. This aligns with the vision of a more modern, survivable, agile naval expeditionary force able to operate within an adversary's weapon engagement zone.

I&L 2030, a logistics-focused publication supporting Force Design 2030, states, "No Later Than (NLT) 1 September 2023, DC, CD&I in coordination with DC, Aviation will expedite requirements development and acquisition of ULS-A Medium and Large with sufficient range and payload capacity to support distributed forces in a contested maritime environment" (USMC, 2023a, p. 6). This sets the stage for the prompt acquisition and fielding of new technology to the Fleet Marine Force inundated with change.

A. THE DEFENSE ACQUISITION SYSTEM

The DAS, often referred to as the "Big A" acquisition, is the overarching system by which the DoD plans, funds, and manages the procurement and acquisition of military materiel, technology, and services. Encompassed within the DAS are three decision support systems: 1) Joint Capabilities Integration and Development System (JCIDS), or the requirements process; 2) Planning, Programming, Budgeting and Execution (PPBE), or the financial processes; and 3) the Adaptive Acquisition Framework (AAF), or the management process. These decision support systems are interrelated and their work harmoniously to shape the DoD's acquisition structure (Figure 2).

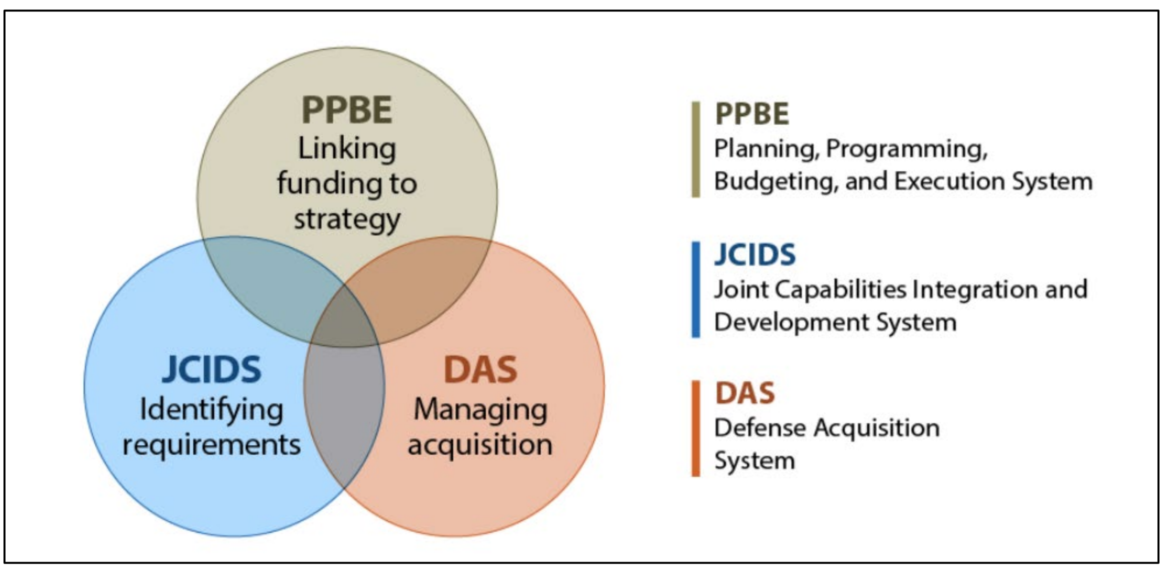

Figure 2. DoD Decision Support Systems. Source: McGarry (2022, p. 6).

Each of the three decision support systems that combine into the “Big A” acquisition process are defined by McGarry (2022) in the *DoD Planning, Programming, Budgeting, and Execution: Overview* as:

- JCIDS. The process by which DoD identifies capabilities, or items, required by the military to fulfill its mission, resulting in programmatic requirements.
- PPBE. The process by which DoD translated strategic guidance into resource allocation decisions, resulting in funding.
- DAS. The process by which DoD manages the development and purchase of products and services, resulting in acquisition (sometimes referred to as “Little A” acquisition). (p. 5)

B. JOINT CAPABILITIES INTEGRATION AND DEVELOPMENT SYSTEM

The JCIDS is the process by which the DoD and Joint Forces assess joint military capabilities, and identify, assess, approve, and prioritize gaps in these capabilities to meet applicable requirements as laid out by the National Defense Strategy (Chairman of the Joint Chiefs of Staff [CJCS], 2021). A function of the Joint Requirements Oversight Committee (JROC), JCIDS is a collaborative effort involving the Joint Staff, Combatant Commands, the military services, and other stakeholders to ensure that the DoD develops and fields the right mix of joint capabilities to meet current and future operational requirements in a cost-effective manner (CJCS, 2021).

The JCIDS process is informed by numerous sources including the previously mentioned entities, but it also closely ties into strategic guidance from the Office of the President through the National Security Strategy (NSS), DoD National Defense Strategy (NDS), the Joint Operating Environment, and many other strategic mission planning documents. Figure 3 depicts the JCIDS relationship with all these entities, as well as the other two decision support systems of the DAS.

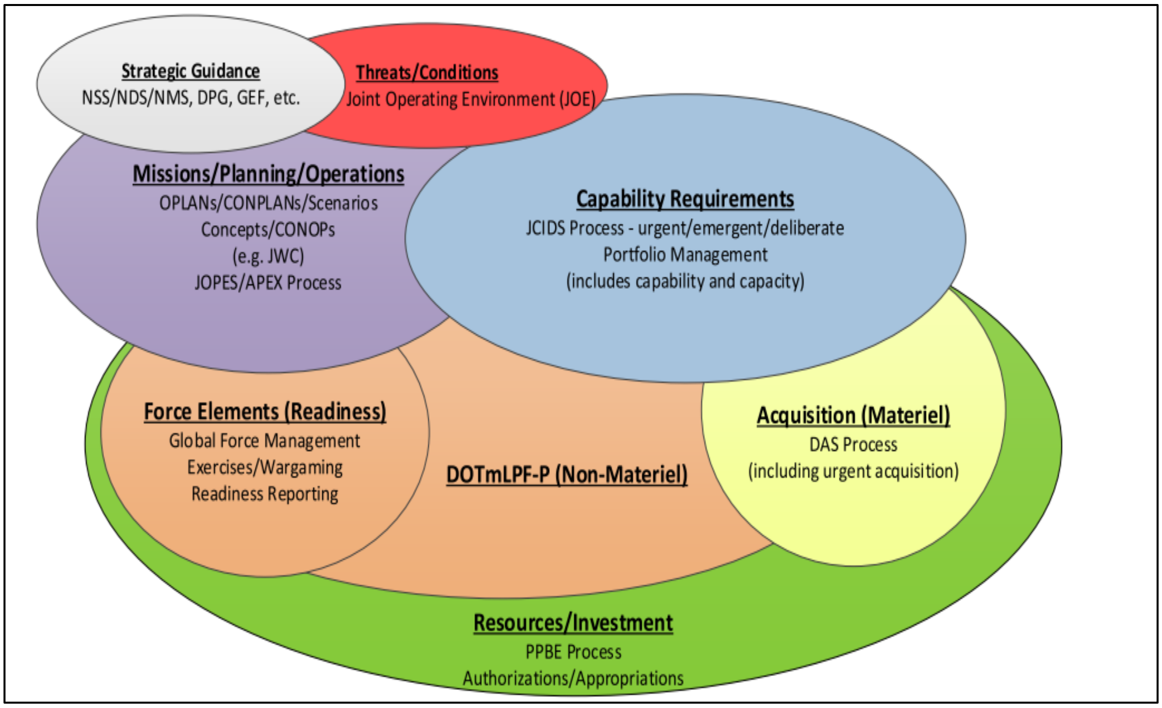

Figure 3. JCIDS Interrelationships. Source: CJCS (2021, p. D-4).

Although the interrelationships are all important to ensuring the effective development of warfighting capabilities, the CJCS (2021) posits that the JCIDS, PPBE, and DAS are the most tightly interrelated and must be in concert to ensure cost-effective capabilities are delivered to the warfighter in a timely manner.

C. DOTMLPF-P ANALYSIS

The DOTmLPF-P analysis is the critical step in the requirements process and Functional Solution Analysis (FSA) to determine whether the identified capability gap has potential solutions within its tenets. Although the solution to the capability gap may not be fully addressed with a DOTmLPF-P Change Recommendation (DCR), the tenets of DOTmLPF-P inevitability impact the life cycle of the potential materiel solution and how a materiel solution is employed.

Table 1 lays out each of the tenets of DOTmLPF-P, their respective definitions, and how they are viewed when conducting a DOTmLPF-P analysis.

Table 1. DOTmLPF-P Tenets. Adapted from CJCS (2016, p. A-3–A-5).

Doctrine	Doctrine comprises the principles which guide the organization in achieving mission objectives. Unique to the USMC, Marine Corps Doctrinal Publications (MCDP) offer guidance service-wide on the conduct of various warfighting endeavors. The doctrine also encompasses Marine Corps Warfighting Publications (MCWPs) through Tactics, Techniques, and Procedures (TTPs).
Organization	Organization is the structure by which the unit operates. Specifically, in a DOTmLPF-P analysis, the consideration is whether the structure of the organization (i.e., Ground Combat Element (GCE), Logistics Combat Element (LCE), Aviation Combat Element (ACE)) should be altered to fill an identified capability gap. The organization tenet is also taken into consideration when determining the placement of personnel to support the operation and sustainment of materiel solutions.
Training	Training considerations in relation to DOTmLPF-P analysis consider the full spectrum of initial Military Occupational Specialty (MOS) training to the continuing education of the warfighter when in the operational forces. All components of the training and support in the conduct of the training must be considered.
materiel	Materiel encompasses any equipment, systems, tools, and information systems. In an analysis, it would consider any existing materiel that could be capitalized upon to fulfill the identified gap in capability, specifically through Commercial Off-the-Shelf (COTS)/Government Off-the-Shelf (GOTS)/Non-Developmental Item (NDI) solutions.
Leadership and Education	Leadership and education account for the education of key personnel leadership on the need for a capability to achieve a particular identified gap. This allows for the acquisition professionals to ensure that the unit leaders and warfighters on the ground are moving in the appropriate direction.
Personnel	Personnel analysis looks at the availability of required people and the balance between active duty or contractor support necessary to support the identified gap through restructuring of the personnel.
Facilities	Facilities analysis examines the military properties, installations, and industrial facilities to determine their abilities to support an identified acquisition program.
Policy	The policy analysis considers the overall governance of all aspects and how policy (DoD, interagency, international) can support other potential changes in doctrine.

D. PLANNING, PROGRAMMING, BUDGETING, AND EXECUTION

The PPBE pillar of the DAS is often referred to as resource allocation, as the objective of PPBE is to “provide operational commanders the best mix of forces, equipment, and support attainable within fiscal constraints” (DoD, 2024, p. G-27). The *DoD Directive 7045.14* (2013) also states, “PPBE shall serve as the annual resource allocation process for DoD within a quadrennial planning cycle” (p. 1). In concert with the DAS and JCIDS, ultimately PPBE appropriately matches priorities with the appropriate levels of support, predominantly fiscally, across the DoD.

The following sections provide overviews of the main actions and objectives of the Planning, Programming, Budgeting, and Execution phases, respectively.

1. Planning

The planning phase of PPBE works to translate strategic guidance into the DoD’s Defense Planning Guidance (DPG), defining strategic goals and priorities aligned with guidance (DoD, 2013). It is during this phase that thoughts laid out through strategic guidance begin to translate into action items across the DoD and Services. Capabilities, both current and future, are evaluated to ensure their alignment with strategic objectives. Finally, the DoD provides Fiscal Guidance (FG) to DoD components and Services to enable appropriate lower-level planning. The Planning phase illuminates priorities, objectives, and resource constraints in a consolidated manner to ensure alignment across the DoD as programs progress through Programming, Budgeting, and Execution.

2. Programming

The Programming phase of PPBE translates the outputs from Planning into actionable items and programs. Throughout this phase, the Program Objective Memorandum (POM) is developed to outline resource and funding requirements for programs over the next 5-year period (DoD, 2013). Additionally, a Capability Program Review (CPR) is conducted to assess a Service’s program proposals to ensure their alignment with higher level strategic objectives (DoD, 2013). Lastly, the Programming phase works to prioritize a Service’s programs across the DoD and allocate resources incumbent upon priorities and fiscal constraints.

3. Budgeting

The budgeting phase of the PPBE refines the outputs from the Planning and Programming phases to formulate detailed budget requests for the DoD and Services. Throughout this phase, a formal Budget Estimate Submission (BES) is compiled from detailed budgeting and justification of DoD proposed programs, considering each program and associated costs, benefits, and funding requirements for the upcoming fiscal year (DoD, 2013). At the conclusion of the budgeting phase, the DoD is able to integrate planned programs and associated fiscal commitments into the Presidential Budget request.

4. Execution

The focus of the execution phase of the PPBE process is to implement approved budgets and monitor and evaluate the programs against key performance indicators. Four major tasks are conducted through the execution phase of PPBE: 1) apportionment, 2) fund allocation, 3) monitoring, and 4) auditing (DoD, 2013). Through apportionment, the DoD distributes funding to Services and DoD components. The fund allocation tasking ensures that the fiscal resources are appropriately allocated to the approved programs and activities. Monitoring and auditing hold similar objectives in the execution phase in that monitoring evaluates program expenditures and performance to ensure strategic alignment, while auditing ensures that funds are utilized appropriately and effectively.

Table 2 summarizes each phase of the PPBE process with a descriptive overview of the phase, who leads the execution of that phase, and the outputs from each phase.

Table 2. Phases, Actors, and Outputs of PPBE Process. Source: McGarry (2022, pp. 7–8).

Phase	Description	Lead Actor	Outputs
Planning	- Review strategic guidance - Assess threats - Evaluate takeaways from wargames - Identify capability gaps and risks	- Under Secretary of Defense (USD), Policy	- Chairman's Program Recommendations - DPG - FG
Programming	- Translate planning decisions into program and resource requirements - Consider program alternatives - Develop five-year projections for forces, personnel, funding	- Director, Cost Assessment and Program Evaluation (CAPE)	- POM - Resource Management Decisions (RMDs) - Future Years Defense Program (FYDP) updates
Budgeting	- Review budget justifications - Consider funding alternatives - Prepare budget submission	- USD, Comptroller	- BES - RMDs - FYDP updates - DoD portion of President's budget request
Execution	- Assess output to planned performance - Adjust resources, as necessary	- USD, Comptroller - DoD component financial managers	- Assessments (internal reviews by OSD and DoD components) - Reprogramming actions and transfers (including external interactions with Congress)

Each phase of the PPBE process is interconnected and plays a critical role in the overall DAS and programs across the DoD. It ensures that the whole of DoD has a comprehensive and cohesive approach to strategic objectives and is appropriately managing its resources. The PPBE process is crucial to ensuring that the DoD is operationally effective and operationally ready at all times.

E. DEFENSE ACQUISITION SYSTEM

The third pillar of the DAS plays a crucial role in executing actions within the DoD's acquisition procedures linking the JCIDS and PPBE processes to ensure that the identified needs of the military are met through the procurement and development of appropriate systems. Often referred to as the "management" portion of the DAS, this pillar addresses the acquisition life cycle for military systems across several stages, starting from initial design and engineering, progressing through production, testing, deployment, and sustainment, and ultimately culminating in the disposal of the systems.

Governed by DoDI 5000.02 (Office of the Under Secretary of Defense for Acquisition and Sustainment [OUSD(A&S)], 2022), which outlines the operation of the Adaptive Acquisition Framework, the process to manage weapon systems acquisition is deliberate and event-driven, advancing through a series of phases and milestones, determining the program's readiness to move forward. A Milestone Decision Authority (MDA) reviews all program documentation and each Milestone to support their decision for a program to progress to the next phase of the acquisition process. For the major capability acquisition pathway, the phases include Materiel Solutions Analysis (MSA), Technology Maturation and Risk Reduction (TMRR), Engineering and Manufacturing Development (EMD), Production and Development (PD), and Operations and Sustainment (OS).

Numerous considerations and stakeholders throughout the process must be balanced to ensure weapon systems acquisition meets the warfighter's needs. These functional supports to the program manager throughout the acquisition life cycle include product support management, test and evaluation, and engineering of defense systems (Defense Acquisition University, 2022).

Checks and balances via the structured approach to acquisition ensure that the DoD effectively manages the development and procurement of military systems, balancing cost, schedule, and performance to meet the needs of the warfighter. But no two systems are alike, and the environment in which they are acquired is fluid. The development and adoption of the AAF enables flexibility within the acquisition strategy to support the needs of the warfighter in a timely manner.

F. THE ADAPTIVE ACQUISITION FRAMEWORK

The AAF offers versatile and flexible methods for acquisition professionals within the DoD to develop effective capabilities. Each pathway and stage within it are designed to ensure that capabilities are developed, produced, and sustained in a way that meets the DoD's strategic needs while simultaneously managing risks and controlling costs. This structured approach ensures that the U.S. military is equipped with the necessary warfighting capabilities to maintain its operational effectiveness and readiness.

The AAF addresses the ever-changing environment surrounding emerging technologies and mission requirements, providing acquisition professionals the opportunity to tailor their acquisition strategy for each unique case. As no two systems are completely alike, the ability to tailor the acquisition pathway enables the AAF to work for those acquisition professionals to effectively deliver capabilities to the warfighter. Figure 4 displays the six frameworks laid out through the AAF and associate governing policies.

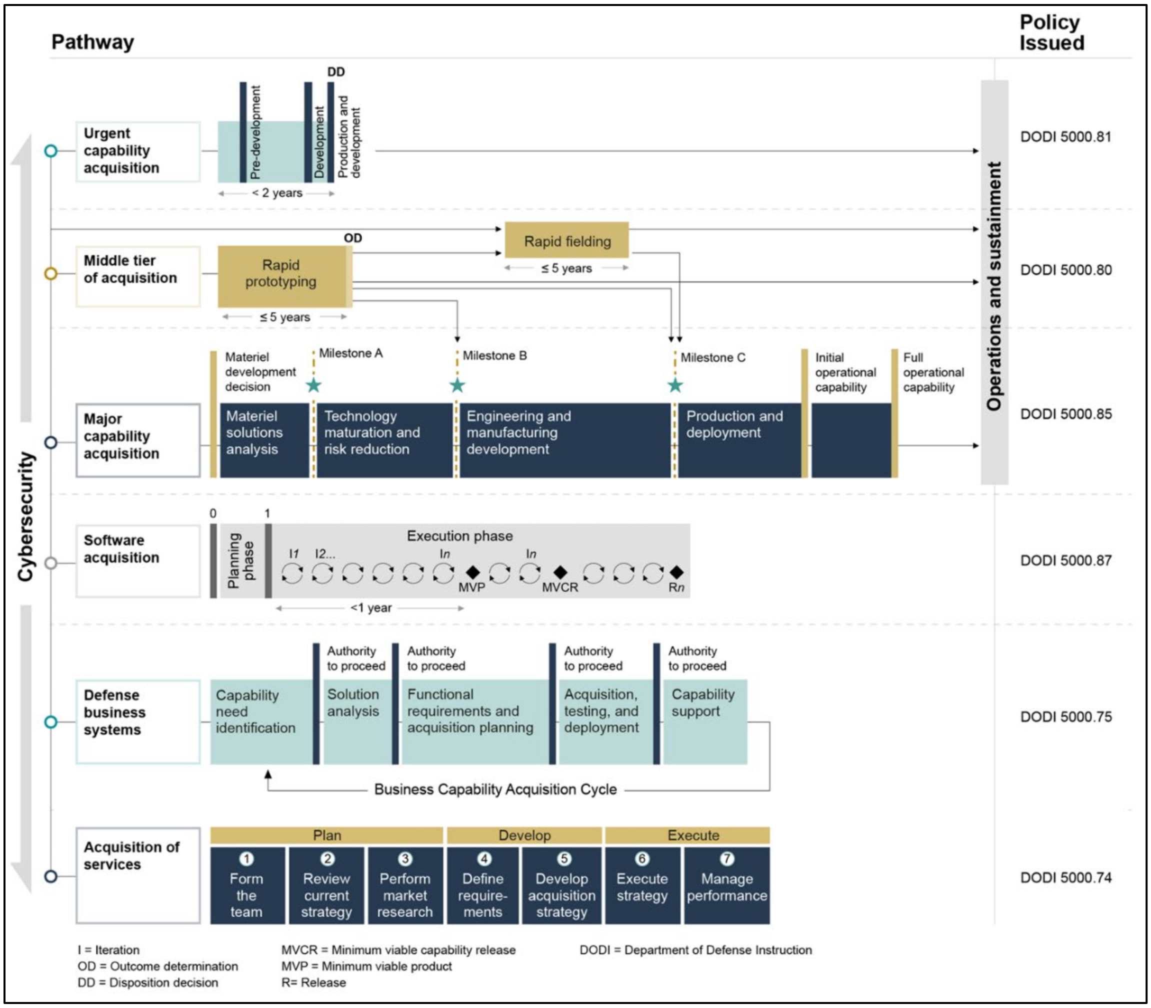

Figure 4. AAF Pathways. Source: Government Accountability Office (GAO; 2023, p. 5).

Specifically, the Middle Tier of Acquisition (MTA) is governed by DoDI 5000.80, *Operation of the Middle Tier of Acquisition (MTA)* (OUSD[A&S], 2019). The MTA is intended to fill a gap in other acquisition pathways to allow technologies with certain levels of technological maturity or technology readiness level (TRL) to be expeditiously acquired and fielded within 5 years. Figure 5 depicts the two pathways—Rapid Fielding and Rapid Prototyping—within MTA.

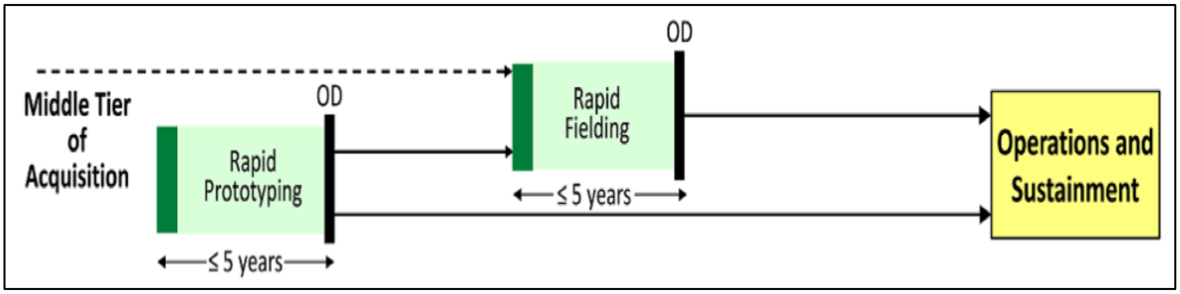

Figure 5. Middle Tier of Acquisition Pathways. Source: OUSD(A&S) (2019, p. 4).

The Rapid Prototyping pathway leverages cutting-edge technologies to swiftly create deployable prototypes, showcasing innovative capabilities and addressing urgent military requirements, attempting to deliver a prototype within 5 years of program initiation. This prototype should meet specified criteria, be demonstrable in real-world conditions, and offer a lasting operational benefit. The Marine Corps is utilizing the MTA to acquire the TRUAS, specifically through the rapid prototyping pathway (Combat Development & Integration [CD&I], 2023).

G. MARINE CORPS FORCE DEVELOPMENT SYSTEM AND CAPABILITIES BASED ASSESSMENT

The Marine Corps Force Development System (MCFDS) is the service-specific process to develop future operational capabilities for the warfighter via an integrated process, closely aligned with JCIDS and PPBE. Its alignment with JCIDS enables the Marine Corps to conduct a Capabilities Based Assessment (CBA) internally but offers the flexibility to pursue a joint capability if the need is identified in other Services. Governed by Marine Corps Order (MCO) 3900.20, *Marine Corps Capabilities Based Assessment* (USMC, 2016), the five-phase CBA process is integral to informing the Marine Corps PPBE process to man, train, and equip Marines with the appropriate capabilities that align with the strategy of the Marine Corps. Figure 6 shows a birds-eye view of the force development activities conducted through the CBA, a continual feedback loop, to develop the most effective warfighting capabilities.

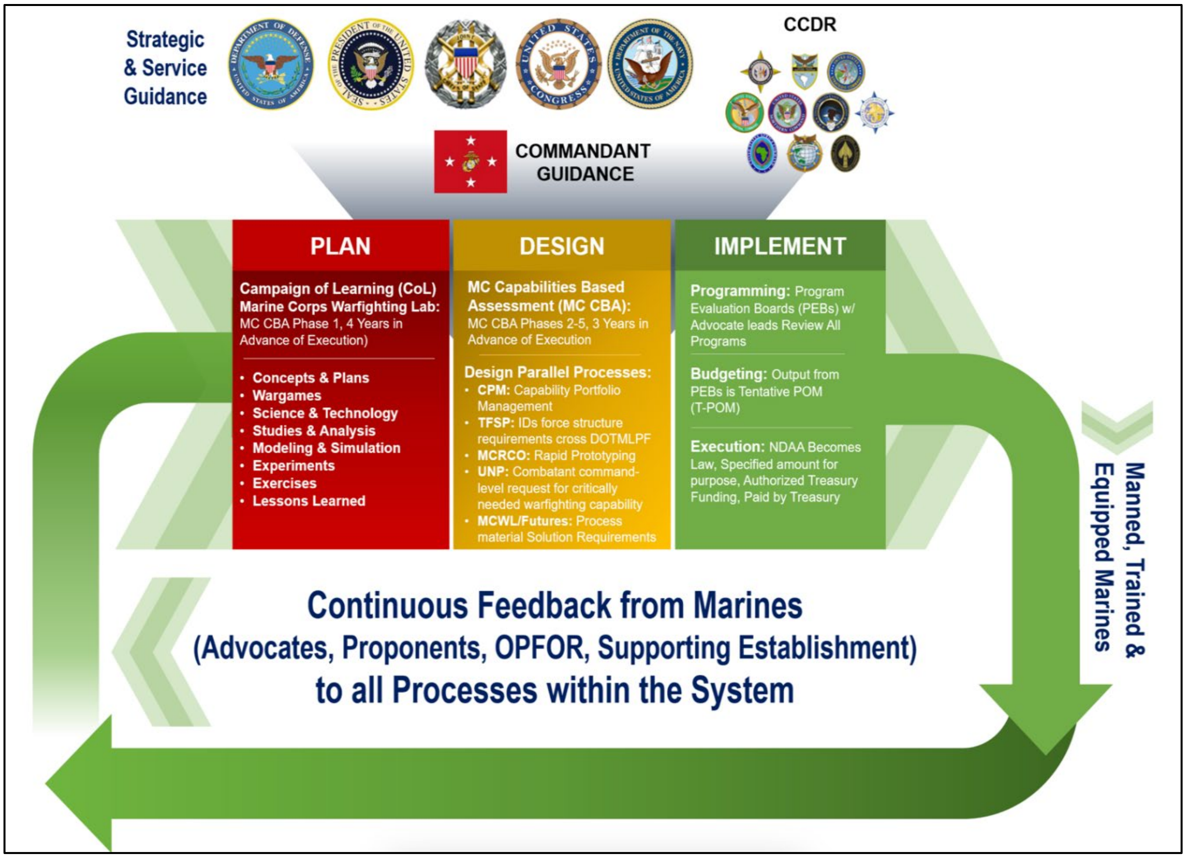

Figure 6. CD&I Force Development Activities. Source: CD&I (n.d.).

Phase I of the Marine Corps CBA is the strategic planning phase also referred to as the “Campaign of Learning” and is initiated by guidance and direction from the president of the United States, Congress, the Office of the Secretary of Defense (OSD), Joint Chiefs of Staff (JCS), the Department of the Navy (DON), the Combatant Commander (CCDR), and the Commandant, Marine Corps (CMC; USMC, 2016). Specific inputs from these entities include the NDS and CMC Planning Guidance. This guidance and direction are birthed from identified needs and gaps in capabilities to advance the Marine Corps warfighter’s capabilities for the future. The two outputs of Phase I are an annual update and a wargame.

Phase II-V is the bulk of the Marine Corps’ CBA to deliberately analyze capabilities, gaps, solutions, and risks across the Marine Air Ground Task Force (MAGTF) warfighting capabilities (USMC, 2016). Figure 7 showcases the detailed flow of Phases II-V of the Marine Corps CBA process, resulting in the capability entering the PPBE process or transitioning to JCIDS.

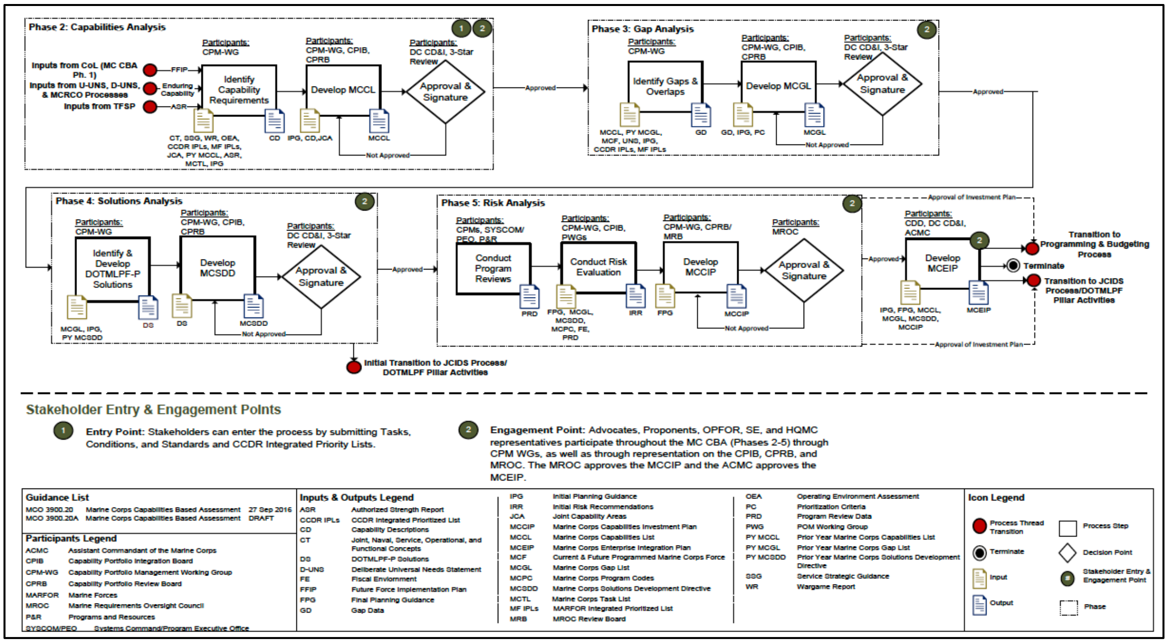

Figure 7. Marine Corps CBA (Phases II-V) Process Flow Chart. Source: CD&I (2018, p. 27).

MCO 3900.20 (USMC, 2016) and the *United States Marine Corps Force Development System User Guide* (CD&I, 2018) define details of the following four phases of CBA as follows. Phase II is Capabilities Analysis, in which capability requirements are defined, born from a plethora of inputs across the Joint and Naval Services, CCDRs, and the CMC. Phase III (Gap Analysis) utilizes those requirements to assess current capabilities and force capacity. Through this process, the Marine Corps Capability List (MCCL) is refined and prioritized based on risk to mission, risk to force, likelihood of occurrence, and the CMC planning guidance, to inform Phase IV, Solutions Analysis. During Solutions Analysis, a DOTmLPF-P analysis is conducted to work toward filling identified gaps, whether through materiel, non-materiel, or a combination of solutions. The solutions analysis moves on to Phase V (Risk Analysis) to synthesize the inputs from Phases II-IV to provide risk recommendations aligned with the initial guidance input into Phase I. As an annual process, the unified approach to identifying gaps, building requirements to fulfill those gaps, and progressing toward the parameters for future warfighting capabilities enables the Marine Corps to support the development of the force for the future.

Embedded within the TFDS, the Marine Corps conducts an annual CBA (see Figure 8). The intent of the CBA process is to

> annually identify and refine Marine Corps and associated naval capabilities, capability gaps and overlaps/redundancies, solutions, and risks within the Future Years Defense Program (FYDP) pertaining to the Program Objective Memorandum (POM) year of analysis. Results of MC CBA analysis will translate Service guidance and the Marine Corps' 10-year objectives into capability development actions and priorities. (USMC, 2016, p. 2)

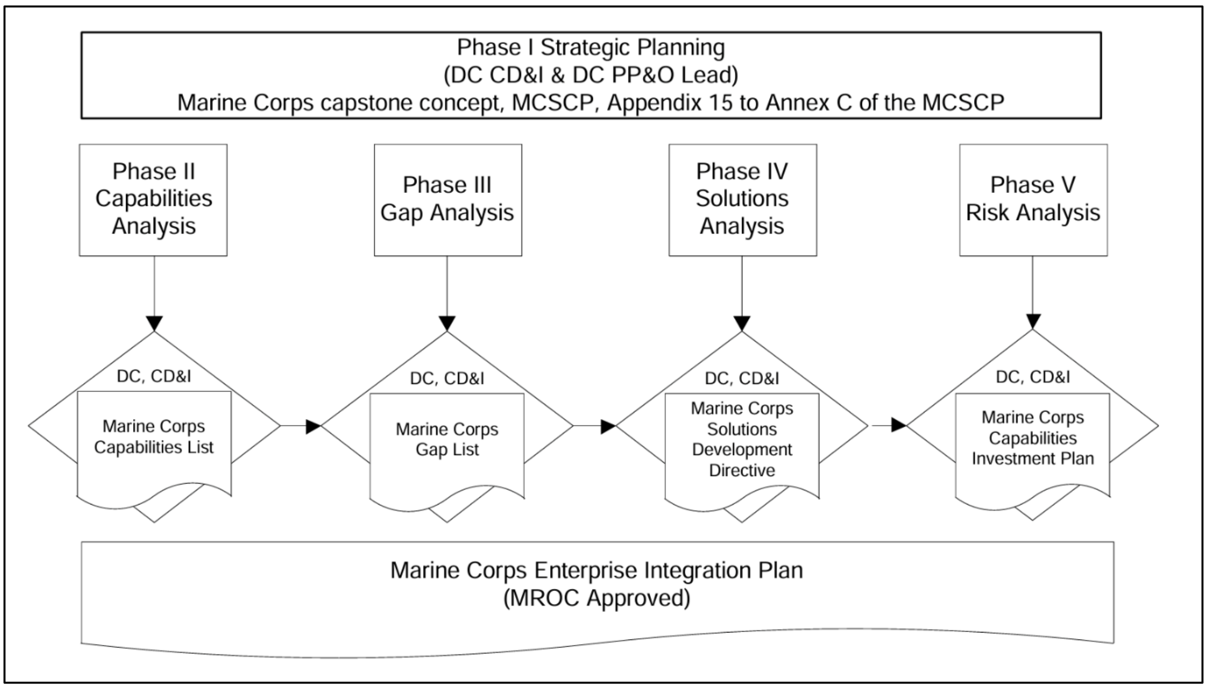

Figure 8. Marine Corps Capabilities Based Assessment Phases. Source: USMC (2016, p. 3).

The five phases of the Marine Corps CBA process are described in detail in the following passages.

1. Phase I: Strategic Planning

Phase I of the Marine Corps CBA process is the transition of strategic guidance into action (USMC, 2016). Similarly to the JCIDS process, the strategic planning phase takes input from strategy documents and direction, operational needs, as well as innovative ideas across the force, and enters them into the CBA process to ensure they align with the strategic objectives of the Marine Corps (USMC, 2016). The strategic planning phase is a three-step process:

Step 1 of Phase I is the development of the Marine Corps Capstone Concept by CD&I. The Capstone Concept provides strategic guidance for the whole of the Marine Corps on how the force will be "postured, organized, trained and equipped to fulfill . . . responsibilities in the evolving security landscape" (USMC, 2016, p. 1-2).

Step 2 of Phase I is Marine Corps Plans, Policies, & Operations (PP&O) providing the MCSCP Base Plan and Annual Update to Appendix 15 to Annex C to CD&I. This step provides the goals and objectives of the Marine Corps, aligned with the 10-year vision of the Marine Corps (USMC, 2016). The Marine Corps Service Campaign Plan (MCSCP) outlays short- and long-term actions to achieve the objectives in supporting the priorities of the CMC.

Step 3 of Phase I is the conduct of the CBA Wargame. The CBA wargame is a biennial occurrence, which gives key stakeholders the opportunity to tease out the requirements surrounding capabilities and gather information to support the MCSCP update (USMC, 2016).

Overall, Phase I of the Marine Corps CBA process intends to bring all guidance and ideas into a cohesive analysis and evaluation process. Table 3 documents the inputs and outputs of each of the steps within Phase I Strategic Planning of the Marine Corps CBA Process.

Table 3. Inputs and Outputs of Phase I of the Marine Corps CBA Process. Adapted from USMC (2016)

Inputs	Outputs
- National and defense strategic guidance - Assessment of threats and the operating environment - Support for Strategic Analysis (SSA) scenario(s), MAGTF Concept of Operations (CONOPS) and associated enterprise Concepts of Support - Allied, Joint, Naval and Marine Corps doctrine and concepts - Marine Corps Lessons Learned - Marine Corps Total Force Structure Authorized Strength Report - Commandant's Planning Guidance (CPG) - Advocates and Proponents Roadmaps - Marine Corps studies, wargaming, experimentation, and science and technology exploration results - Marine Corps Strategic Health Assessment	- Marine Corps capstone concept - MCSCP Base Plan and Appendix 15 update to Annex C - Tasks needed to perform mission outlined in MAGTF CONOPS and support concepts - Updates and refinement of capability requirements based on changes to Appendix 15, Annex C of the MCSCP

2. Phase II: Capabilities Analysis

The Capabilities Analysis (Phase II) is intended to identify capabilities to enable the achievement of Marine Corps strategic objectives. The outcome of Phase II is a prioritized MCCL approved by the Deputy Commandant of Combat Development and Integration (DC CD&I; USMC, 2016). Table 4 documents the inputs and outputs of Phase II Capabilities Analysis of the Marine Corps CBA process.

Table 4. Inputs and Outputs of Phase II of the Marine Corps CBA Process. Adapted from USMC (2016)

Inputs	Outputs
- Applicable Joint, Naval, and Service concepts - Service strategic guidance - Results of the Marine Corps' CBA Wargame results - Threat and operating environment assessments - Deliberate Universal Need Statements - Marine Corps Capabilities List and capability requirements from previous years - Total Force Structure Authorized Strength Report - Marine Corps Task List - Prioritization criteria based on Service strategic guidance for capabilities planning	- Updated capability requirement data elements - MCCL

3. Phase III: Gap Analysis

Phase III is the gap analysis portion of the CBA process in which gaps and redundancies in Marine Corps capabilities are identified and examined (USMC, 2016). Simply because there is a redundancy in capability does not necessarily deter the Marine Corps from pursuing a new capability, but they are specifically identified as redundancy within the force. Conversely, gaps in capabilities are specifically identified and captured in a prioritized manner in the Marine Corps Gap List (MCGL; USMC, 2016). Table 5 documents the inputs and outputs of Phase III Gap Analysis of the Marine Corps CBA process.

Table 5. Inputs and Outputs of Phase III of the Marine Corps CBA Process. Adapted from USMC (2016)

Inputs	Outputs
- Service strategic guidance - Approved, current MCCL - Previous year's MCGL - Current and programmed Marine Corps Forces - Deliberate Universal Needs Statements - Integrated Priority Lists from COCOMs and Marine Corps Forces - Prioritization criteria based on Service strategic guidance	- Updated MCGL - Documentation of analyses

4. Phase IV: Solutions Analysis

Phase IV, the solutions analysis phase of the CBA process, examines the prioritized gaps from the MCGL from a DOTmLPF-P perspective. Within this phase, strategies and supporting tasks are developed to eliminate or mitigate gaps within force capabilities, including recommendations for programming to acquire and develop solutions to fulfill the identified gaps if they are not already developed, or to bolster programs to completely fulfill the required gaps (USMC, 2016). This phase seeks to develop a cohesive strategy, enhancing and drawing down programs, to ensure that solutions are directly impacting the strategic objectives of the Marine Corps. At the conclusion of this phase, the DC CD&I approves the Marine Corps Solutions Development Directive (MCSDD) (USMC, 2016). Table 6 documents the inputs and Outputs of Phase IV Solutions Analysis of the Marine Corps CBA process.

Table 6. Inputs and Outputs of Phase IV of the Marine Corps CBA Process. Adapted from USMC (2016)

Inputs	Outputs
- Current MCGL - Prior year's MCSDD and the status of those solutions - Marine Corps studies, wargaming, experimentation, exercises, and science and technology exploration results and lessons learned - Service strategic guidance	- Marine Corps Solutions Development Directive - DOTmLPF-P solutions for MCGL capability gaps - A set of actions for each DOTmLPF-P solution

5. Phase V: Risk Analysis

Phase V of the Marine Corps CBA process is the risk analysis phase. During this phase, a risk analysis of Tier II and III (Table 7) Marine Corps Capability Areas is conducted to determine which areas programs can accept, maintain, or reduce risk, with the overarching intent of aligning to Service strategic objectives relative to where the capability area is within the POM process (USMC, 2016).

Table 7. Marine Corps Capability Areas Tier Definitions. Adapted from USMC (2016, p. 6-4)

Tier	Definition
I	A collection of similar Marine Corps capabilities grouped at a high level to support strategic investment decision-making, capability delegation, analysis and capabilities based and operational planning. Tier I MCCAs are the Service-level representation of Tier I Joint Capability Areas.
II	A functional or operational capability with sufficient detail to support Service-level operations/mission, or force generation/management activities. Tier II MCCAs scope, bound, clarify, and better define the intended mission set of their Tier I MCCAs.
III	A functional or operational capability with sufficient detail to support Service-level operations/missions, or force generation/management activities. Tier III MCCAs scope, bound, clarify and better define the intended mission set of their Tier II MCCAs.

Table 8 documents the inputs and outputs of Phase V Risk Analysis of the Marine Corps CBA process.

Table 8. Inputs and Outputs of Phase V of the Marine Corps CBA Process. Adapted from USMC (2016)

Inputs	Outputs
- Service strategic guidance - Marine Corps CBA Phase I-IV outputs - Fiscal analyses and analytic support tools - Marine Corps Program Budget Codes mapped to Marine Corps Capability Areas - Program Objective Memorandum - Anticipated fiscal constraints	- Risk recommendations for Tier II and III MCCAs - Fiscally constrained Marine Corps Program Assessment - Marine Corps Capabilities Investment Plan

The production of the Marine Corps Capabilities Investment Plan brings together each phase of the CBA process, aligning with the planning phase of PPBE. This prescriptive CBA process allows the Marine Corps to appropriately allocate resources to ensure the development of capabilities aligned with strategic objectives, in a timely manner. Additionally, the Marine Corps CBA process parallels the JCIDS, in that a DCR or Initial Capabilities Document is developed throughout the CBA process as necessary, to enable fluid transitions through each decision support system. Figure 9 depicts the flow from the Marine Corps CBA process into the JCIDS workflow.

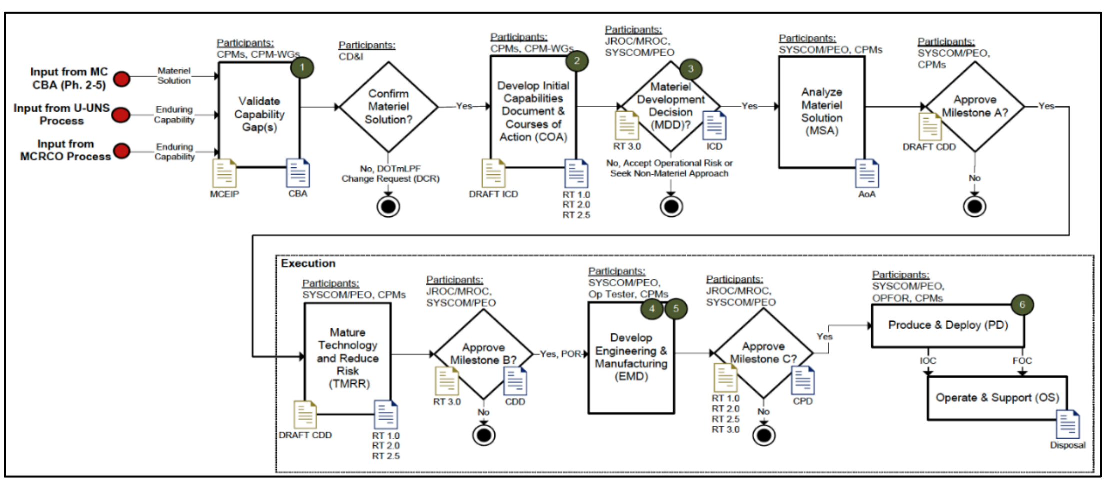

Figure 9. Marine Corps CBA in JCIDS Flowchart. Source: CD&I (2018, p. 37).

H. CONTESTED LOGISTICS

> An environment in which the armed forces engage in conflict with an adversary that presents challenges in all domains and directly targets logistics operations, facilities, and activities in the United States, abroad, or in transit from one location to the other. (Operational Energy, 2024)

The phrase *contested logistics* has become omnipresent in discussions surrounding future conflict and the pacing threats of China and Great Power Competition (Harrison, 2023). Although the term seems new, LTC Fox (2024) contends that contested logistics is nothing new; rather the United States grew accustomed to the relative uncontested nature of the Global War on Terror (GWOT). He continues this argument of the historical nature of contested logistics through vignettes dating back to the U.S. Civil War, World War I, and World War II in which logistics and supply chains, critical to military operations, were contested and when appropriate, targeted, severely diminishing force capabilities. Perna and Beougher (2024) reiterate this point that the two decades of conflict in CENTCOM, which were relatively uncontested and reliant heavily on contracted logistics, have created a gap in experience for the U.S. military in "projecting, protecting, and fighting in multi-domain operations" (p. 3).

As the Title 10 definition states, contested logistics inculcates that adversaries will target logistics operations across the spectrum and globe. The undersecretary of defense for sustainment has prioritized "the ability to navigate and prevail through a Contested Logistics environment" (Lowman, 2023, para. 3).

The priority of contested logistics has seen its way into each of the Services' priorities, specifically the Marine Corps in Force Design 2030, I&L 2030, and even an update to MCDP 4 Logistics. Dougherty (2023) offers an expansive analysis of actions to be considered across the spectrum to address the contested logistics dilemma. He proposes the use of unmanned systems as a tenable solution, in concert with numerous other strategies, to lower the risk of logistics and sustainment operations in contested environments, but concludes that not only the Marine Corps, but the Joint Force must develop adaptive concepts quickly "instead of waiting to adapt in combat" (Dougherty, 2023, p. 35).

Many, if not all, of the discussions surrounding contested logistics posit that action must be swift and flexible to ensure success in the future operating environment. Services are ultimately responsible to man, train, and equip their personnel to support operations, including in the "contested logistics environment," but the Services must work in concert to achieve the greatest level of success. Addressing such challenges, although Joint in nature, is not currently guided by a cohesive, Joint strategy; thus, Services must take actions individually and on the margins to attack the growing gap in knowledge and capability (Perna & Beougher, 2024). The DAS must support these priorities and the Services in their endeavors to act quickly and appropriately to ensure the logistical support capabilities are ready for the battlefield before it is too late.

I. MARINE CORPS ULS-A CHRONOLOGY

For over four decades, the Marine Corps has been utilizing UAS, predominantly for ISR capabilities. But in December 2011, the Marine Corps deployed the KAMAN K-MAX cargo UAS (CUAS) for a logistics mission set in Afghanistan (Roach, 2011). The K-MAX CUAS was deployed to Marine Unmanned Aerial Vehicle Squadron – 1 (VMU-1) and VMU-3 on a rotational basis in Afghanistan. The impetus for the deployment of the K-MAX was due to a realized susceptibility of the traditional ground convoys due to improvised explosive devices throughout Afghanistan. The K-MAX enhanced logistical capabilities and reduced risk to mission in the environment where U.S. forces maintained air superiority.

The KAMAN K-MAX (Figure 10) operated in Afghanistan from December 2011 through April 2014, conducting resupply missions exceeding 2,250 tons of cargo (Freedberg, 2014). Although the capability seemed to show a high degree of mission success and provide a viable capability to supplement traditional resupply methods, when the K-MAX returned from Afghanistan in 2014, its future, militarily, was uncertain (Freedberg, 2014).

Figure 10. KAMAN K-MAX Operating in Afghanistan. Source: Quick (2011).

It wasn't until 2 years later, in 2016, that the JROC approved an ICD from the Marine Corps for the MAGTF UAS Expeditionary (MUX) program in which the program goal was to merge two sets of requirements and provide seven distinct capabilities: 1) MAGTF Command, Control, Communications, and Computing, 2) early warning, 3) persistent fires, 4) escort, 5) electronic warfare, 6) Reconnaissance, Intelligence, Surveillance, and Target Acquisition, and 7) tactical distribution, in a singular platform (Eckstein, 2016). Eventually, Marine Corps planners realized that the desire for a singular system to house these seven capabilities on one platform was unrealistic and in March 2020, LtGen Rudder (Deputy Commandant, Aviation) stated that "the MUX program is […] going to require a family of systems" (Eckstein, 2020, para. 3). To fulfill the distribution capability initially identified with the MUX program, LtGen Dana (2017) proposed concept of hybrid logistics, which included UAS, which ultimately developed into the ULS-A program as it is known today.

Although LtGen Dana's proposition was instrumental in the progression of the conversation surrounding ULS-A, the Marine Corps Warfighting Laboratory (MCWL) began the initial steps of the Marine Corps CBA process through a wargaming scenario of the ULS-A capability in November 2016. During this time, HQMC Logistics Vision and Strategy Branch sponsored the wargame to "explore responsiveness in logistics resupply utilizing limited Amphibious Ready Group/Marine Expeditionary Unit (ARG/ MEU) assets in a distributed environment" (MCWL, 2017, p. 1). The wargame objectives were to 1) explore CONOPS and CONEMPS to assist with the development of notional ULS-A system variants (Small, Medium, and Large) and 2) examine each ULS-A variant's capability (MCWL, 2017). The conclusion of the wargame brought to light eight key insights ranging from C2 to interoperability to DOTmLPF-P considerations, as well as five overarching recommendations surrounding the development of each of the three variants. This wargame was instrumental, as MCWL worked in concert to CD&I to develop the capability requirements for the ULS-A systems.

1. Small, Medium, Large ULS-A Specifications

At the time of the MCWL Wargame, each of the three variants had various platform specifications that supported the notional concept of operations. Table 9 lays out these draft specifications. Due to this Wargame being conducted in/around Phase I of the Marine Corps CBA process, these specifications have developed into the Key Performance Parameters (KPPs) laid out in specific requirements documentation for each variant of the ULS-A.

Table 9. ULS-A Platform Specifications. Source: MCWL (2017, p. 9).

ULS-A Variant	Specifications
Small	Max Vehicle Weight: 150lbs Max. Payload Weight: 50lbs Max. Operational Radius: 30km Max. Endurance: 1 hour Max. Speed: 35kts (65km/hr) DataLink: Line of Sight; 30km Fuel Consumption Rate: 2 gal/hr
Medium	Max Vehicle Weight: 1200lbs Max. Payload Weight: 500lbs Max. Operational Radius: 100km Max. Endurance: 2 hours Max. Speed: 70kts (130km/hr) DataLink: Line of Sight; 100km

	Fuel Consumption Rate: 2 gal/hr
Large	Max Vehicle Weight: 20,000lbs Max. Payload Weight: 5,000lbs Max. Operational Radius: 350nm Max. Endurance: 3.5 hours Max. Speed: 250kts (463km/hr) DataLink: Beyond Line of Sight and Line of Sight; 100km Fuel Consumption Rate: 250 gal/hr

Given these specifications, UAS fall into specific group classifications, which ultimately determine policy implications for operations of the vehicles. Figure 11 displays the requirements for UAS Group Classifications and what classification each ULS-A would potentially be classified given the MCWL Wargame specifications.

UA Category	Maximum Gross Takeoff Weight (lbs)	Normal Operating Altitude (ft)	Speed (KIAS)	Representative UAS
Group 1	0-20	< 1200 AGL	100 kts	WASP III, TACMAV RQ-14A/B, Buster, Nighthawk, RQ-11B, FPASS, RQ16A, Pointer, Aqua/Terra Puma
Group 2	21-55	< 3500 AGL	< 250	ScanEagle, Silver Fox, Aerosonde
Group 3	< 1320	< 18,000 MSL	< 250	RQ-7B Shadow, RQ-15 Neptune, XPV-1 Tern, XPV-2 Mako
Group 4	> 1320		Any Airspeed	MQ-5B Hunter, MQ-8B Fire Scout, MQ-1C Gray Eagle, MQ-1A/B/C Predator
Group 5	> 1320	> 18,000 MSL	Any Airspeed	MQ-9 Reaper, RQ-4 Global Hawk, RQ-4N Triton

Legend

AGL	above ground level	lbs	pounds
FPASS	force protection aerial surveillance system	MSL	mean sea level
ft	feet	TACMAV	tactical micro air vehicle
KIAS	knots indicated airspeed	UA	unmanned aircraft
kts	knots	UAS	unmanned aircraft system

Figure 11. DoD UAS Group Classifications. Source: Joint Chiefs of Staff [JCS] (2021a, p. III-31).

Given initial operational requirements surrounding payload weight, the Small variant would be likely be classified as a Group 3 UAS, while the Medium, renamed to the MARV-EL and Large, renamed ALC, variants would be classified as Group 4 UAS.

These preliminary requirements identified during the MCWL Wargame that, alongside the JCS JP 3-30 (JCS, 2021a), there was an obligation for the Marine Corps to address individual requirements across the spectrum of technical performance, as well as all seven tenets of DOTmLPF-P.

2. Tactical Resupply Unmanned Aircraft System Requirements

On March 10, 2023, CD&I published a Requirements Memorandum (RM) for the Small variant of the Marine Corps ULS-A, renamed TRUAS. The RM sets forth numerous requirements details—Key Performance Parameters (KPP), Key System Attributes (KSA), Other System Attributes (OSA)—surrounding the TRUAS based upon validated capability and POM gaps. Identified in the *TRUAS RM* (CD&I, 2023), those validated capability and POM gaps include

1. Dismounted ground maneuver element combat loading
2. Dismounted group maneuver element unmanned systems capability
3. Dismounted ground maneuver element sustainment capability
4. Ability to conduct distribution operations in support of EABO
5. Distributed laydown logistics support in the Pacific
6. Ability to conduct autonomous distribution in intra-EAB sustainment
7. Ability to conduct littoral distribution operations
8. Operational level logistics integration (p. 8-9)

To fulfill the need of these validated gaps, CD&I developed a comprehensive set of requirements to necessitate the development and procurement of UAS. Table 10 lays out the broad requirements of the TRUAS.

Table 10. TRUAS Requirements Overview. Adapted from CD&I (2023)

Requirement	KPP	KSA	OSA
Cyber Survivability	X (Mandatory)		
Electromagnetic Spectrum Survivability	X (Mandatory)		
Kinetic Survivability	X (Mandatory)		
Non-Kinetic Survivability	X (Mandatory)		
Force Protection	X (Mandatory)		
Energy	X (Mandatory)		
Sustainment	X (Mandatory)		
Performance	X		
Winds	X		
Navigation	X		
Software		X	
Hardware		X	
TRUAS Storage Container Dimensions		X	
Accuracy		X	
Command and Control (C2)		X	
C2 Inflight Commands		X	
Delivery Speed		X	
Lost Link Procedures		X	
Air Drops		X	
Payload Dimensions		X	
One Motor Out Redundancy		X	
Enabling Autonomy Technologies		X	
Waypoint Handling		X	
Maritime Operations		X	
Embedded Instrumentation, Electronic Attack, and Wartime Reserve Mode			X
Human Systems Integration			X
Natural Environmental Factors			X
Physical and Operational Security			X
Weather, Oceanographic, and Astrophysical Support			X
Air and Sea Transportability and Deployability			X
Size, Weight, and Power			X
Physical Interoperability			X
Airspace Control			X
Net-Ready Interoperability			X
Modular Open Systems Architecture			X
Electromagnetic Spectrum Compatibility			X
Electromagnetic Environmental Effects			X
Electrical and Electronic Systems, Subsystems, Equipment			X
Communications/Information System Support			X
Technology Readiness			X

In addition to the specified operational requirements for the TRUAS, the *TRUAS RM* (CD&I, 2023) addressed, at a high-level, DOTmLPF-P considerations for the system (Table 11).

Table 11. TRUAS DOTmLPF-P Considerations. Adapted from CD&I (2023, pp. 45–49)

DOTmLPF-P Tenet	Consideration(s)
Doctrine	- Minor updates to six publications – MCTPs and MCRPs - Necessity to develop standardized TTPs for TRUAs employment
Organization	- Marines across the MAGTF will be trained on the TRUAS and receive a Free MOS
Training	- Operator training via Training and Logistics Support Activity (TALSA) - Unit training via TALSA - Corrective maintenance training by the operator is a goal - Manpower, Personnel, Training Integrated Product Team will provide final recommendations
materiel	- Authorized Acquisition Objective of 179 TRUAS
Leadership and Education	- Need to develop a communications plan
Personnel	- Intended to be operated by Marines with Free Military Occupational Specialty (FMOS) - Only personnel impacts to TALSAs
Facilities	- PMA-263 to conduct a Facilities Impact Report - MILCON and FSRM requirements are TBD - Requirements for storage, battery charging capability, and range requirements - Federal Aviation Administration (FAA), spectrum, Host Nation approval/authorization are expected to have minimal impact - Specific dimensions for storage of one system and number of charging stations requirements
Policy	- Marine Corps and Joint policy implications - Until Training and Education Command has a validated curriculum, TACPs will operate TRUAS - Proposed change to DoD UAS categorization

Overall, the *TRUAS RM* (CD&I, 2023) sets a high-level overview of the operational requirements for the system. Although the acquisition strategy is through Rapid Prototyping, and the TRL of the TRUAS is high, there are a multitude of nuances to ensure the effective and efficient integration of the system into the larger force (CD&I, 2023). Without this integration, the TRUAS, and subsequent ULS-A programs, will fail to achieve the strategic, operational, and tactical objectives.

III. LITERATURE REVIEW

This chapter seeks to provide an overview and synthesis of key documents and publications that influence the ULS-A portfolio for the Marine Corps, along with their impact on the elements of DOTmLPF-P. The discussion begins with a broad examination of DoD policies affecting the DAS and narrows to how the Marine Corps identifies and addresses capability gaps and requirements. The section then progresses to explore Marine Corps strategy and vision documents that have shaped the Service's current and future roles. Following this, the focus shifts to Marine Corps doctrine that specifically addresses the operation of UAS within the context of ULS-A. Lastly, a recently published white paper on contested logistics is reviewed to provide further insight into the future operational environment and inform the concept of employment for ULS-A.

Collectively, these publications offer critical insights into the acquisition landscape and UAS operations, helping to deepen understanding and strengthen DOTmLPF-P considerations for the employment of ULS-A by the Marine Corps.

A. DOD ACQUISITION POLICY

1. Chairman of the Joint Chiefs of Staff Instruction 5123.01i, Charter of the Joint Requirements Oversight Council and Implementation of JCIDS

CJCSI 5123.01I (CJCS, 2021) governs the framework and responsibilities of the JROC and the implementation of JCIDS. The charter serves a crucial role in guiding the DoD's actions in identifying, prioritizing, and validating joint military requirements and capabilities to address strategic and operational capability gaps. The charter also addresses the interrelationship of JCIDS and the JROC in both the PPBE process and the DAS.

The Instruction ensures that the development and acquisition of military capabilities are coordinated and aligned with broader DoD strategic objectives, specifying a structured approach to addressing both current and future operational needs.

2. JCIDS Manual

The JCIDS Manual supports CJCSI 5123.0I in providing granular guidance for the execution of the JCIDS process to enable the JROC to fulfill its duties and enable stakeholders to develop capabilities for the warfighter in a timely and cost-effective manner. The JCIDS Manual (2021b) consists of four major sections: 1) the deliberate, urgent, and emergent JCIDS processes, 2) formats for JCIDS documentation, 3) capability portfolio management, and 4) requirements management (p. 2). Each section, identified as enclosures, provides great detail on how the JROC is supposed to execute its duties, nearly step-by-step.

Annex F to Appendix G of Enclosure B, titled "DOTmLPF-P Guide," has an objective: "to ensure Sponsors adequately address non-material aspects of a capability during requirement definition and capability development (JCIDS Manual, 2021b, p. B-G-F-1). This annex specifically addresses how the JROC will conduct a DOTmLPF-P analysis, across each of the tenets, with additional references on the detail required to ensure a thorough analysis is conducted. The JCIDS Manual also further assigns responsibility to Function Process Owners (FPO) to ensure accountability of each step of the analysis, but also to ensure that appropriate subject matter experts are involved in the evaluation process.

A detailed, desktop guide to JCIDS, the JCIDS Manual prescribes a framework to enable the DoD to make informed decisions on how best to allocate resources and make strategic changes to support the mission effectively.

3. Department of Defense Instruction 5000.02, Operation of the Adaptive Acquisition Framework

The DoDI 5000.02, *Operation of the Adaptive Acquisition Framework* (OUSD[A&S], 2022), provides comprehensive guidance on managing the acquisition of defense systems. Central to the DAS, DoDI 5000.02 (OUSD[A&S], 2022) lays out an agile, yet deliberate, event-driven framework for acquisition professionals to acquire and deliver capabilities within cost, schedule, and performance parameters.

DoDI 5000.02 (2022) provides a modular approach via six tailored pathways to support an agile, responsive, and customizable acquisition strategy. The six AAF pathways governed by this instruction are

- Urgent Capability Acquisition
- Middle Tier Acquisition
- Major Capabilities Acquisition
- Software Acquisition
- Defense Business Systems Acquisitions
- Defense Acquisition Services. (OUSD[A&S], 2022)

Any of the acquisition pathways can be utilized, with approval of the MDA, and can transition from one pathway, but must achieve certain thresholds. Although governed overall by DoDI 5000.02, each pathway has additional instructions related to the execution of each in greater detail.

DoDI 5000.02 aims to make the acquisition process more efficient, responsive, and capable, to deliver warfighting capabilities in a fluid environment. The AAF provides acquisition professionals flexibility to deliver effective, suitable, survivable, sustainable, and affordable solutions in a manner that aligns appropriately to the capability, instead of a one size fits all solution.

4. Department of Defense Instruction 5000.80, Operations of the Middle Tier of Acquisitions (MTA)

DoDI 5000.80, *Operations of the Middle Tier of Acquisitions (MTA)*, delves into greater details on the utilization of the Rapid Fielding and Rapid Prototyping pathways of the AAF. The intent of the MTA is to enable the filling of a capability gap with technologies at a certain level of TRL to field the capability within 5 years (OUSD[A&S], 2019). As with the AAF wholly, the MTA is designed to be agile and allow for the acquisition of weapon systems in a fast, yet efficient manner.

The rapid fielding pathway enables acquisition professionals to utilize proven technology to field quantities of new or upgraded systems that require minimal development (OUSD(A&S), 2019). Unique to this pathway is the expedited production timeline, in that the objective is, “to begin production within 6 months and complete fielding within 5 years of the MTA program start date” (OUSD[A&S], 2019, p. 3). The rapid prototyping pathway enables the use of innovative technologies to demonstrate a capability to meet an identified need. DoDI 5000.80 (OUSD[A&S], 2019) defines the objective of the rapid prototyping pathway as "to field a prototype meeting defined requirements that can be demonstrated in an operational environment and provide for a residual operational capability within 5 years of the MTA program start date" (p. 3).

Although the MTA provides a framework for the DoD to leverage current technology and mature processes to rapidly fulfill the needs of the warfighter, checks and balances are still instituted to ensure appropriate execution. DoDI 5000.80 (2019) prescribes responsibilities and authorities throughout the acquisition life cycle to ensure that programs meet the requirements for entrance into the MTA and align with the intent of the MTA.

B. MARINE CORPS POLICY AND DOCTRINE

1. Marine Corps Order 3900.20, Marine Corps Capabilities Based Assessment

Marine Corps Order 3900.20, *Marine Corps Capabilities Based Assessment* (USMC, 2016), prescribes the procedures and responsibilities throughout the execution of the CBA process. The CBA process is aimed at identifying, analyzing, and addressing capability gaps within the USMC and is integral in ensuring that the Service remains postured to meet operational challenges. Through the systematic approach, the USMC is able to evaluate current capabilities, identify deficiencies and gaps, and propose solutions, whether materiel or non-materiel, that align with strategic objectives.

MCO 3900.20 (USMC, 2016) prescribes a structured approach and clear responsibilities to analyzing USMC capabilities. The five-phase CBA process, defined in detail in Chapter II, Section F.1, ensures that stakeholders across the Marine Corps deliberately and collaboratively conduct the evaluation process as it is crucial in informing decisions surrounding resource allocation, force development, and integration of future capabilities.

Pivotal to the efforts to modernize and adapt to the future operating environments, MCO 3900.20 (USMC, 2016) establishes the robust framework to enable the USMC to maintain and advance its warfighting capability.

2. Marine Corps Warfighting Publication (MCWP) 3–42.1, Unmanned Aerial Vehicle Operations

Marine Corps Warfighting Publication (MCWP) 3–42.1, *Unmanned Aerial Vehicle Operations* (USMC, 2013) is the high-level publication addressing considerations for planners and UAS personnel related to planning requirements, command and support relationships, processes and procedures for requesting UAS support, and individual UAS capabilities. MCWP 3-42.1 establishes a foundational understanding of UAV operations within the Marine Corps to enable successful employment during operations. MCWP 3-42.1 does not specifically address UAS whose primary mission is resupply, but many of the requirements/considerations for UAVs will likely apply to the employment of ULS-A programs.

3. Marine Corps Reference Publication (MCRP) 3–10.3, Small Unmanned Aerial System Operations

Marine Corps Reference Publication (MCRP) 3–10.3, *Small Unmanned Aerial System Operations* (USMC, 2023b), is a publication to refer to the operations and employment of Small UAS. MCRP 3–10.3 addresses considerations surrounding mission planning; airspace integration; aircrew coordination; reconnaissance, surveillance, and target acquisition; ground escort requirements; integration of SUAS with all supporting arms of operations and air support; shore and sea-based operations; extreme environments; electromagnetic warfare; and the TRUAS specifically.

Chapter 13, Tactical Resupply Unmanned Aircraft System, was the major addition to the publication updates in 2023. The three pages delve into the TRUAS purpose and operational employment concept. The majority of the publication surrounding the TRUAS espouses details related to the employment of the system addressing the essential personnel for system use, considerations for airspace coordination, and maintenance requirements for the system.

C. MARINE CORPS STRATEGY

1. Littoral Operations in a Contested Environment

Littoral Operations in a Contested Environment (LOCE) (USMC, 2017) establishes a conceptual framework for U.S. Marine Corps and U.S. Navy operations in an integrated manner, addressing emerging threats. It recognizes that the future operating environment will likely occur in littoral regions, requiring an integrated approach by both Services. The concept emphasizes the need for an integrated naval force that can operate effectively across all domains, prioritizing agile, distributed, and technologically advanced forces to counter anticipated enemy capabilities. *LOCE* (USMC, 2017) stresses the need for capabilities such as improved intelligence, surveillance, and reconnaissance (ISR) systems, long-range precision fires, advanced air and missile defense, and unmanned systems, to enable successful operations.

LOCE (USMC, 2017) concludes with broad capability requirements across the warfighting functions to support the concept. Sustainment capabilities noted were the largest of all functions, implying the need for improvement in weapons systems to support the critical function of logistics in littoral operations in a contested environment.

Not only are advances in weapon systems and capabilities required to achieve the end state proposed in *LOCE* (USMC, 2017), but it also introduces the requirement for changes across each of the tenets of DOTmLPF-P. *LOCE* ignited major shifts in the Marine Corps, which were further supported through the *38th Commandant's Planning Guidance* (Berger, 2019) and *Force Design 2030* (USMC, 2020).

2. 38th Commandant's Planning Guidance

The *38th Commandant's Planning Guidance* (CPG), issued by General David H. Berger in 2019, is a pivotal document outlining the strategic vision and priorities for the Marine Corps. It emphasizes the need for the Marine Corps to adapt to an increasingly complex and competitive environment, marked by innovation and technological change, as well as evolving threats, particularly in the Indo-Pacific region.

General Berger's CPG set the foundation for the more detailed provisions of *Force Design 2030* (USMC, 2020). As a vision for the direction of the Service, the document highlights the necessity of aligning the Marine Corps' resources and capabilities with the demands of the future operating environment, reiterating the importance of EABO, DMO, and the need for a lighter, more agile force that can operate effectively in contested environments.

The CPG also stresses the importance of talent management, modernization, and joint integration. It calls for a reevaluation of personnel policies to attract and retain the best talent, particularly in critical areas such as cyber and electronic warfare. Additionally, the guidance builds upon an emphasis on the need for the Marine Corps to integrate more effectively with the Navy, as set forth in *LOCE* (USMC, 2017). Berger (2019) goes even further to emphasize the importance of integration across the Joint Force, not limited to the Navy.

Moreover, the CPG addresses the importance of innovation and experimentation, encouraging the Marine Corps to adopt new technologies and operational concepts to maintain a competitive edge. It calls for a more iterative and adaptive approach to capability development, where feedback from the field informs the continuous improvement of tactics, techniques, and procedures.

The *38th Command's Planning Guidance* (Berger, 2019) marks a significant shift in the Marine Corps' strategic focus, emphasizing the need for adaptability, innovation, and integration in an era of renewed great power competition. It sets the stage for the transformation of the Marine Corps into a force that is better equipped to meet the challenges of the 21st century.

3. Force Design 2030

Force Design 2030 is a comprehensive plan for modernizing the USMC, first introduced by Commandant General David H. Berger in 2020. This initiative represents a significant shift in Marine Corps strategy, structure, and capabilities to address emerging threats and operate effectively in future conflict environments. As Berger (2020) emphasizes in his planning guidance, the focus is on preparing the Marine Corps for great power competition, particularly in the Indo-Pacific region.

A key aspect of *Force Design 2030* is the concept of EABO, in which Marines operate from austere, temporary locations to support naval campaigns (Berger, 2019). This shift in the way the Marine Corps has operated in recent history, committing resources to GWOT, requires significant changes in force structure, including the divestment of capabilities like tanks and a reduction in traditional infantry units in favor of more mobile, distributed forces.

The plan places a strong emphasis on modernizing the Corps' capabilities for the information age. As outlined in the initial Force Design report (USMC, 2020), this includes investments in long-range precision fires, unmanned systems, and enhanced electronic warfare capabilities. The changes proposed within Force Design 2030 align with broader DoD efforts to maintain technological superiority over potential near-peer adversaries.

The implementation of *Force Design 2030* has significant implications for Marine Corps not only in the acquisition of new technology and weapon systems, but also across the tents of DOTmLPF-P. The strategic vision addresses the necessity for developing new skill sets among Marines, particularly in areas like cyber operations and unmanned systems.

Force Design 2030 represents a bold reimagining of the Marine Corps for the challenges of the future operating environment. There is an understanding that adoption and implementation will be chaotic, but the alignment of Force Design 2030 with broader DoD strategic visions will be crucial to ensure the Marine Corps achieves its goal of maintaining operational readiness and efficiency in future conflict.

4. Installations and Logistics 2030

Installations and Logistics (I&L) 2030 (USMC, 2023a) is a strategic vision document that outlines the future direction for Marine Corps logistics and installation management. It aligns with the broader Force Design 2030 initiative and aims to transform how the Marine Corps supports and sustains its operations in an increasingly complex global environment.

A key focus of *I&L 2030* (USMC, 2023a) is the concept of EABO, which requires a significant shift in logistics capabilities to support DMO. It places a heavy emphasis on the need for more mobile, adaptable, and resilient logistics systems that can operate in contested environments with minimal footprint.

To achieve the goals of EABO and DMO, *I&L 2030* (USMC, 2023a) highlights the importance of emerging technologies, namely artificial intelligence, additive manufacturing, and autonomous systems to enable future logistics operations. Other prominent themes throughout the vision are sustainability and energy efficiency, to improve the overall footprint of logistics operations, especially as it pertains to operating in contested environments. *I&L 2030* (USMC, 2023a) also addresses the human element of logistics transformation and the need for a change in mindset surrounding personnel and manning. The need for a highly skilled, adaptable Marine Corps to leverage potentially new capabilities and technologies in the future operating environment is critical to the success of sustainment operations.

The vision set forth in *I&L 2030* (USMC, 2023a) represents a significant shift in the way in which the Marine Corps must think about logistics and installation management. Throughout I&L 2030, the criticality of logistics is reiterated to emphasize the requirement for changes to occur within the force that and future operational success is heavily weighted on the success of the investment in new technologies and capabilities to support logistics operations.

D. UAS STRATEGY

1. United States Marine Corps Cargo Unmanned Aircraft Systems Program of Record Study

The *Cargo UAS Program of Record Study* was published in 2013, analyzing the potential benefits of CUAS for logistics operations within the Marine Corps (Swan et al., 2013). Broadly, the study looked across the spectrum, from capability requirements predicated upon gaps to future systems requirements, costs, and DOTmLPF implications for such a program. Swan et al. (2013) conducted a very thorough qualitative and quantitative assessment in an attempt to frame the conversation surrounding UAS as a logistical resupply capability.

One key component of the study was an in-depth DOTmLPF analysis, evaluating the non-materiel implications of a CUAS capability. Through an analysis of current doctrine, Swan et al. (2013) addressed two major factors that must be addresses in Marine Corps doctrine, 1) the C2 of CUAS in the airspace with manned aviation assets and 2) the use of CUAS in what they refer to as "seabasing operations," but can be tied to EABO and DMO in today's environment.

Organizationally, they conducted a qualitative analysis via interviews from multiple different communities to highlight the pros and cons of seven unique organizational constructs. Swan et al. (2013) concluded that a CUAS capability would best be organized in a CUAS-specific squadron within the ACE.

Through their analysis of the training implications of a CUAS program, Swan et al. (2013) identified the necessity for a robust training program to enable the employment of such systems, to include the establishment of a specific Primary MOS for CUAS operators. They also addressed current expertise within the Fleet Marine Force that have the potential to conduct operations similar to a CUAS and noted the requirement to look at the force structure broadly to consider potential restructuring.

The study conducted a technical materiel analysis of capabilities, to include the KAMAN K-MAX utilized in Afghanistan, against current manned aviation assets across a variety of technical parameters, identifying near-term solutions for the Marine Corps, as well as emerging capabilities that could be developed further to fulfill the operational capability gap (Swan et al., 2013).

Swan et al. (2013) utilized the assumptions and conclusions from the organizational analysis to provide detailed personnel recommendations for a CUAS capability, utilizing the data from the KAMAN K-MAX operations in Afghanistan to inform their conclusions. Overall, they recommended approximately 20 Marines to support two systems in a detachment task organization and 71 Marines to support 4 CUAS in a larger detachment. This force structure led Swan et al. (2013) to conclude that a unit of three elements (Headquarters, Detachment A, and Detachment B) with approximately 171 Marines and Sailors would be sufficient to support 8 CUAS systems delivering 240,000 pounds of logistical resupply capacity over 8 hours.

Lastly, Swan et al. (2013) looked at projected facility requirements for a CUAS program and concluded that such a capability should be integrated into existing facility infrastructure with minimal additional requirements. They do address and recommend improved storage and maintenance facilities. Swan et al. (2013) also recommended basing a CUAS capability aboard Marine Corps Air Station Yuma, Arizona, and Marine Corps Air Ground Combat Center Twentynine Palms, California, due to their ability to support continuous training of the systems.

The Cargo UAS Program of Record Study is a very thorough analysis of a potential CUAS capability, emphasizing the significant operational and strategic benefits of a program such as a CUAS for the Marine Corps (Swan et al., 2013). By addressing the materiel and non-materiel implications of pursuing a CUAS capability, Swan et al. (2013) provide a very well-informed baseline for the Marine Corps to pursue the development of the capability.

2. Unmanned Systems Integrated Roadmap FY2017–2042

In 2018, the Office of the Assistant Secretary of Defense for Acquisition published the *Unmanned Systems Integrated Roadmap FY2017–2042* to provide strategic guidance to align the DoD Services' unmanned systems efforts. As the use of unmanned systems continues to grow throughout the DoD, the guidance focuses on reducing duplicative efforts and enhancing collaboration across the spectrum to increase the potential operational effectiveness and suitability of unmanned systems. "The intent is to lay a path toward an agile and flexible technology and policy foundation in which unforeseen disruptive technologies and operations can take root and be seamlessly integrated into the current advancements and efforts across DoD" (Assistant Secretary of Defense for Acquisition [ASD(A)], 2018, p. 4). This intent is addressed through four themes: 1) interoperability, 2) autonomy, 3) secure network, and 4) human–machine collaboration (ASD[A], 2018). Although not all encompassing, the four themes lay a foundation for understanding of unmanned systems continued integration into the Joint Force.

The theme of interoperability addresses five subsets of interoperability to progress in the interoperability of manned and unmanned systems. These five criteria are 1) the necessity for common/open architectures to enable the effective and efficient integration of manned and unmanned platforms; 2) modular systems to enable effective support operations; 3) test, evaluation, verification, and validation, to enable a high level of assurance in unmanned systems, 4) fluid data transfer from unmanned systems internally and to external nodes; and 5) securing data rights to unmanned systems to enable cost-effective sustainment activities (ASD[A], 2018). Autonomy focuses on increasing the trust and assurance provided by the unmanned systems architecture and technology. This theme addresses four criteria, 1) artificial intelligence and machine learning; 2) increased efficiency and effectiveness; 3) trust in the system; and 4) autonomy in weaponization (ASD[A], 2018). The secure network theme focuses on the security of information technology to function as intended, when necessary, without compromise. A secure network considers cyber operations, information assurance, and the electromagnetic spectrum (ASD[A], 2018). Lastly, the *Unmanned Systems Integrated Roadmap FY2017–2042* (ASD[A], 2018) identifies the interface of unmanned systems with the human operators, or human systems integration. Until there is a certain level of trust of unmanned systems and the technology supporting their autonomous operation, a human-in-the-loop approach will be utilized so that unmanned systems can support the warfighters by compressing the decision-making cycle time and reduce risk to life (ASD[A], 2018).

Each of these themes identifies specific challenges and ways forward that the Services and the DoD, in collaboration with the commercial industry, can foster successful integration of unmanned and manned systems into the operational environment. Although non-exhaustive, the *Unmanned Systems Integrated Roadmap FY2017–2042* lays a foundation to build upon to enable future strategic objectives related to unmanned systems within the DoD.

E. CONTESTED LOGISTICS: WHO'S IN CHARGE

Contested Logistics: Who's in Charge (2024) discusses the challenges and strategic considerations surrounding logistics in contested environments, particularly focusing on the context of the DoD. It explores various factors that impact logistics operations in areas where adversaries may disrupt or challenge supply chains, and it outlines potential solutions and strategies for overcoming these challenges.

The white paper analyzes the DoD, Joint Force, Services, and industry partners across key points such as strategy, the contested logistics environment and its impact on military operations, emerging technologies, and policy recommendations. Regarding strategy, Perna and Beougher (2024) discuss the need for revisions to the DoD's strategy given the anticipated realities of contested environments including the importance of resiliency, redundancy, and adaptability of supply chains to support sustainment operations. They support these claims through the increasing complexity and contested nature of the logistics environment, particularly through cyber and physical interdiction. These claims lead into assumptions from Perna and Beougher (2024) on the impact to the operational environment and (in)ability to sustain the force.

Perna and Beougher (2024) discuss the role of emerging technologies, such as autonomous systems, to enhance sustainment operations to address issues that arise. With autonomous or unmanned systems, there is an opportunity to make operations more resilient, in time and spaces where the threats are increasing in volume and complexity. In addition to the technological opportunities to achieve success in contested logistics environments, they offer policy recommendations to enable such sustainment operations, including new Doctrine and Training programs that account for these challenges, and to strengthen partnerships with allies and commercial partners.

Perna and Beougher (2024) capture the issue of contested logistics across the spectrum of organizations and offer a "perspective from Strategic to the forward point of conflict" (p. 4). They reiterate the critical fissures in the DoD complex surrounding contested logistics operations from private and public industries to international partners, while offering tangible solutions to ensure successful sustainment operations in future conflict.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. ANALYSIS, FINDINGS, AND RECOMMENDATIONS

This chapter investigates the portfolio of ULS-A across each tenant of DOTmLPF-P and synthesizes the analysis into formal findings and recommendations to address current and potential shortcomings in the support and sustainability of the programs. The analysis is built through interviews and discussion with key leaders within the acquisition of the ULS-A variants, as well as individual Marine units that have been part of the initial fielding of the TRUAS. These discussions offered insight into current operations and provided potential areas of improvement from the warfighter. The analysis is followed by a summary of the findings throughout the analysis across each tenant, which ultimately led to actionable recommendations. The recommendations consist of areas to address or change with the currently fielded TRUAS, as well as areas in the MARV-EL and ALC which could potentially see similar issues.

Collectively, these publications offer critical insights into the acquisition landscape and UAS operations, helping to deepen understanding and strengthen DOTmLPF-P considerations for the employment of ULS-A by the Marine Corps.

A. DOCTRINE

The USMC employs a structured, five-tiered system for its doctrinal publications, Governed by MCO 5600.20R, *Marine Corps Doctrinal Publication System* (USMC, 2018), The tiers of doctrinal publications include MCDPs, MCWPs, Marine Corps Tactical Publications (MCTP), MCRPs, and Marine Corps Interim Publications (MCIP). At the highest level are MCDPs, represent the core philosophy and principles of the Marine Corps' warfighting doctrine, designed exclusively for Marine operations and comprehensible to all Marines. Below MCDPs, the MCWPs provide the essential operational doctrine and TTPs the Marine Corps employs to execute warfighting and assigned missions. MCWPs form the operational blueprint for how the Marine Corps conducts its missions. The third tier, MCTPs, contain more focused TTPs delineated by functional area and next underneath particular MCWPs to amplify and expand upon the details of the particular MCWP. MCRPs, provide comprehensive reference materials for small unit leaders and detailed explanations, ensuring that doctrinal knowledge is both accessible and adaptable to the specific needs of different operational environments. The final tier of doctrinal publications within the Marine Corps are MCIPs, which are utilized to share new TTPs for new or emerging doctrine, informed through lessons learned, training, and experimentation.

MCO 5600.20R, *Marine Corps Doctrinal Publication System* states via the Commanders Intent that, "… Marine Corps doctrine provides institutional authoritative guidance that is timely, relevant, and compelling for use in the philosophy, planning, and execution of operations" (USMC, 2018, p. 2). This understanding of the Marine Corps Doctrinal Publication System formed the basis for the review and analysis of current publications with implications on the employment of ULS-A within the Marine Corps. Table 12 lays out the analysis of a sample of current Marine Corps doctrine which would potentially apply to ULS-A operations and if they address ULS-A in any capacity.

Table 12. Doctrine Analysis

Publication Title	Address ULS-A?
MCDP 4 Logistics	No
MCWP 3-40 Marine Corps Logistics	No
MCWP 3-20.5 Unmanned Aircraft System Operations	No
MCWP 4-32.1 Unmanned Aerial Vehicle Operations	No
MCWP 4-11.3 Transportation Operations	No
MCTP 3-20A Aviation Logistics	No
MCTP 3-20B Aviation Ground Support	No
MCTP 3-40B Tactical-Level Logistics	No
MCTP 3-40C Operational-Level Logistics	No
MCTP 3-40F Distribution and Transportation Operations	No
MCRP 1–10.1 Organization of the United States Marine Corps	No
MCRP 3–10A.2 Infantry Company Operations	No
MCRP 3–10A.3 Marine Infantry Platoon	No
MCRP 3–10A.4 Marine Rifle Squad	No
MCRP 3–10.3 Small Unmanned Aircraft System Operations	Yes

The doctrinal publications in this analysis are not exhaustive of those which will likely impact the operations of ULS-A but does consider the six doctrinal publications identified in the *TRUAS RM* (CD&I, 2023). This Marine Corps doctrine is currently insufficient in addressing the ULS-A capabilities.

As the Marine Corps progresses through the acquisition life cycle for the MARV-EL and ALC variants of ULS-A, there is a general consensus of the doctrinal publications that will need to be addressed but will likely not be addressed until the systems are more technologically mature (M. Wood and J. Bryant, personal communication, October 1, 2024). As an example, the ALC is currently analyzing the options of unmanned versus optionally manned, which has implications on which publications must be addressed and how they align with higher command directives and publications (M. Wood and J. Bryant, personal communication, October 1, 2024). Through this discussion, it seemed as though doctrinal changes take a lesser level of attention until later in the acquisition life cycle. This does not negate the necessity for doctrinal changes when a new weapons system is introduced in the Marine Corps formation but is less of a concern to negatively impact that employment of capabilities.

The nature of ULS-A, cutting across multiple warfighting functions and proponents of the Marine Corps formation, is not necessarily unique, but poses additional challenges when analyzing and addressing gaps in doctrinal publications. The appropriate prioritization of which doctrinal publications need changes would enable an incremental approach to ensuring that the employment of these capabilities is supported early and often. There must be an understanding that this is an iterative process and MCO 5600.20R lays out directed timelines for publication review and revisions, which can truly enable the success of the capabilities at the lowest level.

Marine Corps doctrine provides "authoritative guidance" to the Force and is prescriptive in nature. As the Marine Corps, and the Joint Force, operates through the concept of decentralized command, the warfighter and lowest-level operators are going to be instrumental in how these capabilities are employed and inform how doctrinal changes will support operations.

1. Findings

The analysis of Doctrine related to ULS-A revealed that updates to publications are not aligned with the capabilities in the hand of the Fleet Marine Force. Only one publication throughout the Marine Corps' publication library mentions the ULS-A portfolio, specifically the TRUAS. The attention to doctrinal changes does not occur until the systems have matured both technologically and operationally within the Fleet Marine Force.

The ULS-A portfolio will present challenges to doctrine as the system does not fall squarely within the parameters of one MOS or element of the MAGTF. Although this challenge is not unique, it will require a more detailed approach to ensuring all appropriate publications receive the necessary updates.

Additionally, the lack of doctrinal publications for the ULS-A, specifically the TRUAS at this time, puts Marines in a precarious position, as there are no guiding documents to support their planning, maintenance, or operations.

Doctrine is seen a guidance to the warfighter on the purposeful employment of systems and nesting them into operations. This feedback loop creates an avenue for continuous improvement in doctrine in that initial guidance and doctrine informs the employment of the system, then throughout the employment of the system, requirements are developed or adjusted to inform future development and increments to the capability development process. The Marine Corps must embrace this feedback loop to assist in the continuous improvement of the ULS-A portfolio, as well as with the supporting doctrinal publications.

2. Recommendations

Under the guidance of MCO 5600.20R, *Marine Corps Doctrinal Publication System*, there should be a baseline understanding that doctrine is guidance rather than prescriptive in nature. This will enable the warfighter to effectively inform doctrinal changes for each of the variants of ULS-A, but also promote a level of experimentation as the Marine Corps continues to discover the capabilities of each ULS-A variant and how they will be employed in operations.

Specific recommendations related to doctrinal changes include

- Focus revisions on appropriate MCRPs to provide more detailed guidance to the warfighter on the employment of the ULS-A capability. This focus will provide warfighters with detailed guidance on the employment, setting a baseline understanding, leading to fruitful publication revisions as the capability matures.

- Include the Fleet Marine Force units in the doctrine change process, whether through physical involvement or requesting their Standard Operating Procedures (SOPs) and TTPs to guide changes to doctrine.
- Publish a formal set of doctrinal standards for employment of the systems. Due to the current lack of supporting doctrine to the warfighter, specifically with the TRUAS, there is an unnecessary level of risk involved which can result in mishaps, jeopardizing the ULS-A capability, simply through trust and confidence.

B. ORGANIZATION

The Marine Corps is structured in three major components, the Aviation Combat Element (ACE), Ground Combat Element (GCE), and Logistics Combat Element (LCE). The Marine Corps structure is flexible and adaptable to support the operational needs of the force. Particularly, the Marine Expeditionary Unit (MEU), the cornerstone of Marine Corps operations, utilizes detachments across the three components of the MAGTF to composite into one cohesive force. Each variant of the ULS-A portfolio has distinct capabilities, as well as restraints.

During a demonstration of the TRUAS at the semi-annual Installations and Logistics Board in March 2023 aboard Marine Corps Base Quantico, Master Sergeant Christopher Genualdi, the Aerial Delivery and Autonomous Distribution Capabilities Integration Officer at CD&I, stated, "the true home for the TRUAS is the GCE" (Defense Visual Information Distribution Service [DVIDS], 2023). Through the fielding of the TRUAS, the system was initially fielded to the LCE with the intent of learning from the system and the unit's operating the system, and inoculate the fleet on TRUAS capabilities, prior to fielding to the GCE (DVIDS, 2023).

A decision analysis framework is utilized to weigh the other tenets of DOTmLPF-P against the organizational construct to determine which is most suitable to support operations of both the MARV-EL and ALC variant at this current point in time. The decision analysis framework is qualitative in nature in which the weightings, rankings, and results are based upon personal communication with key leaders within various communities across the MAGTF. The specific weighting for the criteria was gleaned from discussions and were ranked based upon the qualitatively assessed priority which will be the driving factors for the successful fielding and operations of both the MARV-EL and ALC.

Table 13, MARV-EL Decision Matrix, showcases the qualitative weighting of Doctrine, Training, Leadership and Education, Personnel, and Facilities against the and VMU, representing potential organizational structures. Discussions with 3d Littoral Logistics Battalion noted that during their opportunity to interface with the two prototype systems, they believe that the MARV-EL is too large and complex for the aviation system to be implemented within the LCE or GCE (D. Fancher and M. Shiley, personal communication, October 3, 2024). For this reason, neither element of the MAGTF was analyzed as the appropriate organizational construct for the MARV-EL. The ACE was defined as a manned aviation squadron organization, while the VMU organization was analyzed with the current force structure of the unmanned aviation squadrons across the Fleet Marine Force.

Table 13. MARV-EL Decision Matrix

Decision Analysis Matrix							Option Scores (Lower is Better)	
		Doctrine	Training	Leadership and Education	Personnel	Facilities	Unweighted	Weighted
	Criteria Weighting	2.5	2.5	1	5	4		
ACE	Unweighted Ranking	2	2	1.5	2	1.5	9	
	Weighted Ranking	5	5	1.5	10	6		27.5
VMU	Unweighted Ranking	1	1	1.5	1	1.5	6	
	Weighted Ranking	2.5	2.5	1.5	5	6		17.5

The analysis of current Doctrine and Training requirements for both manned and unmanned aviation assets, compared to the anticipated Doctrine and Training requirements to effectively employ the MARV-EL, VMUs seem to be more closely aligned to the desired end state for the MARV-EL. Similarly to the Doctrine and Training requirements for MARV-EL employment, the analysis of organization table of organization and equipment, it was determined that the Personnel who will likely be required to operate the system are more closely aligned to the billets task organized to the VMUs. In this analysis, both Leadership and Education, as well as Facilities fall relatively the same across both organizations due to many unknowns regarding the MARV-EL. These specific unknowns will be addressed in more detail later within the analysis.

Table 14 depicts the same format of a decision analysis framework for the ALC program. The ALC has already been determined to be a weapon system that will be organized within the ACE (M. Wood and J. Bryant, personal communication, October 1, 2024). Although this determination has been made, based upon preliminary high-level requirements, there are subordinate commands within the ACE which have different capabilities and expertise that should be considered when determining where the ALC should be task organized. Similar to the MARV-EL analysis (Table 13), Leadership and Education, as well as Facilities factors fall relatively the same across both organizational structures due to many unknowns regarding the ALC. These specific unknowns will be addressed in more detail later within the analysis of other DOTmLPF-P tenets. In this analysis the ACE and the VMU organizational constructs are scored similarly overall, due to trade-offs in the Doctrine and Training criteria, while they are ranked equally across the three other criteria.

Table 14. ALC Decision Matrix

Decision Analysis Matrix							Option Scores (Lower is Better)	
		Doctrine	Training	Leadership and Education	Personnel	Facilities	Unweighted	Weighted
	Criteria Weighting	2.5	2.5	1	5	4		
ACE	Unweighted Ranking	1	2	1.5	1.5	1.5	7.5	
	Weighted Ranking	2.5	5	1.5	7.5	6		22.5
VMU	Unweighted Ranking	2	1	1.5	1.5	1.5	7.5	
	Weighted Ranking	5	2.5	1.5	7.5	6		22.5

Overall, the qualitative weighting to the ACE compared to the VMU came to be the same. Leadership and Education, and Facilities were equal across the two organizations due to the sharing of resources. Personnel was also weighted similarly but for different reasons. With the projected size requirements of the ALC, there is expertise that will be required across both specialties of manned and unmanned aviation assets. Lastly, there is a balance between Doctrine and Training across the ACE and VMU. The Doctrine established and practiced within manned aviation squadrons most closely aligns with the cargo resupply missions anticipated with the ALC (i.e., assault support). Although the VMU construct employs doctrine aligned with UAS operations, they are more aligned with reconnaissance and surveillance operations. In the analysis of the training tenet of DOTmLPF-P, VMUs have an established training curriculum aligned to UAS operations which are unique in comparison the manned aviation operations.

Overall, the qualitative decision analysis provides that the ACE and VMU are similarly capable in the effective employment of the ALC, presuming that the fielding would be relatively similar in either a manned or unmanned aviation squadron.

There is a large gap in this analysis in that it does not consider the course of action of establishing a specific squadron, uniquely organized for the ALC. This consideration was left from the analysis due to the common understanding that the Marine Corps seemingly has a better appetite for reorganizing personnel within the current force structure rather than standing up a completely new organization. Although a new squadron is not in the organizational analysis, this course of action is briefly addressed in personnel considerations. If the Marine Corps desires for the ALC to be maintained as a capability over an extended period, and not simply for what is anticipated to be the next conflict, the Marine Corps should seriously consider a uniquely task organized squadron for the ALC. If the Marine Corps determines that this course of action is most appropriate, tailoring the organization to the ALC capability, it will be best suited to employ the ALC if there are conscious thought and decisions related to the other seven tenets of DOTmLPF-P.

These analyses are qualitative in nature and are not to be considered as a definitive solution. The intent of this analysis framework is to qualitatively compare the criteria against the current Fleet Marine Force organizational construct for the MARV-EL and ALC variants.

1. Findings

The TRUAS is currently showing promise with initial fielding within the LCE. There are issues, as are anticipated, but units currently employing the system are effectively identifying the issues and using their decision-making authority to adjust course and meet the intent of the program.

The MARV-EL and ALC capabilities present unique considerations and challenges related to where the equipment should be placed within the force structure. Current organizations do not have the Doctrine, Training, Leadership, Personnel, or Facilities to effectively employ and sustain the MARV-EL and ALC. The VMU seems like a good place for an unmanned aviation asset, but the introduction of an aviation capability that is significantly different from their current mission could create a level of discomfort that could lead to a failure in the program. There does not seem to be a discussion of a tailored squadron to ULS-A–a VMU but with a logistics mission–but this has a potential to fit the bill.

2. Recommendations

The Marine Corps must truly evaluate the organizational construct of the ULS-A portfolio to meet the desired end state of the capability. Although the TRUAS is showing promise, below are some recommendations for each variant to ensure success in the future.

- Employ and advocate for the task organization that 3d Littoral Logistics Battalion is utilizing to enable the employment of the TRUAS at the lowest level. The successes of 3d Littoral Logistics Battalion should weigh heavily on the decision to either continue with the objective of fielding the TRUAS to the GCE or maintain the capability within the LCE.
- Conduct an in-depth analysis of establishing a dedicated MARV-EL and ALC squadron. Due to the juncture of the MARV-EL acquisition, this may not be feasible, but the infancy of the ALC acquisition lends itself to this analysis. If this analysis is not conducted, the Marine Corps must accept the associated risks, which has the potential to lead to lack of employment, ineffective employment, or a high rate of aviation mishaps during operations. Each mishap associated with MARV-EL and ALC would likely fall into a Class A or B mishap categorization (Office of the Under Secretary of Defense for Personnel and Readiness [OUSD(P&R)], 2019).

C. TRAINING

The training tenet of DOTmLPF-P addresses how individuals who interact with the systems are qualified to employ the systems. Specifically, for the ULS-A portfolio, this training cuts across a multitude of MOS classifications–pilots/operators, maintainers, logisticians, air traffic controllers or Joint Terminal Attack Controllers–as well as adjacent units in which the operations of ULS-A may conflict with their mission (i.e., airspace deconfliction).

A major component of the training tenet for the ULS-A portfolio is Marine Corps Training and Readiness Manuals, which outline the standards Marines and units are supposed to achieve to maintain qualification and readiness for the system. In December 2023, NAVMC 3500.107C Ch 2, *Small Unmanned Aircraft Systems Training and Readiness Manual* was published with an update defining the requirements for a TRUAS operator specifically (USMC, 2023c). Table 15 outlines the initial training program that Marines are to complete to be qualified to operate the TRUAS.

Table 15. TRUAS Initial Training Requirements. Adapted from USMC (2023c)

Course	Hours	Performing Activity
TRV-150 Core Introduction	40	TALSA
Core	8.1	Unit

These are minimum standards to achieve the FMOS of 8623, to operate the TRUAS and these Marines must maintain currency through 1.6 hours of training events (USMC, 2023c). If the Marine lapses in qualification for a period of greater than 731 days, they must reattend the TRV-150 Core Introduction course hosted by their respective TALSA (USMC, 2023c).

Current training standards are not published for logisticians (i.e., S-4) writ large, who are likely to be planning to employ the system in the scheme of maneuver. This is neither good nor bad, if the operators are appropriately trained to conduct thorough mission planning and can work with staff personnel to enable the effective utilization of the capability.

Another key cohort of Marines that play a critical role in the success of the TRUAS, as well as the MARV-EL and ALC ULS-A variants are the maintainers. Currently, only the TRUAS has been able to address the required maintenance of the system. As the TRUAS was acquired via COTS (CD&I, 2023), the current structure for maintenance is to retrograde the system back to the manufacturer for repair. In the AAO, there are 24 complete systems allocated to PMA-263 as spares, in the instance that systems are damaged beyond depot-level maintenance (DVIDS, 2023). The TRUAS is fielded with minimal spare parts, allowing FMOS 8623 operators to conduct operator-level maintenance, receiving this training through the TALSA via the training event ACAD-6005 (USMC, 2023c).

An instrumental factor in the training capabilities for operators is the fact that training can be enabled through the TALSA, who is qualified to train UAS operators on Group 1 and 2 systems. Although the TRUAS is classified as a Group 3 UAS based upon the specifications laid out in *MARADMIN 327/24* (USMC, 2024), the Marine Corps received an Exemption to Policy to enable Marines to be trained to operate the system. *MARADMIN 327/24* (USMC, 2024) lays out permissive guidance to the training standards and requirements for operating the TRUAS and although this establishes a medium to introduce the TRUAS into operations, the Exemption to Policy only temporarily addresses the hurdles to effectively train operators of the system.

There are still a number of gaps in the training requirements and capabilities to effectively employ the TRUAS within the Fleet Marine Force. Some of these considerations, such as airspace coordination and more detailed mission planning requirements for TRUAS operators can severely inhibit operations. Additionally, the lack of formal training and requirements for TRUAS maintainers to conduct maintenance on the systems creates a heavy reliance on the contractor to support the Marine Corps in maintaining operational availability of the system. Lastly, the Exemption to Policy to allow operator training of the TRUAS by the TALSAs is a temporary solution to meet the requirements for employment of the systems. Although the first units being fielded the TRUAS are understandably the "guinea pigs" in experimenting with the system, as the ULS-A portfolio continues to progress into larger, more intricate systems, and the ULS-A capability becomes integrated into the tactical and operational scheme of maneuver for the Marine Corps, current training standards will create large gaps in effectively employing the systems.

1. Findings

The analysis of Training for the TRUAS through conversations with 3d Littoral Logistics Battalion, certain perspectives exposed key findings to support their operations. These findings can help to inform the requirements for training as the TRUAS matures and as the Marine Corps begins to field the MARV-EL and ALC.

- The operator training provided via the TALSA to Marines to operate the TRUAS is sufficient for the physical aspect of flying the system but is insufficient in training personnel on detailed mission planning. This creates a gap in the employment of the TRUAS in concept of operations.

- There is a lack of training and readiness standards for the Marines who are intended to conduct maintenance of the TRUAS at the tactical level. Ground Electronic Repair Maintainers are not formally trained on maintenance operations of the TRUAS and lack the necessity to learn the system, leaving a gap in readiness and operational availability.
- Logistics Officers within the Marine Corps do not have any training on the capabilities of the TRUAS to effectively plan the employment of the system. Although there are (theoretically) subject matter experts within their formation, the staff position (i.e., S-4) does have a baseline understanding of the system to advocate for its employment. This knowledge for logisticians will become more critical with the fielding of the MARV-EL and ALC.

2. Recommendations

Throughout the analysis of the Training tenet of DOTmLPF-P, the findings informed the following recommendations for the Marine Corps to address with the TRUAS, and to consider with the MARV-EL and ALC.

- The Marine Corps should investigate the cooperative/Joint training opportunities. Similarly to other MOSs within the Marine Corps, Marines attend initial training through the Army training pipeline. For Primary Military Occupational Specialty (PMOS) training this can provide an opportunity for Marines to receive more in-depth training and qualifications, while leveraging resources within the DoD.
- For TRUAS, if a PMOS will not be designated, the Marine Corps should advocate for a more robust Program of Instruction, to include mission planning details. This will allow the TRUAS operators to advocate for the capability more competently to key leaders who do not have resident knowledge of the capability.
- The Marine Corps must revisit Training and Readiness Manuals for Ground Electronic Repair Maintainers to establish training standards for the maintenance of the TRUAS.
- Specifically for MARV-EL and ALC capabilities, the Marine Corps should conduct an in-depth analysis on the establishment of a PMOS for the operators and maintainers. As the vehicles become larger and more intricate, the level of expertise to operate and maintain the systems within the force structure will be critical to their sustainability and the financial sustainability of the respective programs.

D. MATERIEL

The Marine Corps has a validated capability gap and has determined that neither current weapons systems nor a DCR will fulfill the need of the warfighter. As a part of the materiel decision, the Marine Corps has determined that a portfolio of three various sized UAS would fulfill the mission requirements.

Specifically, the TRUAS program is executing an incremental approach to the acquisition strategy, employed initially via MTA for rapid prototyping as well as an Abbreviated Acquisition Program to support the rapid production and fielding on the system (CD&I, 2023). The *TRUAS RM* (CD&I, 2023) supports this strategy with the statements support the rapid evolving environment surrounding UAS, providing the Marine Corps an opportunity to remain flexible and leverage developments with the integrated technology. The intent of this strategy was realized early in the acquisition through the evaluation of COTS solutions, highlighted by a Field User Capability Assessment in March 2021 at Yuma Proving Ground (Jones, 2021). Events such as this enabled a detailed evaluation of the TRUAS capability in a realistic environment, to assist in both the refinement of requirements and the eventual selection of the system which would be most operationally effective and suitable. It seems that the Marine Corps truly understands the volatile environment of UAS technology and the decision to assess COTS solutions would be the most suitable approach in achieving rapid fielding of the capability.

As the Marine Corps and PEO Aviation began the assessment of materiel solutions for the ALC, a thorough analysis has been continuously conducted throughout the MSA Phase of acquisition (M. Wood and J. Bryant, personal communication, October 1, 2024). These findings are helping to inform the acquisition strategy, as well as the technical requirements for the capability. RAND has been engaged to conduct an official materiel solutions analysis, leveraging the Analysis of Alternatives framework to provide the Marine Corps with a larger assessment of the direction of the ALC program (J. Bryant, personal communication, 21 August 2024). Similarly to the TRUAS, the ALC program is attempting to execute an incremental approach in fielding the capability to enable more rapid fielding to the Fleet Marine Force, in which Increment I is projected to assess upgrading a current capability to achieve the technical requirements, with technology upgrades in Increment II and III (J. Bryant, personal communication, 21 August 2024).

Conclusions from the interim briefing for the ALC, dated August 2024, state that no COTS/GOTS solutions provide the uncrewed capability desired by the program thus, additional analyses will need to be conducted to evaluate the trade space to balance the technical requirements against the desired cost and schedule of the program (J. Bryant, personal communication, 21 August 2024).

1. Findings

The Marine Corps has a history of acquiring and employing capabilities like those desired by the ULS-A portfolio. The KAMAN K-MAX was employed effectively but seemed to be terminated without careful consideration for the FOE and success of Marine Corps logistics. The current acquisition of each of the variants of ULS-A seem to be back tracking on past success and committing resources to reestablish a logistical UAS as a critical need for the Fleet Marine Force.

Although the Marine Corps potentially missed an opportunity with the KAMAN K-MAX, the Marine Corps is effectively utilizing the MTA to rapidly field the TRUAS to the warfighter to fulfill the capability gap. The speed at which the Marine Corps is evaluating potential COTS/GOTS capabilities is enabling the Marine Corps to move towards a more ready force in EABO/DMO. Additionally, the Marine Corps seems to be translating the successes of the TRUAS acquisition into an effective acquisition strategy for the MARV-EL and ALC, but as these capabilities progress along the acquisition life cycle, there will likely be more roadblocks simply based upon the size and complexity of the systems.

2. Recommendations

Although the Marine Corps seems to be effective in the use of the MTA in relation to the acquisition of the TRUAS, the MARV-EL and ALC will be more complex systems, simply due to their anticipated requirements. To enable the successes of TRUAS to be translated into future acquisition programs of similar capabilities, there are a few recommendations that were gleaned from the analysis.

- The Marine Corps should establish more formal relationships with institutions to evaluate emerging technologies that can enhance the ULS-A portfolio. It is commonly understood that the pace of technology development far surpasses the DoD acquisition life cycle. With this understanding, the Marine Corps must be at the front end of technology improvements and should leverage COTS/GOTS materiels to remain at the tip of the technological spear.

E. LEADERSHIP AND EDUCATION

Leadership and education play a critical role in the employment of the portfolio of ULS-A systems in the Fleet Marine Force. Although an individual tenet of DOTmLPF-P, leadership impacts many of the other tenets. As the new capabilities are fielded, there is a lot of unknowns—both known and unknown—which put leadership in a risk decision predicament. In discussions with 3d Littoral Logistics Battalion leadership, the lack of SOPs and guidance on maintenance and operational employment puts commanders in a scenario where they must have established trust and confidence in the operators' capabilities to operate the system (D. Fancher and M. Shiley, personal communication, October 3, 2024).

In instances where the leaders are not educated on the capability, there is potential for the system to either go unused or the risk of a Class A or B mishap increases (OUSD(P&R), 2019). Decision-making predicated upon a thorough risk assessment is a cornerstone of military operations. If leadership is unable to effectively make decisions surrounding the employment of any variant of ULS-A, a capability gap will remain. This begins with Marine Corps leaders, at tactical and operational levels, to buy-in to ULS-A as a necessary system for Marine Corps operations.

A key factor in this level of knowledge and buy-in to the ULS-A as a critical capability for Marine Corps operations is the task organization of the system. Each variant of the ULS-A portfolio offers a unique capability that cuts through both the logistics and aviation fields. If leaders are exposed to UAS and aviation logistics throughout their career, and understand the capability, as well as the risks associated with UAS, it would be likely that there is a greater appetite for their employment. On the inverse, they may not have the experience and knowledge surrounding logistics operations, which is the mission of the ULS-A portfolio. A leader within the logistics community may have a better understanding of how a ULS-A variant can support logistics operations but is hesitant on the employment of an unmanned aviation asset in their concept of operations. To add complexity to this dilemma, there seems to be a culture across leadership to be hesitant to change, especially when it relates directly to their or their unit's occupation (M. Wood and J. Bryant, personal communication, October 1, 2024).

Overall, for the portfolio of ULS-A to be effectively implemented into the Fleet Marine Force, a paradigm shift is in thought is likely going to need to occur (M. Wood and J. Bryant, personal communication, October 1, 2024). Currently, leaders within the Marine Corps seem to be steadfast on the capabilities of legacy systems, and seemingly unwilling to accept ULS-A as a necessary capability to augment both aviation and logistics support capabilities (M. Wood and J. Bryant, personal communication, October 1, 2024). This paradigm shift is a timely endeavor, but one that must be addressed. Arguably, the leadership and education will be the largest contributing factor to how well or poorly ULS-A are integrated into the force and indoctrinated into the decision-making process for all level of leaders within the Marine Corps.

1. Findings

Marine Corps leadership, predominantly on the tactical and operational level, do not seem to be bought-in to ULS-A as a critical capability for the force. Continued reliance on legacy capabilities is preventing leaders from recognizing the capability that the ULS-A portfolio provides to the Marine Corps.

2. Recommendations

The Marine Corps at large, but more specifically, the entities managing the acquisition of new capabilities, such as MCWL and CD&I, must continue to educate the Fleet Marine Force leaders on the ULS-A portfolio. ULS-A must be framed as an augment and an asset to both logistics and aviation operations, rather than a replacement.

The Marine Corps must effectively address the other tenets of DOTmLPF-P and the leadership will fall into place. A bottom-up approach to the training and education of Marines will matriculate through the force and indoctrinate ULS-A as a standard capability. As Marines who have subject matter expertise related to ULS-A progress through the Fleet Marine Force, the capability will become more common knowledge. The paradigm shift discussed will take time but will only occur if the Marine Corps addresses it at the foundation of the force.

F. PERSONNEL

The personnel to support the ULS-A portfolio is arguably the most important to ensure the success of the capability upon fielding. Currently the TRUAS capability is supported through a task organization of 13 Marine operators and five Marine maintainers within the Combat Logistics Battalions (DVIDS, 2023). The five maintainers within the Combat Logistics Battalions are shared from the task organized Ground Electronic Repair Maintainers within the 28XX series of MOSs (DVIDS, 2023). 3d Littoral Logistics Battalion, 3d Marine Littoral Regiment was one of the first Fleet Marine Force units to be fielded the TRUAS, operating the systems under the proposed task organization of 13 Marine operators and five Marine maintainers.

3d Littoral Logistics Battalion is employing a structure in which the task organized 13 Marine operators are subject matter experts for the unit and are enabling the training for Marines throughout the formation (D. Fancher and M. Shiley, personal communication, October 3, 2024). The structure being employed is sufficient for operating the TRUAS, but have identified that the use of 28XX Ground Electronic Repair Maintainers is non-existent due to training factors (D. Fancher and M. Shiley, personal communication, October 3, 2024).

As the Marine Corps considers personnel requirements for the MARV-EL and ALC variants of ULS-A, a study conducted by Swan, Heffren, and Larkin (2013) analyzed and provided various recommendations of the potential task organization of a capability like the ULS-A. Their rough estimates of an element to support such operations would require 20–40 personnel with a variety of skills or MOSs. The study introduced a notional squadron for cargo UAS which includes 16 vehicles and mirrors the structure of a HMLA squadron within the Marine Corps force structure. Figure 12 depicts what their anticipated personnel structure of a detachment within the squadron would include.

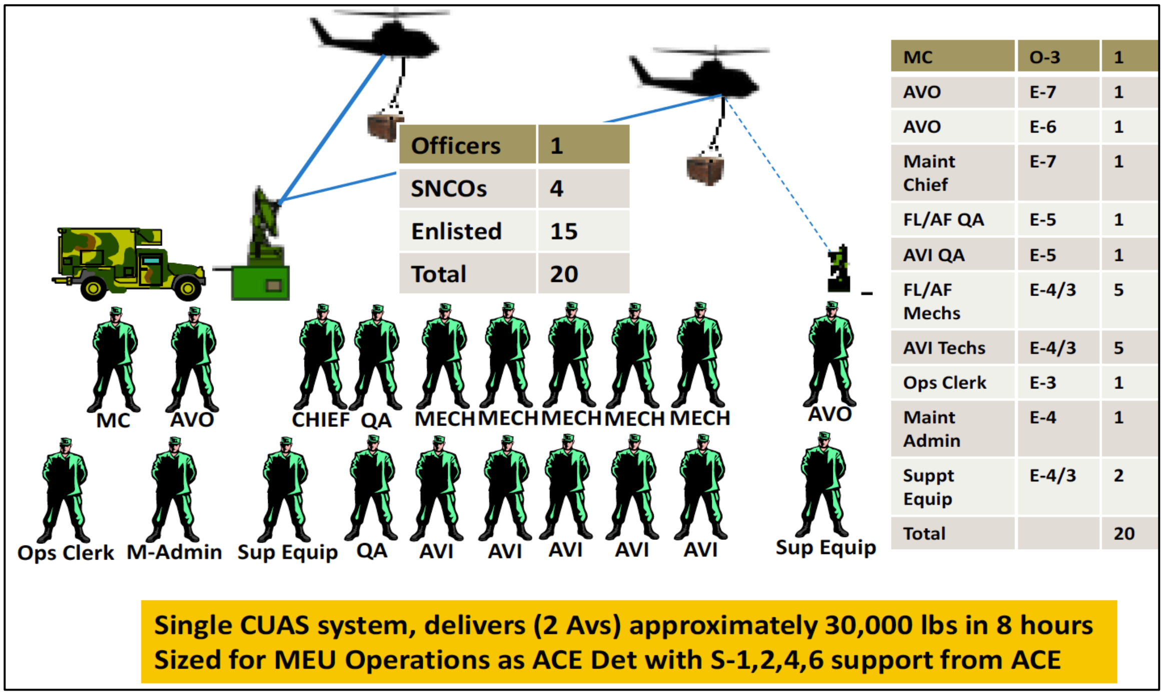

Figure 12. Notional ULS-A Detachment Task Organization. Source: Swan et al. (2013, p. 39).

All of the considerations provided by Swan et al. (2013) related to the personnel to support ULS-A operations have implications on the organization tenet of DOTmLPF-P. Their analysis was predicated upon the assumption that such a capability is best fit within the ACE. When analyzing the personnel implications for the MARV-EL and ALC variants of ULS-A, Swan et al. (2013) provides an in-depth and realistic personnel force structure to enable the support for operational employment.

1. Findings

The analysis of Personnel related to each of the variants of ULS-A showcased the criticality of appropriate individuals, with appropriate qualifications, task organized to the appropriate unit. Throughout the analysis there was significant overlap with considerations surrounding Personnel and Organization. Overall, there was a common sentiment that the personnel supporting ULS-A operations will need some very specific skills and knowledge to employ the systems are intended. There seems to be a lack of common understanding if the operation of ULS-A variants will be aviators conducting logistics missions or logisticians that learn to operate aviation assets, which becomes even more complex with the intricacies of MARV-EL and ALC.

3d Littoral Logistics Battalion provided a modified structure of their personnel to achieve the desired end state, which can help to inform how the Marine Corps moves forward with future increments of TRUAS, as well as with the MARV-EL and ALC fielding.

2. Recommendations

Specific recommendations for Personnel are predominantly related to MOS qualifications and the implications of a PMOS for the MARV-EL and ALC

- A FMOS for TRUAS operators is sustainable. The Marine Corps should advocate for task organizing personnel in the same manner as 3d Littoral Logistics Battalion, a squad of dedicated TRUAS operators to act as subject matter experts for their units, while enabling training for Marines throughout the unit. This will also enable an opportunity to exploit train the trainer events within each unit.
- The Marine Corps should consider the establishment of a PMOS for MARV-EL and ALC operators and maintainers. The intricacies of the systems will require a high level of expertise to operate and maintain. Without a thorough analysis of establishing a PMOS, there would seem to be an increase in sustainment/total life cycle costs for the systems as the Marine Corps relies upon contractor supported maintenance.
- The Marine Corps should investigate the use of contractors for the ownership and or operation of both the MARV-EL and ALC. This could provide an opportunity for risk reduction, as well as learning about the personnel requirements for operations of each of the variants.

G. FACILITIES

An analysis of the facilities tenet of DOTmLPF-P was not conducted due to several constraints. Due to the current intent that no variants of the ULS-A portfolio will replace any current aircraft, but rather augment current capabilities within the Marine Corps fleet, a more in-depth analysis of the current Marine Corps installations and facilities would need to be conducted. This would likely include an analysis of Military Construction planning, programming, budgeting, and execution.

Factors from other tenets of DOTmLPF-P must also be considered when analyzing the facility requirements for the ULS-A portfolio. For the TRUAS, there are four crates for storage of the system, equating to a total of approximately 68.25 cubic feet of storage per system (CD&I, 2023). With the approved AAO, each Combat Logistics Battalion, Reconnaissance Battalion, and Marine Corps Special Operations Command are to be fielded six systems each (CD&I, 2023). This requires each unit to have approximately 410 cubic feet of storage for their systems, when they are in their containers. This does not consider the requirement for appropriate power requirements for battery charging, in which each system is fielded with eight batteries (DVIDS, 2023). The *TRUAS RM* states

> TRUAS requires review of each impacted Installation Master Plan. A Facilities Impact Report analysis conducted by PMA-263 will determine the effect of TRUAS on the installations. IOC is not expected to generate significant requirements; however, interim relocatable facilities may be required in some locations. MILCON and FSRM requirements are TBD. Among the requirements are storage, battery charging capability, and range requirements. Permits and agreements pertaining to Airspace, the FAA, spectrum, Host Nation approval/authorization and others are required but are expected to have a minimal impact. (CD&I, 2023, p. 48)

The impact seems to be understated for the TRUAS and as the Marine Corps proceeds with the acquisition of the MARV-EL and ALC variants, the space requirements and power requirements are likely to grow exponentially. Without specific parameters on size of the system and battery charging requirements, the requirement for facilities has the potential to create a significant strain on budgets to ensure appropriate facilities are either identified or constructed.

A critical facility consideration that is neglected in current DOTmLPF-P analyses is the integration of the ULS-A into naval vessels. The analysis of installations is critical to enable the effective storage and maintenance of the capabilities but fails to meet the full intent of the capability gap. As the capabilities are being fielded and intended to be utilized in operational environments such as EABO and DMO, a further analysis must be conducted on the facility availability for ULS-A on naval vessels (i.e., ARG/MEU). Due to the seemingly heavy lift of integrating ULS-A into existing installations, the ability for the systems to be deployed from sea-bases poses a greater level of concern. The Marine

Corps consistently has difficulty integrating current capabilities within the ARG. Considering the anticipated storage and power requirements of the TRUAS, and presumably larger requirements for the MARV-EL and ALC variants, there will be a necessity for trade-offs and or risk assumptions to enable to deployment of ULS-A from naval vessels.

1. Findings

The analysis of Facilities, as it relates to each of the variants of ULS-A, is minimal. Basic requirements of cubic feet of storage for the TRUAS has led to end users having to determine the optimal storage spaces, as well as charging stations for the system batteries, putting a strain on unit resources.

Additionally, the avenue of Facilities seems to be assumed away during the initial DOTmLPF-P considerations. Initially, this may suffice, but as ULS-A become indoctrinated into the Fleet Marine Force, aviators and logisticians will become more intertwined, a time may come where an aviation culture is placed on logistics units, if they own the aviation systems. Expectations and standards of aviation maintenance standards could then find their way into a requirement for the ULS-A (i.e., foreign object debris). The standards set in place for aviation facilities may creep into the mission of the ULS-A and the Marine Corps must be prepared for the second and third order effects.

Lastly, throughout the analysis of Facilities, there was no mention of the integration of any ULS-A variant with the Navy. As the Marine Corps prepares for EABO and DMO, there is a deep integration with the naval force and to neglect the integration of new capabilities into the naval force is a large oversight.

2. Recommendations

Recommendations surrounding the analysis of Facilities as it relates to each of the ULS-A variants include:

- Conduct an analysis of each of the ULS-A variants and their integration with the ARG, specifically in EABO and DMO.
- Prior to fielding of the MARV-EL and ALC, conduct a thorough facilities analysis to determine current availability for storage and maintenance requirements and or MILCON requirements.

H. POLICY

The FAA controls and manages the National Airspace System (NAS) to include both manned and unmanned aviation assets. Given the characteristics of military UAS, many FAA policies and regulations are more applicable to Group 3 through 5 systems, which aligns with the capabilities provided through the ULS-A portfolio. There is a plethora of regulations that the FAA has implemented to ensure safe integration of UAS into the NAS that have the potential to pose difficulties when employing ULS-A in training environments, specifically the *Aeronautical Information Manual* (FAA, 2024). Some of the key policy constraints include

- Airspace access and Certificate of Waiver or Authorization
- Beyond Visual Line of Sight limitations
- Sense-and-avoid technology
- Use of restricted or special-use airspace
- Radio frequency spectrum allocation
- Safety and security certification

Airspace access and the issuance of a COA requires detailed coordination with the FAA to authorize the use of Group 3–5 UAS, which include specific details on each, individuals flight operation (Federal Aviation Administration [FAA], 2024). With this requirement for COA approval, each flight operation requires the issuance of a Notice to Airman, which notifies all aircraft that may be operating in the same airspace to potential hazards which could impact their operations (FAA, 2024).

Another key policy constraint via the FAA impacting Group 3–5 UAS are limitations surrounding beyond visual line of sight. As these systems, as with the intent with the ULS-A variants, typically operate outside of visual observation, there are raised safety concerns. Thus, the FAA (2024) requires systems to have demonstrated effective sense-and-avoid technology. This enables an unmanned system to detect hazards while in flight and redirect their flight pattern to avoid hazards. This critical technology must be included within the requirements to each of the ULS-A variants, or it will severely impact the ability to employ these systems within the NAS. With this policy constraint in place by the FAA and the potential safety risk involved, the FAA (2024) generally limits the use of Group 3–5 UAS to restricted airspace or military operating areas (Figure 13). The use of such airspace constraints severely limits the employment of such systems while in a CONUS training environment, not enabling the systems to be utilized to their fullest capability (i.e., range).

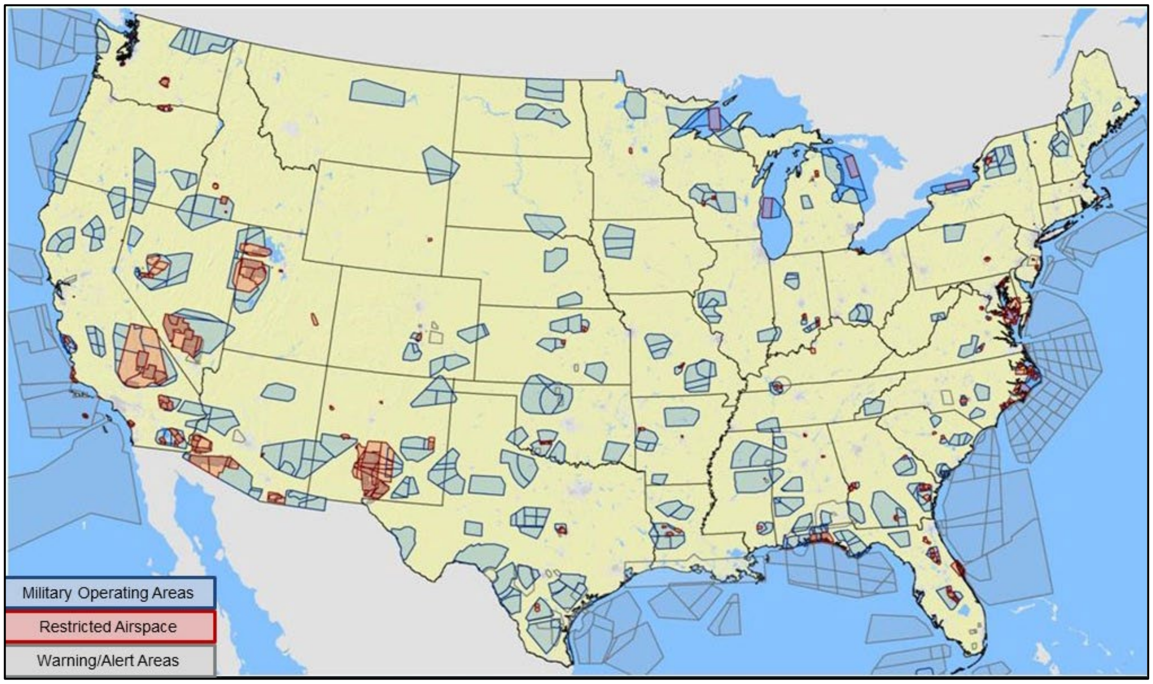

Figure 13. FAA DoD Special-Use Airspace. Source: FAA (n.d.).

These policy considerations and constraints as it relates to the FAA are fairly limited in scope. The ability for Marine Corps units to coordinate such operations with the FAA can be done, but not without a high-level of expertise which is not currently included in the training for ULS-A operators (D. Fancher and M. Shiley, personal communication, October 3, 2024). As the portfolio of ULS-A progresses through development, acquisition, and fielding, the policy considerations will need special attention. Additionally, these issues are not unique to the Marine Corps. As UAS proliferate as a key strategic and operational asset to the DoD, the alignment between the FAA and DoD will remain a critical priority. Discussions between the DoD and FAA are being had but there is no public information on the status of any changes to FAA policy related to DoD UAS (M. Wood and J. Bryant, personal communication, 1 October 2024).

1. Findings

The policies surrounding UAS operations administered and enforced by the FAA are constraints that have the potential to put a high level of strain on ULS-A operations across the continental United States. The employment of the TRUAS is minimally affected due to the altitude at which it operates, but the MARV-EL and ALC will require a higher ceiling and range, which may exceed current FAA/DoD airspaces.

The current efforts to amend policies related to UAS operations in the NAS for DoD systems is relatively minimal. There is a common understanding that unmanned systems will continue to proliferate the DoD and civilian sector, which requires concerted efforts to ensure the safe operation of these systems.

2. Recommendations

The gaps in policy related to UAS policy is a large concern that extends beyond the Marine Corps. From the perspective of the individual military services, a coalition to advocate for reasonable policy changes within the FAA are necessary. Two main and broad recommendations that the Marine Corps can pursue to push the needle in the right direction are:

- Spearhead and/or advocate for a Joint Force UAS Working Group. Charter the group to work alongside OSD and the FAA to formulate policy changes that enable a more permissive employment of UAS within the NAS.
- Analyze current NAS against DoD bases and installations. This can help to identify existing training areas and airspace to allow for training of each ULS-A variant in a CONUS environment. This should include airspace within littoral regions to emulate the FOE. Additionally, this can provide an opportunity for the Marine Corps to partner with other military services to integrate training and facilitate a more interoperable Joint Force.

V. CONCLUSION

As the Marine Corps, alongside the other military services within the DoD, continues to prepare for the future operating environment, the acquisition of advanced technologies is foundational to enabling our success. Since Gen (Ret.) Berger posited that logistics is the pacing function of military operations, there has been a concerted effort by the Marine Corps to strengthen its logistical capabilities. The acquisition of the three variants of ULS-A is working to achieve the end state of a more survivable and effective logistics chain in EABO and DMO.

The acquisition of the physical capabilities is an instrumental but only partial answer to the capability gaps at hand. The DOTmLPF-P framework and analysis of the eight tenets is critical to enable the sustainability of the acquired weapon systems. As technology advances at a rapid rate, the detailed analysis and addressing of the various supporting elements must not be downplayed. Although each tenet is critical independently, their interrelationship will exponentially magnify the issues and risks if they are not appropriately addressed.

The acquisition of the portfolio ULS-A variants represents a significant step toward strengthening logistical capabilities for the future operating environment, the success of this initiative extends beyond mere procurement. A comprehensive DOTmLPF-P framework implementation is crucial for the long-term sustainability and effectiveness of these systems. The interrelated challenges across each of the DOTmLPF-P tenets demand meticulous attention and coordinated solutions. Critical considerations include developing robust doctrine for ULS-A mission sets, resolving organizational structure challenges between the LCE and ACE, establishing comprehensive training programs for operators, maintainers, and planners, and ensuring adequate facilities for maintenance and operations.

The considerations, although relatively unique to the ULS-A, are not new. Each time a capability matures through the DAS, the tenets of DOTmLPF-P remain as foundational support to effective employment and sustainment of the systems. The KAMAN K-MAX is a valid and recent historical example of how a system can show success in the intended operational environment for the Marine Corps. No one answer to sunsetting of the system within the Marine Corps can be established, but the Marine Corps failed in ensuring the sustainability of the program and is now reeling to reestablish a logistics UAS to fulfill a need.

The Marine Corps stands at a crucial junction where the successful integration of each variant of ULS-A could significantly enhance its logistical resilience in contested environments. However, without thorough analysis and implementation of appropriate DOTmLPF-P adjustments, these advanced systems risk becoming either underutilized assets or, more critically, failing to provide essential sustainment during EABO/DMO. The path forward requires not only continued acquisition efforts but also a steadfast commitment to developing and maintaining the comprehensive support structure these systems demand for effective operational employment. If the Marine Corps fails in this arena, the Marine Corps is set to relive the story of many systems before, like the KAMAN K-MAX, and more concerning, strand Marines in EABO and DMO without sustainment. We – the Marine Corps – will lose.

A. RESEARCH QUESTIONS

This research addresses two questions related to the ULS-A portfolio for the Marine Corps. Firstly, using a DOTmLPF-P framework, what are the potential concepts of employment and force structure of the ULS-A capability? This research provides recommendations across the tenets of DOTmLPF-P for the Marine Corps to address current and future issues/concerns surrounding the effective and sustainable employment of each of the ULS-A variants.

The second question that the research attempts to address is what are lessons learned from previous UAS acquisition programs to support the Marine Corps framework for DOTmLPF-P analysis of future ULS-A acquisitions? Throughout this research and analysis, interviews with personnel within the acquisition profession, as well as the UAS industry, provided insight into historical successes and failures in UAS acquisition programs. Additionally, reviewing the use of the KAMAN K-MAX by the Marine Corps and conversations with individuals involved in researching the program, provided valuable lessons learned that can inform the future of the ULS-A portfolio.

B. LIMITATIONS IN RESEARCH

This research's examination of the Marine Corps acquisition of the three ULS-A variants encountered a few limitations. While these limitations influenced certain aspects of the analysis, findings, and recommendations, they do not diminish the validity of the research.

The primary limitation throughout the research process was the accessibility to key acquisition documents. Although this constraint was realized, the conduct of interviews and discussions with key personnel directly involved with the ULS-A acquisition programs provided valuable insights to the analysis.

Another key limitation realized throughout the research was the ongoing source selection for the MARV-EL variant. This necessitated a heavy reliance on publicly available information and reasonable assumptions regarding capability requirements. In a similar vein, as the TRUAS is the only fielded variant of the ULS-A, warfighter experiences and feedback was limited to the TRUAS. Again, certain assumptions were made to be able to translate feedback on the TRUAS to the MARV-EL and ALC.

Finally, while the DOTmLPF-P framework provided a rigorous analytical structure, the analysis was limited to non-combat environmental considerations. When the ULS-A is employed in a combat environment, specifically, in contested and distributed littoral operations, additional factors will present themselves across each of the DOTmLPF-P tenets.

C. FUTURE RESEARCH

Through this research and analysis, opportunities for future research presented themselves, but were outside the scope of this research.

One future research opportunity is to conduct a more full, in-depth analysis of each of the tenets of DOTmLPF-P individually. Although each tenet of DOTmLPF-P is inherently related, to look at each tenet individually would allow for the appropriate level of depth. Ideally, a team would utilize the framework, and each team member would analyze a tenet, then synthesize findings and recommendations.

Throughout this research, it was identified that there is no standard framework or process on how to conduct a DOTmLPF-P analysis. Each military service conducts the process slightly differently, and the DoD provides minimal guidance on the standards of the process. A future research opportunity tied to this finding is for a research team to develop a formal DOTmLPF-P analysis framework or process map that the DoD could adopt and revise. Inconsistencies in the conduct of DOTmLPF-P analysis has the potential to lead to holes in the sustainability of acquisition programs, that a standard framework/process could alleviate.

This research was conducted based upon the understanding that the Fleet Marine Force would own and operate each of the variants of ULS-A. There is a unique opportunity to research of the relationship of contractors in the ownership and operation of each of the variants. There is potential for such a structure to provide valuable insight into considerations surrounding DOTmLPF-P, develop best practices for the employment of each ULS-A variant, and provide a glide path for the Marine Corps to eventually assume the mission of the ULS-A in the future. An in-depth business case analysis of Contractor-owned, Contractor-operated or Government-owned, Contractor-operated avenues for ULS-A employment could provide the Marine Corps valuable information to assist the decision-making process for the future of the ULS-A portfolio.

LIST OF REFERENCES

Assistant Secretary of Defense for Acquisition. (2018). *Unmanned systems integrated roadmap FY2017-2042*. Department of Defense. https://apps.dtic.mil/sti/pdfs/AD1059546.pdf

Bennett, L. (2012). The grand failure: How logistics of supply defeated Napoleon in 1812. *Primary Source: The IU Undergraduate Journal of History, 1*(1), 1–8.

Berger, D. H. (2019). *38th commandant's planning guidance*. Headquarters, U.S. Marine Corps. https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf

Center for Strategic and International Studies. (2021, September 1). *Maritime security dialogue: An update on the Marine Corps with Commandant Gen. David H. Berger* [Video]. https://www.csis.org/events/maritime-security-dialogue-update-marine-corps-commandant-gen-david-h-berger

Chairman of the Joint Chiefs of Staff. (2016, August 17). *Guidance for developing and implementing joint concepts* (CJCSI 3010.02E). Joint Chiefs of Staff. https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/cjcsi_3010_02e.pdf?ver=2018-08-01-134826-593

Chairman of the Joint Chiefs of Staff. (2021, October 30). *Charter of the Joint Requirements Oversight Council and implementation of the Joint Capabilities Integration and Development System* (CJCSI 5123.01I). Joint Chiefs of Staff. https://www.jcs.mil/portals/36/documents/library/instructions/cjcsi%205123.01i.pdf

Combat Development & Integration. (n.d.). *CD&I overview*. Retrieved August 6, 2024, from https://www.cdi.marines.mil/About/What-we-do/CD-I-Overview/

Combat Development & Integration. (2018). *United States Marine Corps force development system user guide*. https://www.cdi.marines.mil//Portals/172/Docs/MCCDC/FDSP/USMC%20Force%20Development%20System%20User%20Guide.pdf?ver=W7KSOXNdINQFNofpPxFx2w%3d%3d&timestamp=1671649657624

Combat Development & Integration. (2023). *Requirements memorandum for tactical resupply unmanned aircraft system* [Memorandum].

Dana, M. G. (2017). 21st century logistics: Designing and developing capabilities. *Marine Corps Gazette*, *101*(10), 12–15.

Defense Acquisition University. (2022). *A guide to program management business processes*. https://aaf.dau.edu/wp-content/uploads/2023/09/A-Guide-to-DoD-Program-Management-Business-Processes.pdf

Defense Visual Information Distribution Service. (2023, March 29). *Tactical Resupply UAS demonstration* [Video]. https://www.dvidshub.net/video/882502/tactical-resupply-uas-demonstration

Department of Defense. (2013). *The planning, program, budgeting, and execution (PPBE) process* (DoD Directive 7045.14). https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/704514p.pdf

Department of Defense. (2022). *National defense strategy of the United States of America*. https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF

Department of Defense. (2024). *Financial management regulation (FMR) glossary*. https://comptroller.defense.gov/Portals/45/documents/fmr/current/glossary.pdf

Dougherty, C. (2023). *Buying time: Logistics for a new American way of war*. Center for a New American Security. https://www.cnas.org/publications/reports/buying-time

Eckstein, M. (2016, October 24). *Marines pursuing large ship-based UAV for comms, ISR, fires*. USNI News. https://news.usni.org/2016/10/24/marines-pursuing-large-ship-based-uav-for-magtf-comms-isr-fires

Eckstein, M. (2020, March 10). *Marines ditch MUX ship-based drone to pursue large land-based UAS, smaller shipboard vehicle*. USNI News.

Federal Aviation Administration. (n.d.). Section 3. Large UAS (GMOW 55 pounds or more). Retrieved October 8, 2024, from https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap11_section_3.html#j5B4a1355Shaw

Federal Aviation Administration. (2024). *Aeronautical information manual*. U.S. Department of Transportation. https://www.faa.gov/air_traffic/publications/atpubs/aim_html/

Freedberg, S. J. (2014, July 24). *K-MAX robocopter comes home to uncertain future*. Breaking Defense. https://breakingdefense.com/2014/07/k-max-robocpter-comes-home-to-uncertain-future/

Fox, A. C. (2024, February 2). Contested logistics: A primer. *Landpower Essay No. 24–1*. Association of the United States Army. https://www.ausa.org/publications/contested-logistics-primer

Government Accountability Office. (2023). *Middle-tier defense acquisitions: Rapid prototyping and fielding requires changes to oversight and development approaches* (GAO-23-105008). https://www.gao.gov/products/gao-23-105008

Haddick, R. (2016). *Improving the sustainment of SOF distributed operations in access-denied environments* (JSOU Report 16–2). Joint Special Operations University Press. https://www.hsdl.org/?view&did=789778

Harrison, S. (2023, June 26). *Contested logistics remains "top of mind."* DAU. https://www.dau.edu/blogs/contested-logistics-remains-top-mind

Head, E. (2020, March 12). *U.S. Marine Corps partners with Air Force to explore eVTOL potential*. Vertical. https://verticalmag.com/news/marine-corps-agility-prime-evtol/

Joint Chiefs of Staff. (2021a). *Joint air operations* (JP 3-30). Department of Defense. https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_30.pdf?ver=2019-09-04-142255-657

Joint Chiefs of Staff. (2021b). *Manual for the operation of the Joint Capabilities Integration and Development System (JCIDS)*. Department of Defense. https://www.dau.edu/sites/default/files/2024-01/Manual%20-%20JCIDS%20Oct%202021.pdf

Jones, C. (2021, April 9). *U.S. Marine Corps successfully tests new cargo drones*. Defence Blog. https://defence-blog.com/u-s-marine-corps-successfully-tests-new-cargo-drones/

Lowman, C. J. (2023). *Sustaining a resilient joint force and defense ecosystem that enables integrated deterrence part 1 of 2*. DAU. https://www.dau.edu/library/damag/may-june2023/sustainingresilientjointforce-part1

Marine Corps Warfighting Laboratory. (2017). *Unmanned logistics systems wargame 2016: Final report*. United States Marine Corps, Quantico, VA.

Martin, B., Barnett, D. S., & McCarthy, D. (2023). *Russian logistics and sustainment failures in the Ukraine conflict* (Report No. RR-A2033-1). RAND. https://doi.org/10.7249/RRA2033-1

McGarry, B. (2022). *DoD planning, programming, budgeting, and execution (PPBE): Overview and selected issues for Congress* (CRS Report No. R47178). Congressional Research Service. https://crsreports.congress.gov/product/pdf/R/R47178

Office of the Assistant Secretary of Defense for Acquisition. (2018). *Unmanned systems integrated roadmap FY2017–2042*. Department of Defense. https://apps.dtic.mil/sti/pdfs/AD1059546.pdf

Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Operation of the middle tier of acquisition (MTA)* (DoDI 5000.80). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500080p.PDF

Office of the Under Secretary of Defense for Acquisition and Sustainment. (2022). *Operation of the adaptive acquisition framework* (DoDI 5000.02). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002p.PDF

Office of the Undersecretary of Defense for Personnel and Readiness. (2019). *Mishap notification, investigation, reporting, and record keeping* (DoDI 6055.07). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/605507p.pdf

Operational Energy, 10 USC § 2926 (2024).

Perna, G., & Beougher, G. (2024). *Contested logistics: Who's in charge?* Cypress International. https://www.dmi-ida.org/knowledge-base-detail/Contested-Logistics-Whos-in-Charge

Quick, D. (2011, December 28). *Unmanned K-MAX helicopter makes first combat cargo flight in Afghanistan*. News Atlas. https://newatlas.com/unmanned-k-max-first-combat-cargo-mission/20951/

Roach, J. (2011, December 21). *Robotic helicopters at work in Afghanistan*. MSNBC. http://futureoftech.msnbc.msn.com/_news/2011/12/21/9612653-robotic-helicopters-at-work-in-afghanistan

Swan, D., Heffern, T., & Larkin, T. (2013). *United States Marine Corps cargo unmanned aircraft system program of record study*. Patuxent River, MD: Naval Air Systems Command

United States Marine Corps. (2013). *Unmanned aerial vehicle operations* (MCWP 3-42.1).

United States Marine Corps. (2016). *Marine corps capabilities based assessment* (MCO 3900.20). https://www.marines.mil/portals/1/Publications/MCO%203900.20.pdf?ver=2016-10-18-062819-560

United States Marine Corps. (2017). *Littoral operations in a contested environment*. https://www.hqmc.marines.mil/Portals/61/Docs/LOCE%20Concept%20v1%2020170705.pdf

United States Marine Corps. (2018). *Marine corps doctrinal publication system* (MCO 5600.20R). https://www.marines.mil/portals/1/Publications/MCO%205600.20R%20v2.pdf?ver=2018-06-29-134027-227

United States Marine Corps. (2020). *Force Design 2030*. https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf

United States Marine Corps. (2023a). *Installations and Logistics 2030*. https://www.marines.mil/Portals/1/Docs/Installations%20and%20Logistics%202030.pdf

United States Marine Corps. (2023b). *Small unmanned aircraft system operations* (MCRP 3–10.3).

United States Marine Corps. (2023c). *Small unmanned aircraft systems training and readiness manual* (NAVMC 3500.107C Ch 2).

United States Marine Corps. (2023d). *Tentative manual for expeditionary advanced base operations 2nd edition*. https://www.marines.mil/Portals/1/Docs/230509-Tentative-Manual-For-Expeditionary-Advanced-Base-Operations-2nd-Edition.pdf

United States Marine Corps. (2024). *MARADMIN 327/24: Exception to policy (ETP) waiver for tactical resupply unmanned aircraft system (TRUAS) TRV-150 in regard to (IRT) MARADMIN 284/24*. https://www.marines.mil/News/Messages/Messages-Display/Article/3846508/

Acquisition Research Program
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

www.acquisitionresearch.net