Sustainment Considerations for the Multi-Domain Battle

A Monograph

by

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In 2016, Chief of Staff of the Army, General Mark A. Milley described his vision of the future operational environment. This vision encompassed many new challenges for the US Army and the Joint Force. Specifically, the concept of multi-domain battle requires the Joint Force to operate in ways not experienced in the recent past. The potential lack of air supremacy, in particular, will not only force the US military to change the way it fights, but also logistics support to those combat forces. The current capabilities of the US Army sustainment community are not adequate to order to operate successfully in the future operational environment as described by Army leadership. Counter-Anti Access/Area Denial (A2/AD) and dispersed operations present difficult challenges for the sustainment community. In order for the US Army to maintain its core competency of "set the theater," to include theater distribution, the Army sustainment community must conduct capability gap analysis, using the DOTMLPF-P framework, for both counter-A2/AD and dispersed operations challenges. Possible solutions for these challenges include sea basing and cache operations, which encompass the breadth of the DOTMLPF-P spectrum, in order to ensure robust sustainment operations capable of supporting in the future

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Abstract

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In 2016, Chief of Staff of the Army, General Mark A. Milley described his vision of the future operational environment. This vision encompassed many new challenges for the US Army and the Joint Force. Specifically, the concept of multi-domain battle requires the Joint Force to operate in ways not experienced in the recent past. The potential lack of air supremacy, in particular, will not only force the US military to change the way it fights, but also logistics support to those combat forces. The current capabilities of the US Army sustainment community are not adequate to order to operate successfully in the future operational environment as described by Army leadership. Counter-Anti Access/Area Denial (A2/AD) and dispersed operations present difficult challenges for the sustainment community. In order for the US Army to maintain its core competency of "set the theater," to include theater distribution, the Army sustainment community must conduct capability gap analysis, using the DOTMLPF-P framework, for both counter-A2/AD and dispersed operations challenges. Possible solutions for these challenges include sea basing and cache operations, which encompass the breadth of the DOTMLPF-P spectrum, in order to ensure robust sustainment operations capable of supporting in the future operational environment.

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Acronyms

A2/AD	Anti-Access/Area Denial
ADRP	Army Doctrine Reference Publication
AUSA	Association of the United States Army
AFC-MM	Army Functional Concept for Movement and Maneuver
AFC-S	Army Functional Concept for Sustainment
CASEVAC	Casualty Evacuation
DOTMLPF-P	Doctrine, Organization, Materiel, Leadership, Personnel, Facilities, Policy
EMS	Electromagnetic Spectrum
FM	Field Manual
GPS	Global Positioning System
IED	Improvised Explosive Device
ISB	Intermediate Staging Base
JCIDS	Joint Capabilities Integration and Development System
JP	Joint Publication
JPADS	Joint Precision Airdrop System
KSCB	Khe Sanh Combat Base
MEDEVAC	Medical Evacuation
NVA	North Vietnamese Army
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
POL	Petroleum, Oil, and Lubricants
RSOI	Reception, Staging, On-ward Movement, and Integration
TFW	Tactical Fighter Wing
TRADOC	Training and Doctrine Command
UAV	Unmanned Aerial Vehicle

Introduction

On October 4, 2016, Army Chief of Staff, General Mark Milley, described what he envisioned for the future of warfare to the Association of the US Army (AUSA) Eisenhower Luncheon. General Milley described a future where small units will be constantly on the move, perpetually surrounded, and cut-off from other friendly forces. No longer will US forces enjoy the security of air supremacy. Enemy aviation and artillery assets will threaten operations, make supply lines unsecure and extremely dangerous, and immediately target static facilities.[1] Most importantly, Milley stated there will be "somewhat of a role reversal." Forces in the land domain will be required to assist the other domains. The lack of air supremacy will force the US Army to operate in denied areas in order to set conditions for the US Air Force to establish air superiority.[2] This future operational environment demands a relook at an old concept: multi-domain battle, which requires all domains to assist all other domains in order to achieve mission success.

Milley also mentioned a few sustainment considerations in his address during the Eisenhower Luncheon. He suggested soldiers producing water for themselves, using three-dimensional printing for repair parts, and autonomous, robotic resupply convoys as potential means to overcome the challenge of non-contiguous operations.[3] While these are good ideas, there are still some significant capability gaps not discussed. To support the force appropriately for anticipated future challenges, the sustainment community must fundamentally change the way it operates by conducting a gap analysis and develop solutions within the doctrinal, organizational, training, materiel, leadership, personnel, facilities, and policy (DOTMLPF-P) spectrum.

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[1] C. Todd Lopez, "Milley: Army on Cusp of Profound Fundamental Change," US Department of the Army News Service, October 6, 2016, accessed June 25, 2017, https://www.army.mil/article/176231.

[2] Ibid.

[3] Ibid.

Anti-Access/Area Denial (A2/AD) is likely to be the first challenge facing sustainment operations in the future operational environment. Sustainment units will not be able to stage large quantities of stocks on-shore, and may not even be able to reach shore for a significant amount of time. Current sustainment operations rely heavily on large basing capabilities that house significant stocks of equipment and supplies to support combat forces in an area of operations. Joint interoperability with our maritime domain-focused sister services becomes increasingly vital to success in the multi-domain battlefield. Determining how Army sustainment forces will integrate into sea-basing facilities and will sustain combat forces from such bases without access to traditional land lines of communication in an A2/AD environment is absolutely essential to the Joint Force's overall success in future conflicts.

Small units are expected to conduct dispersed operations in the multi-domain battlefield. Milley's description of dispersed operations in his speech to AUSA envisioned small units operating in extremely austere environments, with little to no contact with higher headquarters, for significant periods of time.[4] How to sustain small forces, while keeping the sustainment footprint small and limited, will present unique challenges that the current organization of sustainment units cannot support. Present-day sustainment organizations reflect the reliance on large basing techniques by their massive size and cumbersome resupply operations. Simply moving certain classes of supply, such as bulk fuel, is a telltale sign of friendly operations and significant target of opportunity for the enemy.

As it stands, current capabilities of the US Army sustainment community are not adequate when it comes to operating in the future operational environment as described by Army leadership. Multi-domain battle presents such a fundamental shift in the conduct of warfare that the same magnitude of change must occur for the sustainment community. Changes in how sustainment units are organized, manned, trained, equipped, and employed can address the

[4] Lopez, "Milley: Army on Cusp of Profound Fundamental Change."

capability gaps in existing support capabilities that prevent them from successfully operating in the multi-domain battlefield.

In order to find potential DOTMLPF-P solutions that can address capability gaps that might prevent such successful mission accomplishment, there must be an assessment of the ability for current US Army sustainment forces to be successful in the multi-domain environment. Although there are many areas of concern for sustainment in the multi-domain battlefield, the two major potential gaps are sustainment operations in A2/AD environments and dispersed operations. The use of historical examples of these situations from World War II and the Vietnam War, as well as tactics, techniques, and procedures used by sister services and special operations forces provides possible solutions to potential capability gaps.

Capabilities determination, or capabilities development, is the Army's implementation of the Joint Capabilities Integration and Development System (JCIDS).[5] JCIDS is the process used to identify capabilities required by the warfighter using the DOTMLPF-P framework.[6] Capabilities development starts with identifying capability gaps (the incongruence between the capabilities we have today and what capabilities we believe we would need in the future), confirming and integrating the requirements needed to close the gaps using the DOTMLPF-P framework, and the development of the resulting solutions.[7] Similar to solving other design problems, gap analysis calls for an understanding of the current state and the desired end state, and then the formulation of an operational approach that contains the solutions necessary to achieve the desired end state.[8]

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[5] US Department of the Army, Training and Doctrine Command (TRADOC) Regulation 71-20, *Concept Development, Capabilities Determination, and Capabilities Integration* (Fort Eustis, VA: Government Printing Office, 2013), 37.

[6] Ibid.

[7] Ibid., 39.

[8] US Department of the Army, Army Techniques Publication (ATP) 5-0.1, *Army Design Methodology* (Washington, DC: Government Printing Office, 2015), 1-3 – 1-5.

The DOTMLPF-P framework addresses cost throughout the development process and ensures consideration for as many solutions as possible.[9] One major concern with capabilities development is an over-reliance on expensive materiel solutions. DOTMLPF-P is a forcing function to incorporate other solutions that may fall into changes or updates to the other non-materiel variables. The "M" for materiel in DOTMLPF-P is further broken down into "big M" and "little m," where "little m" represents solutions based on increased use or quantities of existing materiel solutions, alternate application of existing materiel solutions, or government off-the-shelf and commercial off-the-shelf solutions.[10]

To determine how the US Army can implement solutions for the multi-domain battle capability gap across the DOTMLPF-P spectrum to build the sustainment capability necessary to support operations in a multi-domain environment, an analysis of the sustainment community's understanding of the effects of multi-domain battle on future operations must first occur. The community addresses a number of issues facing sustainment in the proposed future operational environment and gives a variety of potential solutions and considerations in the TRADOC Pamphlet 525-4-1, *The US Army Functional Concept for Sustainment* (AFC-S), published in February 2017. The literature review outlines the major points of the AFC-S. However, a few of these solutions and considerations do not sufficiently address how the sustainment community plans on overcoming the challenges posed by a peer-level adversary, especially in an A2/AD situation or where the US Army must sustain dispersed forces in remote and austere environments.

An explanation of the current structure of US Army sustainment then gives the reader a basic understanding of how sustainment forces operate by using the elements of operational art of

[9] US Army, TRADOC Regulation 71-20, *Concept Development*, 68.

[10] Darren W. Rhyne, "U.S.-Coalition Forces and Host Nations: DOTmLPF-P for Contingency Procurements, Part II," *Defense AT&L* (July-August 2014), 24, accessed November 15, 2017, http://dau.dodlive.mil/files/2014/10/Rhyne1.pdf.

basing to achieve operational reach and maintain tempo. US Army sustainment operations are vital to the success of the Joint Force. A brief description of this relationship allows the reader understand how important it is for the US Army sustainment community to be successful in the future operational environment conducting multi-domain battle.

The latest guidance from Army leadership and current doctrine defines and describes the concept of multi-domain battlefield. Once current capabilities [current state] and the envisioned future operational environment [end state] are understood, a gap analysis of the sustainment community's ability to operate in the future operating environment becomes the problem frame. The AFC-S contains much of the gap analysis, but two significant gaps, logistics considerations for A2/AD and dispersed operations, do not receive as much attention as they should.

Both gaps are then analyzed by determining the disconnects between current sustainment capabilities and the challenges both gaps could potentially present to US Army logistics. Those disconnects are understood by using historical precedents and modern analysis to describe the difficulties presented by A2/AD environments and dispersed operations. To help understand the types of logistical challenges presented by these gaps, an examination of the Allied invasion of France in 1944 provides an example of logistics operations in an A2/AD environment and the Battle of Khe Sanh during the Vietnam War provides an example of dispersed operations.

Finally, while the intent is not to give specific solutions to these capability gaps, a number of ideas are explored by using gap analysis and the DOTMLPF-P spectrum. Creating the capability to sea-base would enable US Army sustainment forces in an A2/AD environment and dispersed operations. A sea-basing solution would require a number of elements across the DOTMLPF-P spectrum, but such operations are not unprecedented. Doctrine, training, and materiel already exist for sea basing in the US Marine Corps and examples from history show sea basing's effectiveness. In regards to dispersed operations, traditional methods of resupply would not only decrease the survivability of sustainment forces, but could also threaten the security of combat forces. Caching, as a potential solution, is not a new technique for small, dispersed forces.

Applying such a technique to conventional Army units may require technological adaptations and doctrinal changes. This monograph hopes to encourage creativity and innovation in developing solutions to the challenges that multi-domain battle presents to US Army sustainment.

Literature Review

In response to the US Army Training and Doctrine Command (TRADOC) White Paper: *Multi-Domain Battle: Combined Arms for the 21st Century*, a number of functional concepts describing the impacts to, and the adaptations required, for the individual warfighting functions caused by multi-domain battle considerations. The AFC-S is one such publication. The AFC-S first discusses the envisioned future operational environment, which will require US forces to engage in multi-domain battle, and how it relates to sustainment operations. The AFC-S then describes the problem as it pertains to sustainment operations in multi-domain battle and offers potential solutions. Finally, the document goes over the Army sustainment key tasks and how their application in multi-domain battle.

The problem identified in the AFC-S is how the US Army can sustain multi-domain battle in the future operational environment to achieve mission success.[11] The AFC-S's solution is to develop an optimized, fluid, integrated, and adaptable sustainment structure, capable of providing the commander with multiple options through "semi-independent operations, cross-domain maneuver, and integrated security operations in the land, air, maritime, space, and cyber-space domains."[12] The AFC-S also outlines a number of components to this solution, such as addressing mission command and leadership considerations, some technological advancements, and industrial base considerations.

[11] US Department of the Army, Training and Doctrine Command (TRADOC) Pamphlet 525-4-1, *The US Army Functional Concept for Sustainment, 2020-2040* (Fort Eustis, VA: Government Printing Office, 2017), 10.

[12] Ibid.

While the AFC-S identifies many important components of the solution, it does not sufficiently address how US Army sustainment will face the most challenging gaps: A2/AD and dispersed operations. The growing complexity of the battlefield and the increased sophistication of the enemy will fundamentally change the way sustainment forces support the warfighter. Before describing how the concept of multi-domain battle will change sustainment functions, it is important to understand how the Army currently conducts sustainment operations and proposes what multi-domain battle is to look like.

Multi-Domain Battle

The concept of multi-domain battle is not new. For at least the past seventy years, the integration of the air, land, and maritime domains and synchronization of their capabilities has been a cornerstone of the joint force concept.[13] The Joint Force Component's operational environment includes the physical domains of land, maritime, air, and space, and the information environment (includes cyberspace) and the electro-magnetic spectrum (EMS).[14] In the 2017 publication of FM 3-0 *Operations*, the US Army states that with significant advancements in technology, additional domains beyond air, land, and maritime such as space, EMS (especially cyberspace), and information become increasingly important to military operations.[15] The point of multi-domain battle is not merely the combination of these domains, but how the individual domains must enable each other in order to allow the joint force to win the next conflict.

Historical Precedence for Multi-Domain Battle

As mentioned before, multi-domain battle is not a new concept. An outstanding historical example of multi-domain battle comes from World War II during the American island hopping

[13] US Department of the Army, Field Manual (FM) 3-0, *Operations* (Washington, DC: Government Printing Office, 2017), 1-6.

[14] US Department of Defense, Joint Staff, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 2017), IV-1.

[15] US Army, FM 3-0, *Operations*, 1-6.

campaign in the Pacific theater. The domains of land, maritime, air, and information worked in concert to enable each other in order to advance as close to the Japanese mainland as possible. During the Battle of Guadalcanal, the intent of US operations was to build and maintain an airfield on the island. It was the land domain, manned by the US Marine Corps and the US Army, which secured the lodgment and then built and defended the airfield on Guadalcanal. The US Navy, operating the in the maritime domain, deployed the land forces onto the island, provided naval gun fire in support of operations there, and kept them supplied using the sea LOCs. Initially, the maritime domain enabled the air domain through the use of aircraft carriers.

The air domain, at the same time, enabled the land and maritime domains by providing defensive and offensive fires support, and intelligence gathering services. Once established on Guadalcanal by the land domain, the airfield allowed the air domain to continue offensive operations against Japanese land, air, and naval forces in support of all three domains. Also essential to operations in and around Guadalcanal was the information domain. Coast watchers reported Japanese movements to US forces, allowing for early warning of approaching enemy air and naval forces. Once the United States established its first major foothold in the Pacific during World War II at Guadalcanal, the land, sea, air, and information domains continued this symbiotic relationship for the duration of the island hopping campaign.[16]

Era of Service Independence and Multi-Domain Battle in Contemporary Use

Since the end of World War II, the US military enjoys the freedom of action provided by air supremacy gained primarily by the US Air Force.[17] Air supremacy is "that degree of control of the air wherein the opposing force is incapable of effective interference within the operational area using air and missile threats."[18] While air supremacy is not considered a prerequisite for

[16] Richard B. Frank, *Guadalcanal* (New York: Penguin Books, 1992), 600-608.

[17] Ibid.

[18] US Department of Defense, Joint Staff, Joint Publication (JP) 3-01, *Countering Air and Missile Threats* (Washington, DC: Government Printing Office, 2017), I-4.

starting combat operations, the United States achieved as much prior to the conflicts the United States has been involved with since the end of the Cold War, such as Desert Storm, Operation Iraqi Freedom (OIF), and Operation Enduring Freedom (OEF). The land and maritime domains obtained a high degree of freedom of action under the protection of air supremacy in these conflicts as well as during peacetime operations. Multi-domain battle and the future operating environment, where the United States is in parity or even overmatched against a technologically advanced enemy, the United States will not consistently have air supremacy. In fact, the United States may not even enjoy air superiority.

According to JP 3-01 *Countering Air and Missile Threats*, air superiority has proven historically to be a prerequisite for mission success. Air superiority prevents enemy air and fires assets from interfering with friendly land, maritime, and air actions.[19] Along with air supremacy, air superiority may be difficult to achieve in future conflicts. The concept of multi-domain battle addresses how each domain works to enable each other domain. The requirement for the land, maritime, space, information, and EMS domains to enable the air domain in an effort to achieve air superiority is just one example of the intention for multi-domain battle application. FM 3-0 *Operations* provides an example of how the Army, as a force operating across multiple domains, enables the air domain by conducting actions against enemy air defense assets, command and control (C2) nodes, and/or EMS capabilities.[20]

The TRADOC White Paper, *Multi-Domain Battle: Combined Arms for the 21st Century*, discusses the changes in the future operational environment where increasing sophistication of peer adversary threats challenges how the US Army, along with the rest of the joint force, can defeat such threats. The paper identifies states such as Russia and China as potential peer-level

[19] US Joint Staff, JP 3-01, *Countering Air and Missile Threats*, I-4.

[20] US Army, FM 3-0, *Operations*, 1-18.

enemies.[21] These potential adversaries have the ability to significantly challenge or even overmatch US capabilities in all domains. The United States' involvement in counterinsurgency operations for the past sixteen years against a technologically inferior enemy degraded US capabilities through the refocusing of research, development, procurement, and training operations to defeat insurgencies and build functioning governments.[22] Additionally, the proliferation of technology increased the potential for less-than-peer states and non-state actors to challenge the United States in multiple domains.[23] As such, the air supremacy/superiority enjoyed by the United States in conflicts since World War II will no longer be initially or continuously available or reliable.[24] The White Paper states, "enemy capabilities now threaten Joint Force interdependence, which turns long-assumed strengths into weaknesses."[25]

Future high intensity combat operations will demand fluid joint force interoperability and synchronization in order to defeat a sophisticated enemy. Lack of immediate and assured air superiority will cause the remainder of the joint force to conduct operations in severely contested environments with actions meant to enable the air domain to gain or regain air superiority. Which, in turn, will enable the other domains in their actions against the enemy.[26] When it comes to the US Army, primarily operating in the land domain, these actions to enable the air domain will require ground forces to conduct operations in very austere environments, where

[21] US Department of the Army, Training and Doctrine Command (TRADOC), *Multi-Domain Battle: Combined Arms for the 21st Century, White Paper* (Fort Eustis, VA: Government Printing Office, 2017), 2.

[22] Ibid., 1.

[23] Albert Palazzo and David P. Mclain, "Multi-Domain Battle: A New Concept for Land Forces," *War on the Rocks*, September 15, 2016, accessed February 4, 2018, https://warontherocks.com/2016/09/multi-domain-battle-a-new-concept-for-land-forces/.

[24] US Army, TRADOC, *Multi-Domain Battle White Paper*, 1-2.

[25] Ibid.

[26] Ibid.

communications are significantly degraded, units are separated and potentially surrounded by the enemy, and traditional sustainment operations are no longer feasible to support the fight.[27]

Current US Army Sustainment Operations

The operational concept, unified land operations, is the US Army's contribution to unified action, the Joint operational concept, and is how the Army applies land power to defeat the enemy in support of unified action.[28] The Army does this "through simultaneous offensive, defensive, and stability tasks to seize, retain, and exploit the initiative, and consolidate gains."[29] Sustainment for the US Army is a massive and complex element of combat power that aims to allow the US Army the freedom of action to accomplish unified land operations in support of the Joint force.

According to ADRP 4-0 *Sustainment*, the sustainment warfighting function is "the related tasks and systems that provide support and services to ensure freedom of action, to extend operational reach, and to prolong endurance."[30] In order to accomplish this enormous mission, the Army sustainment community divides into three elements, managed separately at the strategic level, yet come together in modular and multifunctional units at the operational and tactical levels. These elements are logistics, health service support, and personnel services.[31]

Logistics is primarily the planning and executing of the movement of forces and the support those forces require to execute their missions. The bulk of logistics operations consist of maintenance, transportation, supply, distribution, and field services.[32] Field services includes, but

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[27] US Army, TRADOC, *Multi-Domain Battle White Paper*, 3.

[28] US Department of the Army, Army Doctrine Reference Publication (ADRP) 3-0, *Operations* (Washington, DC: Government Printing Office, 2017), 3-1.

[29] Ibid.

[30] US Department of the Army, Army Doctrine Reference Publication (ADRP) 4-0, *Sustainment* (Washington, DC: Government Printing Office, 2012), 1-1.

[31] Ibid.

[32] Ibid.

is not limited to, aerial delivery, field feeding, and mortuary affairs operations.[33] Logistics is a critical enabler, which allows forces to stay engaged in operations throughout the battlefield and is necessary for successful mission accomplishment.[34]

The next element of sustainment, heath service support, provides "continual, flexible, and deployable medical support designed to sustain force projection" and mission accomplishment.[35] The three missions of health service support include casualty care, medical evacuation, and medical logistics. Casualty care is divided into three roles: Role 1 is medical treatment provided by a combat medic at the point of injury or by medical personnel at a battalion aid station, Role 2 provides greater resuscitative capability than Role 1 and can receive, maintain, and transfuse blood products and Role 3, or hospitalization, which provides the next level of care, to include surgery, rendered by combat support hospitals operating in an area support role.[36] Medical evacuation (MEDEVAC), which provides en-route medical care, or casualty evacuation (CASEVAC), which provides does not provide en-route medical care, are essential to enhancing casualty prognosis. In 2009, then Secretary of Defense Robert M. Gates mandated the "golden hour" standard for the conflicts in Iraq and Afghanistan. The "golden hour" requires the evacuation of all critically injured combat casualties to Role 3 via MEDEVAC within a 60-minute window.[37] Health service support mission capabilities can greatly affect the depth, endurance, and freedom of action of forces.

Personnel services, the final element of sustainment, provides the services required to maintain personnel individual readiness and quality of life that enables the Army to achieve

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[33] US Army, ADRP 4-0, *Sustainment*, 4-4.

[34] US Department of the Army, Field Manual (FM) 4-95, *Logistics Operations* (Washington, DC: Government Printing Office, 2014), 1-1.

[35] US Army, ADRP 4-0, *Sustainment*, 4-11.

[36] Ibid., 4-11 – 4-12.

[37] Robert M. Gates, *Duty: Memoirs of a Secretary at War* (New York: Random House, 2014), 304-305.

endurance. Personal services include human resources, financial management, and legal, religious, and band support.[38] Some of the functions of personnel services that end up directly influencing or enabling logistics are postal operations, legal support, and casualty operations management. While personnel services are a key element to sustainment operations and essential to the effectiveness of US Army forces, the requirements and capabilities of logistics and health service support are sufficient to help describe sustainment considerations for multi-domain battle.

Sustainment and Operational Art

Throughout history, militaries sustained their operations using the element of operational art, basing, to enable combat operations. Basing is the use of physical geographic areas to build up, store, and project forces, equipment, supplies, and support elements.[39] As the "teeth" of armies have increased in size and complexity over time, their "tails" have grown exponentially in comparison. As a result, basing became more essential to successful operations. Over the last few decades, the US Army enjoyed the protective umbrella of air superiority. As a result, the use of basing not only increased, but also grew in size and permanence.

The leveraging of basing to enable the commander to orchestrate other elements of operational art, such as tempo and operational reach attributes much of the success of current Army sustainment operations. According to JP 4-0 *Joint Logistics*, a base is "a locality from which operations are projected or supported" that are often located in and leased long-term from host nations with which the United States has a status-of-forces agreement.[40]

The goal of successful sustainment operations is to provide the commander with options but it also "determines the depth and duration" of operations.[41] Operational reach is the ability of

[38] US Army, ADRP 4-0, *Sustainment*, 4-6.

[39] US Army, ADRP 3-0, *Operations*, 2-9 – 2-10.

[40] US Department of Defense, Joint Staff, Joint Publication (JP) 4-0, *Joint Logistics* (Washington, DC: Government Printing Office, 2013), GL-5.

[41] US Army, ADRP 4-0, *Sustainment*, 1-1.

a force to achieve its objectives as far as possible in time and space prior to culmination.[42] Basing extends operational reach by increasing endurance and momentum through the shortening of the distance between warfighting forces and their support forces. In the future operating environment, these types of bases may not be able to exist. Therefore, operational reach may be limited unless the force employs new methods of sustainment operations to maintain operational reach. Basing does not just enable operational reach, but allows for optimal tempo.

ADRP 3-0 *Operations* describes tempo as "the relative speed and rhythm of military operations over time with respect to the enemy."[43] The ADRP goes on to state it is important to control the tempo of operations based on available resources. Higher tempo requires more energy and resources to maintain.[44] Basing can help maintain high tempo by keeping resources as close to the fight as possible, allowing sustainment forces to reach the warfighter quickly. It is easier to maintain high tempo in conflicts, such as the later years of OIF and OEF, because of already established bases throughout the area of responsibility. In a decisive action scenario, coupled with the challenges of multi-domain battle, high tempo may be harder to maintain without serious adaptation in sustainment operations.

The Army's Role in Joint Sustainment

According to FM 4-95 *Logistics Operations*, "logistics is inherently joint."[45] The individual services' roles in joint logistics vary based on the organic capabilities of each service. As the Joint Force's largest and primarily ground-based service, the Army performs unique additional roles in support of the joint force when it comes to sustainment. One of the Army's major core competencies in joint operations is setting the theater and, as part of setting the theater, theater distribution. The US Army's Operating Concept: *Win in a Complex World* states

[42] US Army, ADRP 3-0, *Operations*, 2-8.

[43] Ibid., 2-7.

[44] Ibid.

[45] US Army, FM 4-95, *Logistics Operations*, 2-8.

that "the Army's ability to set the theater is essential to preventing conflict and, if deterrence fails, allowing the Joint Force to seize the initiative while protecting the force and restricting the enemy's options."[46] Setting the theater, or Reception, Staging, On-ward Movement, and Integration (RSOI) is "the process used to deliver combat power to the joint force commander."[47] Army sustainment organizations handle these tasks to set the logistics conditions necessary to conduct military operations in a theater, which may include establishing and operating intermediate staging bases (ISB).[48]

The US Army provides the Joint Force with "common-user support, common-user logistics, and common land transportation support."[49] This second part of the "set the theater" core competency, theater distribution, is necessary to provide the Joint Force with the materiel required gain and maintain the initiative. Distribution-based logistics requires a network of nodes and lines of communication to support the force. Theater distribution operations are essential to achieving freedom of action and movement.[50]

Current joint sustainment operations rely on interdependencies between services. According to FM 4-95 *Logistics*, joint interdependence is "the purposeful reliance by one service's forces on another service's capabilities to maximize the complementary and reinforcing effects of both."[51] Joint interdependence is vital to the success of joint operations, especially when one service holds the vast majority, if not all of the capability, such as the US Air Force and

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[46] US Department of the Army, Training and Doctrine Command (TRADOC) Pamphlet 525-3-1, *The US Army Operating Concept: Win in a Complex World* (Fort Eustis, VA: Government Printing Office, 2014), 23.

[47] Kenneth Gaines and Reginald Snell, "Setting and Supporting the Theater: RSOI," *Army Sustainment* (November-December 2015): 14, accessed January 15, 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/1001685.pdf.

[48] US Department of the Army, Army Techniques Publication (ATP) 4-93, *Sustainment Brigade* (Washington, DC: Government Printing Office, 2016), 5-2 – 5-3.

[49] Ibid., 1-4.

[50] Gaines and Snell, "Setting and Supporting the Theater," 14.

[51] US Army, FM 4-95, *Logistics Operations*, 2-8.

strategic airlift, the US Navy and strategic sealift, and the US Army with theater basing and distribution. Joint interdependence maximizes these complementary abilities in order to reduce "duplication of effort and competition for resources."[52]

OEF and OIF provided an enduring environment for the US Army to practice logistics. The nature of the environment allowed for increased asset visibility, which in turn, allowed the Army to practice more demand-supported, or distribution-based, logistics.[53] This concept differs from supply-based logistics, which is dependent on cumbersome "iron mountains" of supplies. Distribution-based logistics depends on a robust network of nodes and links in the form of bases and lines of communication. It also depends on near-real time asset visibility to ensure forces had adequate supply for operations and distribution efforts did not exceed end-user capacity.

Sustainment Operations Dependencies

Current army sustainment operations are dependent on a number factors. First, guaranteed air superiority is essential to current basing and distribution techniques. Second, sustainment operations developed a reliance on the predictability of the last sixteen years of war rather than the fluid nature of the anticipated future operational environment. The routine nature of everything from strategic-level RSOI operations to daily tactical resupply convoys. The implementation of decisive action scenarios during training exercises forces logistics units to operate in more challenging environments. Finally, sustainment units have become complacent with the level of intensity of recent counter-insurgency conflicts.

Sustainment operations are extremely complex, but over the last sixteen years of conflict, the development of robust systems and processes minimized the complexity needed to support the conflicts in Iraq and Afghanistan. The complacency that grew from predictable and familiar

[52] Gaines and Snell, "Setting and Supporting the Theater," 14.

[53] C. Brandon Cholek and Matthew A. Anderson, "Distribution-based Logistics in Operation Iraqi Freedom," *Army Logistician* 39, no. 2 (March-April 2007), accessed January 18, 2018, http://www.alu.army.mil/alog/issues/mar-apr07/distib_log_oif.html.

operational environments, guaranteed air supremacy, assured communications systems, and minimally contested bases and lines of communication drove the dependency of sustainment forces, and the joint force as a whole, to robust in-theater basing and stockpiling techniques. The future operating environment will not guarantee the safeguards to sustainment that were available in the past. The disconnects between what sustainment forces are used to and what they can expect to experience in the future are extreme.

Sustainment in Multi-Domain Battle: A Gap Analysis

The various sources that describe multi-domain battle discuss how each domain may enable others, but with an expressed emphasis on lethal or non-lethal fires and effects enabling maneuver forces. These ideas, and their maneuver focus, fail to take into consideration multi-domain sustainment operations. To sustain the multi-domain battle, sustainment itself must become more multi-domain. Joint logistics must become more integrated and interdependent. The AFC-S outlines many capability gaps between how the Army conducts sustainment operations currently and how sustainment operations must adapt based on changes in the operational environment.

The future operating environment poses many challenges for sustainment in a multi-domain battle. The AFC-S describes many of these challenges in detail and provides a number of potential solutions. However, the AFC-S does not adequately address two significant gaps that the future operating environment presents: the ability to sustain in an A2/AD environment and dispersed operations. In order to conduct the gap analysis, the development of an understanding of these future challenges must first occur. Current capabilities must then be analyzed based on the understanding of the future challenges to determine where those capabilities are inadequate. The DOTMLPF-P framework is then used to achieve holistic potential solutions to fill the capability gaps. A2/AD and dispersed operations present difficult challenges to US Army sustainment, but there are a number of solutions that can improve future performance.

Counter-Area Access/Area Denial Operations

JP 3-0 *Operations* identifies a number of strategic environment and national security challenges that US forces may face in the near future. One of these challenges is increased adversary anti-access and area denial capabilities. This publication defines A2 as "capabilities, usually long range, [that] prevent or inhibit an advancing force from entering an operational area," and AD as "capabilities that can limit a force's freedom of action within an operational environment."[54] Like multi-domain battle, A2/AD is not a new concept. US forces have faced enemy A2/AD operations many times throughout history, and the challenges with sustaining counter-A2/AD operations were apparent.

Historical Precedent – Operation Overlord

Arguably the most famous successful counter-A2/AD operation (and a superb example of multi-domain battle) by US and allied forces is Operation Overlord on June 6, 1944, better known as the D-Day invasion of France in World War II. After the successful occupation of France and the rest of Western Europe, Germany began to harden the coastal defenses along the Atlantic wall from Denmark through Northern France.[55] Adolf Hitler personally ordered one of his most revered generals, Field Marshal Edwin Rommel, to inspect the defensive perimeter. By 1944, the Germans emplaced thousands of permanent coastal artillery guns, 4.5 million landmines, layered anti-landing craft and anti-ship mines and obstacles, machine gun emplacements, ditches, and other obstacles along the beaches.[56] In the rear areas, the Germans maintained reserves of troops and tanks, emplaced redundant long-range ground and anti-air artillery, and "Rommel's asparagus" fields, which described poles topped with explosives to counter glider landings.[57]

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[54] US Joint Staff, JP 3-0, *Operations*, I-3.

[55] Sam J. Tangredi, *Anti-Access Warfare: Countering A2/AD Strategies* (Annapolis: Naval Institute Press, 2013), 135-136.

[56] Ibid., 136.

[57] Ibid.

Allied success against this formidable defense came from a combination of brute force and effective deception operations.

Pas-de-Calais held the majority of German capability along the Atlantic wall because of the long-held assumption that it would be the most likely approach for an Allied attack. This assumption was not only because Pas-de-Calais is the closest point in France to England, just 33 kilometers across the Strait of Dover, but also due to a highly effective Allied deception operation. Operation Fortitude included the First US Army Group commanded by Lieutenant General George S. Patton, who used radio transmissions, fake tanks, and other deception tactics to help keep the Germans' attention on Pas-de-Calais while Allied forces launched the real invasion at Normandy.[58]

Operation Overlord was the largest amphibious invasion in history.[59] Nearly 7,000 vessels and 12,000 aircraft supported the invasion of 155,000 allied troops on D-Day. By the end of the fifth day, over 325,000 troops, 54,000 vehicles, and 100,000 tons of supplies made it into France.[60] The objective of Operation Overlord was to establish a lodgment on the European continent to allow for follow on counter-A2/AD offensive operations against the Germans.[61] The enormous scale and complexity of Operation Overlord created significant challenges for sustainment operations.

Steve Waddell, author of *United States Army Logistics: The Normandy Campaign, 1944*, argues that despite being the best-equipped and supplied force during the war, the US Army Service Forces "often functioned at less-than-peak efficiency and encountered difficulties that

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[58] Tangredi, *Anti-Access Warfare*, 137.

[59] Steve R. Waddell, *United States Army Logistics: The Normandy Campaign, 1944* (Westport: Greenwood Press, 1994), xv.

[60] Seattle Times Staff, "About D-Day: Operation Overlord Facts and Figures," *The Seattle Times*, June 4, 2014, accessed December 15, 2017, https://www.seattletimes.com/nation-world/about-d-day-operation-overlord-facts-and-figures/.

[61] Gordon A. Harrison, *United States Army in World War II – The European Theater of Operations: Cross-Channel Attack* (Washington, DC: Center for Military History, US Army, 1993), 158.

should have been anticipated."[62] Waddell states there were two major obstacles facing logisticians in support of Operation Overlord. The first was supplying the invasion forces adequately enough to prevent culmination prior to establishing the lodgment. The second major obstacle was the establishment of supply points to support the follow-on attack on German forces through France.[63]

Problems with distribution and supply shortages caused US forces to culminate by September 1944. Patton's Third Army, consuming more than 300,000 gallons of fuel per day, out ran the capabilities of the unit's sustainment assets. Additionally, combat forces developed bad habits of discarding reusable material, such as metal fuel canisters, and hording supplies to counter shortages.[64] However, maneuver forces were not entirely to blame. Mismanagement by logistics leaders resulted in overworked truck drivers who would sabotage their own vehicles to get out of missions and sell their own cargo.[65]

Sustaining counter-A2/AD operations is a difficult undertaking as shown by the Operation Overlord example. One could argue the size and scope of the invasion caused many of the sustainment issues faced by the Allies, but even smaller counter-A2/AD operations will pose a significant challenge for sustainment forces used to operating in assured environments. In recent history, especially OIF and OEF, US forces established lodgments in friendly, secure countries and with guaranteed air superiority where there was little to no adversary A2/AD operations occurring.

There are numerous indications that near-peer and peer level adversaries are increasing their A2/AD capabilities. Improvements in technology and training to harden A2/AD capabilities show that countries such as Russia and China are preparing to protect themselves against a more

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[62] Waddell, *US Army Logistics: The Normandy Campaign*, xvii.

[63] Ibid., 25.

[64] Ibid., 153.

[65] Ibid., 132.

capable adversary. These efforts could potentially degrade the United States' ability to sustain any operations against such adversaries.

For example, Russia's growing A2/AD capabilities constitute a "thicket of overlapping and redundant" systems.[66] Russian A2/AD assets consist of air defense, land-based strike, and naval strike missiles designed to impede NATO's ability to respond to crisis in the Baltics or Poland.[67] Further, NATO depends on the large collection of air and sea ports of debarkation and embarkation found in Europe.[68] Russia's increased A2/AD capability enhances the country's ability to strike these important nodes, directly affecting the key sustainment operations of RSOI and distribution.

Sustainment Capability Gaps for Counter A2/AD Operations

As long as the United States military remains a smaller, all-volunteer force, it cannot expect to be able to conduct counter-A2/AD operations by using brute strength as it did in Operation Overlord. A small invasion force may not be able to secure a lodgment necessary to support follow on operations and the loss of guaranteed air superiority in an A2/AD environment will prevent the use of robust basing. Additionally, depending on the sophistication of the adversary's A2/AD capabilities, US forces may not be able to count on using already established air and sea ports of debarkation. In order to support the joint force in future counter-A2/AD environments, more mobile and collaboratively joint sustainment operations may be required.

The concept of basing and how basing is currently used must adapt in order to support an integrated joint force and dispersed warfighters in highly contested environments. Current sustainment operations depend on the ability to base in order to support the force. While

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[66] Kathleen Hicks, *Evaluating Future US Army Force Posture in Europe: Phase II Report* (Washington, DC: CSIS, 2016), 34, accessed October 25, 2017, https://www.csis.org/analysis/evaluating-future-us-army-force-posture-europe-phase-ii-report.

[67] Ian Williams, "The Russia-NATO A2AD Environment," *Missile Threat: CSIS Missile Defense Project*, January 3, 2016, accessed November 15, 2017, https://missilethreat.csis.org/russia-nato-a2ad-environment.

[68] Ibid.

distribution-based logistics is now the norm and "iron mountains" of supplies are not typical at forward echelons, the US military is still dependent on large, permanent bases in theater to support sustainment operations. These bases not only provide the logistics storage and distribution hubs required of distribution-based logistics, but they also provide the security necessary to house and support the massive amounts of contractors US Army logistics has come to depend on.

The envisioned future operating environment is more dangerous, austere, contested than operational environments experienced in the recent past. The security of basing will not be guaranteed and may not even allow for basing to exist in the same ways it has in the past. A contested environment for basing presents a significant capability gap for sustainment forces. One of the US Army's core competencies is setting the theater.[69] The inability to establish the necessary basing to conduct RSOI and support the theater due to enemy action could have terrible implications for follow-on operations. The Army must find solutions to this gap in order to mitigate the effects of such an environment.

One potential way to construct a joint collaboration effort for sustainment is sea basing; the combination of US Navy maritime assets with US Army sustainment organizations. Sea basing is currently a capability owned by the Department of the Navy in conjunction with the US Marine Corps. As the AFC-S states, multi-domain battle "emphasizes the need to achieve cross-domain synergy through coordinated, simultaneous actions across contested spaces."[70] In order to successfully set and support the theater, US Army sustainment forces must expand out into the maritime domain as required to maintain their core competency as a member of the Joint Force.

[69] US Army, TRADOC Pamphlet 525-3-1, *US Army Operating Concept*, iv.

[70] US Army, TRADOC Pamphlet 525-4-1, *Functional Concept for Sustainment*, 8.

Dispersed Operations

Milley's AUSA speech expanded upon the 2014 Army Operating Concept, *Win in a Complex World*, describing the future of Army combat operations as highly dispersed. According to the publications now dedicated to multi-domain battle, the concept of dispersed operations describes various-sized units spread out across wide areas, cut off from direct access to adjacent and supporting forces and operating semi-independently.[71] To determine how to sustain dispersed operations, first it is important to understand how maneuver forces plans to conduct such operations.

The TRADOC Pamphlet 525-3-5, *US Army Functional Concept for Movement and Maneuver* (AFC-MM) lays out in detail the reasons for dispersed operations. First, as described in the concept of multi-domain battle, Army forces will fight in contested domains. AFC-MM states that while the Army is experienced in operating in a contested land domain, future adversaries will contest other domains.[72] The idea of a contested air domain is especially new and concerning for the Army. In order to operate in an environment where air superiority is not guaranteed, US ground forces must conduct dispersed operations for their own protection from enemy air operations. Additionally, dispersed operations can improve the ability of the Army to enable the other domains by limiting the enemy's capability of friendly force detection through their use of the air, space, and information domains.[73]

Increased enemy capability in the other domains will also force the United States to conduct decentralized, semi-independent, dispersed operations. In the land domain, highly advanced, lethal, and massed artillery poses a significant threat to US forces. Such artillery

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[71] US Department of the Army, Training and Doctrine Command (TRADOC) Pamphlet 525-3-1, *The US Army Operating Concept: Win in a Complex World* (Fort Eustis, VA: Government Printing Office, 2014), 22; US Department of the Army, Training and Doctrine Command (TRADOC) Pamphlet 525-3-6, *The US Army Functional Concept for Movement and Maneuver* (Fort Eustis, VA, Government Printing Office, 2017), 13; US Army, TRADOC Pamphlet 525-4-1, *Functional Concept for Sustainment*, 11.

[72] US Army, TRADOC Pamphlet 525-3-6, *Functional Concept for Movement and Maneuver*, 13.

[73] Ibid.

capabilities will require the US military to limit its traditional use of extensive basing and disperse units further apart and in smaller elements. Similarly, in the information domain, advanced offensive cyber operations by the enemy may cause substantial communications, and other technological, issues for US forces.[74] These problems could force the US military to operate in a more decentralized and independent fashion.

Multi-domain battle may drive the need for dispersed operations which increases the complexity not only for maneuver forces, but also for sustainment forces as well. Dispersed operations may be required to counter enemy air superiority, both as a defensive and an offensive measure. While the other domains may disperse units to the degree that they are no longer have continuous communication with higher echelons. These issues pose new problems for sustainment forces that are at odds with current distribution techniques.

Historical Precedence

During the Vietnam War, the Battle of Khe Sanh forced a number of innovative sustainment techniques by US Marines in order to support the Khe Sanh Combat Base (KSCB) and the other defensive positions on surrounding hills. The Battle of Khe Sanh occurred from January 21 to July 8 of 1968. The Marines at KSCB, surrounded by the North Vietnamese Army (NVA), had significant resupply issues. Coupled with the enemy threat, the winter monsoon closed Route 9, the main ground line of communication, and by mid-January the Marines required approximately 185 tons of supplies per day.[75]

The monsoon and enemy anti-aircraft fire also limited rotary wing aerial resupply operations to the Marines at Khe Sanh.[76] The Air Force, who had significantly more experience in

[74] Keir Giles, "Assessing Russia's Reorganized and Rearmed Military," *Carnegie Endowment for International Peace*, May 3, 2017, accessed February 23, 2018, http://carnegieendowment.org/2017/05/03/assessing-russia-s-reorganized-and-rearmed-military-pub-69853.

[75] Moyers S. Shore, *The Battle for Khe Sanh* (Washington, DC: Historical Branch, G-3 Division, Headquarters, US Marine Corps, 1969), 90.

[76] Ibid., 72.

air drop operations than the Marines, ended up airdropping nearly 65 percent of supplies by C-130 cargo aircraft throughout the battle.[77] In order to resupply the outlying, isolated hill outposts surrounding KSCB, the Marines instituted what they called the "Super Gaggle."[78] The concept called for a group of fighter-bombers to provide flak suppression for massed rotary wing resupply sorties, which would resupply the outposts simultaneously.[79]

Sustainment Capability Gaps for Dispersed Operations

Dispersed operations presents many challenges for future sustainment operations. Like A2/AD, dispersed operations may prevent US Army sustainment units from using bases as they traditionally have. Dispersed operations will also present new challenges to distribution techniques. Both physical and technological security concerns for logistics operations show the need for further gap analysis when it comes to sustaining dispersed operations.

The dependence of current sustainment operations on air superiority is not compatible with the concept of multi-domain battle. Distribution-based logistics, as it exists, requires an extensive network of bases and lines of communication to conduct sustainment operations. The loss of air superiority puts traditional distribution networks at risk. Like counter-A2/AD, dispersed operations could require the US Army to change how it bases in order to maintain the ability to conduct theater distribution for the Joint Force. Basing from the maritime domain could assist with dispersed operations sustainment issues depending on the proximity to sea lines of communication.

In addition to basing issues, traditional distribution techniques present a problem in a multi-domain battle environment with dispersed operations. While theater distribution is multi-modal in current practice, much of these operations depend on robust basing on substantial

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[77] Clark Dougan and Stephen Weiss, *Nineteen Sixty-Eight* (Boston: Boston Publishing Company, 1986), 49.

[78] Shore, *The Battle for Khe Sanh*, 89.

[79] Ibid.

airfields, large convoys, and a high dependence on contractor support. Current distribution techniques that are useful to dispersed operations, such as aerial delivery, depend on an environment where the US forces enjoy air superiority. Aerial delivery is also only effective with certain classes of supplies, and in certain quantities. To support dispersed operations effectively, there must be diverse methods of aerial delivery, such as the traditional airdrop and sling load methods, and new, innovative methods using unmanned aerial vehicles (UAV) and delivery via artillery. While aerial delivery is essential to supporting dispersed operations, lesser-used methods of logistics may now fit the environment. Caching is typically associated with insurgent or inferior conventional forces, but is a method of resupply used by US special operations in their own often-dispersed situations.

Just as daunting as the distribution issue, retrograde and evacuation present other, perhaps more serious problems. The lack of retrograde of supplies and equipment from a dispersed operations environment could be detrimental to the current supply system that depends on the return of inoperable equipment, repair parts, and other reusable materiel to maintain stock levels. The military and industry must be prepared to sustain a war without the expectation of the quick retrograde of equipment. Evacuation of causalities and remains is another great concern. US forces still operate under the “golden hour” policy from operations in Iraq and Afghanistan where robust basing and air supremacy provided the necessary protection for far-forward medical support. Operating in dispersed environments may force units to increase their own medical capabilities at the lowest levels and use more innovative techniques for evacuating casualties, such as autonomous MEDEVAC UAVs or ground traversing robots. Additionally, due to the nature of dispersed operations, the evacuation of remains may not occur quick enough to maintain the integrity of the remains. In-theater graves registration (burial of personnel in theater), once a common method in past wars, may become standard practice again.

Sustaining counter-A2/AD and dispersed operations presents major capability gaps that the current sustainment community is not able to address. Major changes and innovations across

the DOTMLPF-P spectrum must be achieved in order to successfully support a war that occurs the future operating environment. Because sustainment equipment and formations are not typically the recipients of major funding efforts, consideration must be made to the types of solutions presented. Many of these innovations do not require "big M" solutions, but can be integrated into already existing equipment, contracts, and sustainment methods.

Solutions for Multi-Domain Battle Sustainment Capability Gaps

Once gap analysis is conducted and capability gaps identified, the development of solutions can begin. The DOTMLPF-P framework is essential to developing solutions because it ensures that all possible solutions are considered and prevents a dependence on "big M." This allows solutions to develop as rapidly as possible and safeguards the budget and taxpayer from excessive spending. Many of the solutions presented for counter-A2/AD and dispersed operations sustainment gaps have a materiel element, but the majority are not new concepts and exist in some form either in the civilian or military worlds.

Sea-Basing

One solution for both counter-A2/AD and dispersed operations is US Army sea basing. The US Marine Corps and US Navy already exercise this capability. They define sea basing as "the deployment, assembly, command, projection, sustainment, reconstitution, and reemployment of joint power from the sea without reliance on land bases within an operational area."[80] Sea basing eliminates, or greatly reduces the need for on-shore logistics assets and reduces the need for strategic airlift capabilities.[81] However, due the US Marine Corps' expeditionary nature and small size, the service would not be able to support a massive RSOI operation anywhere near the scale of Operation Overlord. Additionally, setting and supporting the theater is the US Army's

[80] US Department of the Navy, US Marine Corps, *Maritime Expeditionary Warfare Annual Report* (Washington, DC: US Government Printing Office, 2017), 8.

[81] Ibid.

core competency. Therefore, the US Army must achieve the capability to sea base in order to successfully sustain US forces in the future operational environment.

In a counter-A2/AD environment, sea basing can provide the necessary logistics to support RSOI of combat forces while maintaining freedom of movement to avoid enemy countermeasures. Not only can massive amounts of materiel and equipment be staged at a sea base, ready for rapid employment, a sea base can serve as a mobile ISB, able to change location when necessary to support the fight from the best position possible and mitigate the effects of enemy air superiority. A sea base can support an invading force until enough space is created and enough security is available to establish a land-based ISB.

Certain classes of supply present more difficult problems than others. Bulk fuel storage and distribution is one of the most significant, mission-impacting challenges facing sustainment operations in any conflict. In a counter A2/AD operation, storing bulk fuel on-ground only increases risk to forces and to the mission. Sea basing may provide additional options to counter this challenge. An Army sustainment brigade, with a quartermaster petroleum, oil, and lubricants (POL) element, operating on a ship in the littoral could use floating or seabed pipelines to transport bulk fuel from ship to shore.

The US Air Force 12th Tactical Fighter Wing (TFW) did just that in the Vietnam War. During the establishment of the Cam Ranh Bay airstrip in early 1966, the 12th TFW used an anchored tanker ship off the coast to fuel its F-4C Phantoms. The pipeline from the tanker could move approximately 30,000 gallons of fuel per hour; using booster pumps to push the fuel a distance of seven miles and over difficult terrain. Besides making it possible for the airstrip to function, the pipeline method prevented the airstrip from becoming more of a target to the Viet Cong due to the lack of large fuel tanks on ground. Additionally, the tanker ship was easily

resupplied by other ships, decreasing the need for large resupply convoys of tanker vehicles moving through hostile territory.[82]

The capability to conduct ship-to-shore bulk fuel distribution is available and used by the US Navy today. In June 2010, the Military Sealift Command's offshore petroleum distribution system ship, USNS Vice Admiral K.R. Wheeler, notionally practiced pumping fuel to shore from a tanker up to eight miles out to sea.[83] The ship operates as a floating pumping station, moving fuel from a tanker vessel to shore using 35 spools of flexible, metal-lined, pipe. In a real-world operation, the Wheeler could deploy its full length of pipe ashore and be ready to pump fuel in as little as 20 hours.[84] Whether an Army sea-basing concept would include these capabilities in a single sustainment ship, or use vessels like the Wheeler to assist in bulk fuel operations as a true collaborative joint operation, the doctrine, training, and materiel already exist.

For both counter-A2/AD and dispersed operations, sea basing provides facilities that can support retrograde and evacuation operations without having to put bases on land before air superiority is established or are distant that they affect operational reach. Sea bases can support large, immobile capabilities such as three dimensional printing and component repair units for the reconstitution of repair parts. Role III medical facilities with robust triage, surgical, and other trauma care for casualties can be relatively free from enemy interference, and refrigeration capabilities can assist with blood storage and remains processing as well.

Like many solutions to complex problems, sea basing does create additional problems that must be solved. Sea basing could potentially be offset further from combat operations than typical on-shore basing depending on the distance between combat operations and littoral areas.

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[82] Wallace Beene, "Floating Fuel Dump Keeps Thirsty Phantoms Filled Up," *Stars and Stripes*, February 8, 1966, accessed September 17, 2017, https://www.stripes.com/news/floating-fuel-dump-keeps-thirsty-phantoms-filled-up-1.59778#.WbspaXpOmf0.

[83] Ed Baxter, "One-of-a-Kind Wheeler Trains to Deliver Fuel to Shore," Military Sealift Command, August 2010, accessed September 17, 2017, http://www.msc.navy.mil/sealift/2010/August/wheeler.htm.

[84] Ibid.

Additionally, sea basing is highly reliant on vertical lift capabilities for distribution for many sustainment operations. The US Army currently does not have vertical lift aircraft capable of prolonged distances and flight times necessary to support counter A2/AD or dispersed operations either with sea-basing or distant land-basing. However, the V-280 Valor, a new prototype tilt-rotor aircraft competing for the US Army's Future Vertical Lift replacements for the UH-60 Blackhawk and AH-64 Apache, took its first flight in December 2017.[85] The V-280 has a combat range of over 900 miles and a top speed of nearly 350 miles per hour.[86] Compared to the US Army's most useful aircraft for logistics, the CH-47 Chinook, the V-280 has nearly double the speed and range.[87] This type of aircraft is essential to the success of US Army sea basing.

Sea basing is a solution that requires elements across the DOTMLPF-P spectrum in order for the US Army to implement successfully. However, many of these elements do not require extensive innovation and can be adapted from already established capabilities in the sister services. The US Marine Corps and US Navy currently have a robust sea basing capability. Where this capability falls short is the ability to support large-scale and prolonged counter-A2/AD operations. Regardless, the US Army can quickly adapt Marine Corps and Navy doctrine, organization, and training, among other DOTMLPF-P elements, to suit Army sea-basing. Much of the materiel elements of the sea basing solution already exist, with US Navy and merchant marine assets, or material solutions for other purposes in development, such as Army tilt-rotor capabilities.

The challenges of Army sea basing are extensive, but not insurmountable. Like the US Marine Corps, the Army will depend on the Navy to provide and operate the shipping necessary

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[85] David Cenciotti, "Bell V-280 Valor Next-Generation Tilt-Rotor Aircraft Prototype Has Just Made Its First Flight," *The Aviationist*, December 18, 2017, accessed February 23, 2018, https://theaviationist.com/2017/12/18/bell-v-280-valor-next-generation-tilt-rotor-aircraft-has-just-made-its-first-flight/.

[86] Ibid.

[87] "[C]H-47 Chinook," Boeing Defense, accessed February 23, 2018, http://www.boeing.com/defense/ch-47-chinook.

to support sea basing. It is unlikely that the Army would develop its own shipping, operating, and support structure, to enable sea basing. The Army must also establish rotational training opportunities for the types of units designated to conduct sea basing operations. This may affect other deployment schedules for both the Army and Navy and disrupt other sustainment operations. However, since multi-domain battle requires increased service interdependence, Army sea basing with Navy support feeds into that interdependence requirement. Ultimately, the capability to support counter-A2/AD and dispersed operations in the future operational environment outweighs the challenges of Army sea basing.

Caching

In Multi-Domain Battle, especially in an environment where the United States does not have the advantage of air superiority, small elements of US forces can expect to conduct dispersed operations. Where these dispersed units are isolated and operating deep into enemy territory, effective resupply operations become highly degraded and put an increased risk on sustainment units and those supported units. Traditional ground resupply operations present a lucrative target for the enemy and have the potential to reveal the locations and activities of friendly forces. The lack of air superiority may limit predictable and accurate aerial delivery resupply operations. One technique that could reduce these risks to both sustainment and combat forces is caching.

As defined by JP 3-50 *Personnel Recovery*, a cache is "a source of subsistence and supplies…packaged to prevent damage from exposure and hidden in isolated locations by such methods as burial, concealment, and/or submersion, to support isolated personnel."[88] The JP goes on to describe that caches are useful in environments where the extended concealment and evasion of US forces is necessary. Caches can be emplaced before the outbreak of and during

[88] US Department of Defense, Joint Staff, Joint Publication (JP) 3-50 *Personnel Recovery* (Washington, DC: Government Printing Office, 2015), GL-7.

hostilities, and are typically pre-positioned in "adversary-controlled territory or regions subject to being overrun."[89] Caching is a resupply method typically used by insurgent or counter-insurgency forces, and in the traditional sense, is not conducive to large-scale operations. However, in a multi-domain battle where small conventional land forces conduct dispersed operations in order to enable the other domains, caching may be one solution to the sustainment problem. Adjusting the concept of caching slightly may also enable larger forces to extend their operational reach and maintain tempo longer than would otherwise be possible with traditional logistics operations.

One potential way to sustain dispersed operations either directly or through caches is to increase the innovative use of aerial delivery. The Joint Precision Airdrop System (JPADS), already in use, allows for Global Positioning System (GPS) guided parachutes to deliver supplies to a direct point of need with extreme accuracy.[90] Similar to JPADS, the US Marine Corps is testing glider drones capable of delivering payloads of about 700 pounds at a range of up to 70 miles, also guided by GPS.[91] Resupply via artillery is now a possibility, as well. The Ammunition Resupply Projectile is a hollow mortar shell capable of delivering small amounts of small-arms ammunition quickly to the point of need using mini GPS-guided parasails, similar to JPADS.[92] As well as using these innovative resupply methods to deliver to the point of need, these methods could establish caches ahead of moving forces to prevent signaling friendly force locations to the enemy.

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[89] US Joint Staff, JP 3-50, *Personnel Recovery*, VI-15.

[90] Gareth Evans, "JPADS: Circumventing GPS for Next-Gen Precision Airdrops," *Air Force Technology*, April 25, 2017, accessed December 13, 2017, http://www.airforce-technology.com/features/featuresjpads-circumventing-gps-for-next-gen-precision-airdrops-4872436/.

[91] Kyle Mizokami, "The Marines Are Testing a Glider Drone Made of Plywood," *Popular Mechanics*, April 20, 2017, accessed December 13, 2017, https://www.popularmechanics.com/military/aviation/a26150/marines-testing-plywood-drone/.

[92] Kyle Mizokami, "Special Delivery: The US Army Plans to Shoot Supplies to its Own Soldiers Inside Hollow Mortars," *Popular Mechanics*, March 9, 2017, accessed December 13, 2017, https://www.popularmechanics.com/military/weapons/a25613/us-army-ammunition-resupply-projectile-mortar/.

Milley mentions the development and use of autonomous convoys in his speech to the AUSA and in the AFC-S. While autonomous convoys would help to prevent casualties, they will do nothing to stop the adversary from interdicting supplies vital to friendly forces and destroying expensive, technologically enhanced equipment that is difficult to replace quickly. Single vehicle resupply operations are typically out of the question due to the risk to forces, but autonomous vehicles might make this possible in the future. Single vehicles moving at different times, along different routes may prevent enemy action from having a significant effect on ground resupply operations. These autonomous vehicles, like the innovative aerial delivery methods, could establish small caches along movement routes for units to collect later in the operation. Autonomous fuel trucks could download large amounts of fuel at existing infrastructure (civilian fuel stations), secured by forward dispersed forces, at multiple points along the battlefield. This type of cache could enable major combat units that require extensive fuel support, such as an Armor Brigade Combat Team or Armor Division.

Like sea basing, the caching solution requires elements across the DOTMLPF-P spectrum. Similar to sea basing, many of these elements only need modification for use in the conventional Army. Special operations forces already have the doctrine and training established for cache operations. The larger Army could adapt those methods to suit more conventional requirements. In addition, the material solutions mentioned are already in development. While many of these innovations are designed to support direct resupply operations, it would not a stretch to apply them to caching techniques.

Caching would not only help solve the problem of sustaining dispersed forces by hiding small supply depots throughout the battlefield, but also allow commanders to maintain and dictate tempo and extend their operational reach. Caching operations also presents the enemy with multiple dilemmas by having multiple forward resupply points for friendly forces to choose from, ideally remaining in unknown locations, and not presenting soft, easy targets such as logistics convoys and large supply bases close to the fight. Of course, caching is not without risk or cost.

JPADS and other GPS-guided systems are costly and often not reusable. Loss of supplies to malfunction, misplacement, or the enemy are also risks. However, the traditional method of resupply using large, predictable, and manned convoys presents even more risk to force and mission in the future operational environment. Additionally, use of GPS-guided systems require dominance of the space domain to guarantee the fidelity of navigation data.

Security

The AFC-S discusses security considerations for sustainment operations as it pertains to the challenges multi-domain battle presents. Sea basing and caching address some security issues, particularly when they pertain to physical security of logistics bases and convoys. Other security concerns, such as the well-being of sustainment assets, are addressed by potentially removing bases and manned convoys in part from the land domain in the future operating environment. However, it is not realistic to expect the removal of basing and manned convoys entirely from the operational environment. Therefore, there are a number of physical security solutions that can address this capability gap. Additionally, cyber and other forms of non-physical security considerations will become increasingly important to sustainment operations in the future operational environment.

Current sustainment forces are heavily reliant on security provided by other, more capable units, whether it be for bases or distribution operations. In the multi-domain battle, while the domains must become more interdependent, forces may become more independent when it comes to security. In recent conflicts, sustainment forces and operations were typically subject to insurgent tactics like small ambushes and improvised explosive devices (IED). In the future operational environment, there is an expectation that these tactics will continue, along with the even more severe threat of enemy conventional and special operations forces. This is especially true for dispersed operations. Any sustainment force operating in austere, decentralized, and isolated environments must have the capability to defend itself against enemy action.

Along with increased firepower, sustainment units need innovative methods for physical security. UAVs operating autonomously to collect data and alert forces to possible enemy action around bases or moving with convoys can provide vital intelligence and early warning to sustainment forces. Increased electronic jamming that does not interfere with sensitive friendly technological capabilities can prevent IEDs and enemy communication around bases and convoys. Sustainment units will continue to have the expectation to operate in areas with non-combatant populations. Such units need non-lethal methods of crowd control and dispersal, such as the long-range acoustic device (LRAD) which can produce sounds loud enough to deter potential threats without resorting to deadly force.[93] Additionally, solutions such as sea basing and caching require increased reliance on aerial delivery methods of resupply. In the future operating environment there is the expectation for a contested air domain. As with the Battle of Khe Sanh with "super gaggles," the Army may need to establish what the AFC-S described as "windows of domain superiority" in order to make aerial delivery feasible.[94]

Cyber security is another significant concern for sustainment operations in the multi-domain battle. Many solutions to the sustainment of counter-A2/AD and dispersed operations problems depend on technology to be successful. For example, many of the GPS-guided solutions present the enemy with potential cyber targets. One counter to a GPS-denied environment is visually aided technology. The US Army Natick Soldier Research, Development, and Engineering Center is developing sensors that will allow JPADS to use visual cues to navigate instead of GPS.[95] Similar optical sensors could be used for base and convoy security.

The problems with sustaining counter-A2/AD and dispersed operations in the future operating environment are complex. This complexity leads to complex solutions that present their

[93] "Applications," Long-Range Acoustic Device (LRAD), accessed January 17, 2018, https://www.lradx.com/application/defense.

[94] Shore, *The Battle for Khe Sanh*, 89; US Army, TRADOC Pamphlet 525-4-1, *Functional Concept for Sustainment*, 18.

[95] Evans, "JPADS."

own problems needing solutions before implementing. Sea basing and caching produce capability gaps in physical and cyber security. The solutions for the security issues also cut across the DOTMLPF-P spectrum. New technology and capabilities require new doctrine, organization, and training, as well as the materiel requirements to produce those technological advancements. Reimagining commercially available products, or technology already in use elsewhere within the military or other government agencies can prevent an undue burden on the taxpayer while still providing the force with what is required to operate successfully in the future operational environment.

Conclusion

The envisioned future operational environment General Milley described in his speech to the Association of the US Army presents significant challenges to the entire force. After decades of enjoying the freedom of movement and enduring security that air supremacy brings, the US Army will almost certainly find itself fighting to establish a foothold into an area of operations and operating on extremely dangerous and austere battlefields. The proliferation of technology has the potential to make any enemy, peer-level or not, a significant threat in the future. Counter-A2/AD operations will become an essential first task in operations against future adversaries and dispersed operations will become the norm until US forces achieve domain superiority, particularly air superiority.

Expectations and requirements for a more interdependent Joint Force and for each service to enable the others in order to achieve mission success will increase. This concept of multi-domain battle presents significant challenges to the US Army, which enjoyed the comfort and protection of air superiority since the end of World War II. Past air superiority not only enabled combat forces, but allowed for robust sustainment operations as well. Secure basing and relatively safe lines of communication ensured predictable and reliable logistics. However, the complexity of the future operational environment and the concept of multi-domain battle presents

numerous challenges to sustainment operations. No longer will secure basing and distribution be a given.

Counter-A2/AD and dispersed operations present particular challenges to sustainment operations unlike any seen in the recent past. The Joint Force relies on the US Army to set the theater and maintain theater distribution. An enemy A2/AD capability could potentially threaten the Army's ability to achieve this core competency. Dispersed operations, where combat forces operate in small elements cut off from traditional support, defies normal distribution techniques. The US Army cannot expect to achieve survivability of sustainment assets using the same logistics methods employed in recent conflicts, but it must still meet its obligations to the Joint Force. Therefore, security of sustainment operations in the future operating environment becomes a difficult challenge that must be overcome.

These capability gaps require innovative solutions that take into consideration fiscal and technological constraints. Gap analysis, using the DOTMLPF-P spectrum, provides a framework to develop effective solutions that fit within these constraints. New, technologically advanced materiel solutions cannot be the only answer. Changes to doctrine, training, or personnel, among other elements of DOTMLPF-P, are required not only to integrate new materiel solutions, but may be solutions in and of themselves. Additionally, the adaptation and adjustment of materiel solutions already implemented, or in design meant to address other gaps, can address these unique challenges.

Sea basing is one solution to the sustainment of counter-A2/AD and dispersed operations capability gaps that requires elements across the DOTMLPF-P spectrum. Much of the materiel elements of the solution are already in existence or in development, such as shipping and vertical lift capabilities. The US Marine Corps, with the Navy, are the current owners of sea-basing capability. Changes to doctrine, organization, training, and other elements can be achieved by simply modifying current sister-service methods. In a large-scale future war against an A2/AD-capable adversary, the Marine Corps might not have a large enough capability to be effective.

Therefore, it is imperative that the Army establishes a sea-basing capability in order to maintain the ability to achieve its core competency of setting the theater.

Caching is another solution that can potentially aid in the sustainment of forces in the future operating environment, particularly with dispersed operations. Caching may seem like a de-evolution in logistics methods, especially since it is normally used by less militarily capable forces against a superior adversary. However, caches are still in use as a sustainment method for modern, sophisticated special operations forces conducting their own dispersed operations. Like sea basing, caching as a solution that requires elements across the DOTMLPF-P spectrum. Innovative materiel elements, together with changes to doctrine, training, personnel, and other elements, produce an effective caching solution able to close the gap on sustaining dispersed operations.

The complexity of the future operating environment and the concept of multi-domain battle drives complex solutions to address sustainment problems. These complex solutions, such as sea-basing and caching, present their own problems. Security of sustainment assets, supplies, and personnel is another capability gap, which is potentially exacerbated by these solutions. Dispersed combat operations will require dispersed sustainment operations on some level. These forces need security solutions in the form of new doctrine, organization, materiel, and personnel in order to be able to achieve mission success in the future operating environment.

The future operating environment and the concept of multi-domain battle presents significant challenges to the entire Joint Force. Sustainment of the force is essential to mission success, so the unique problems facing the sustainment community must receive major consideration. The US Army Functional Concept for Sustainment recognizes and addresses many future difficulties, but does not fully describe how the Army will maintain its core competency of setting the theater and theater distribution in counter-A2/AD and dispersed operations. Although this monograph is not full gap analysis of sustaining counter-A2/AD and dispersed operations, it hopes to bring these concerns, and their potential solutions, to bear for the Army's consideration.

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