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14. ABSTRACT
In the initial stages of an operation, the MAGTF is most effective and relevant to a JFC by planning for responsive-logistics instead of logistics self-sufficiency. Core to the doctrinal design of a MAGTF is the concept of self-sufficiency, bringing its own embedded logistics to sustain its operations for a specified period. The ACE is the element whose combat power is most dependent on logistics, because the loss of one aircraft has significant impact on the MAGTF's combined-arms capability, and thousands of different components on an aircraft must be functional for the aircraft to be mission-capable. Instead of trying to anticipate every potential mission-critical requirement and bringing it forward, most of the aviation logistics infrastructure can be maintained at an ISB. With minimal investment in intra-theater distribution infrastructure, any Class IX(A) material the ACE requires can be delivered to a FOB within 24 hours. Reorienting on this design for responsive-logistics provides opportunities to accelerate the MAGTF's effectiveness, maintain flexibility, and expand its relevancy. Most importantly, the combined-arms combat potency of the MAGTF is increased by maximizing aircraft availability. The Cargo Resupply Unmanned Aerial System (CRUAS) is a critical enabler.

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An Alternative to MAGTF Self-Sufficiency

by

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A paper submitted to the Naval War College faculty in partial satisfaction of the requirements of the Joint Military Operations Department.

Signature: ___*<signed>*________

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Paper Abstract

In the initial stages of an operation, the MAGTF is most effective and relevant to a JFC by planning for responsive-logistics instead of logistics self-sufficiency. Core to the doctrinal design of a MAGTF is the concept of self-sufficiency, bringing its own embedded logistics to sustain its operations for a specified period. The ACE is the element whose combat power is most dependent on logistics, because the loss of one aircraft has significant impact on the MAGTF's combined-arms capability, and thousands of different components on an aircraft must be functional for the aircraft to be mission-capable. Instead of trying to anticipate every potential mission-critical requirement and bringing it forward, most of the aviation logistics infrastructure can be maintained at an ISB. With minimal investment in intra-theater distribution infrastructure, any Class IX(A) material the ACE requires can be delivered to a FOB within 24 hours. Reorienting on this design for responsive-logistics provides opportunities to accelerate the MAGTF's effectiveness, maintain flexibility, and expand its relevancy. Most importantly, the combined-arms combat potency of the MAGTF is increased by maximizing aircraft availability. The Cargo Resupply Unmanned Aerial System (CRUAS) is a critical enabler.

Introduction

The Marine Air-Ground Task Force (MAGTF) is a formidable tool available to a Joint Force Commander (JFC), but its logistics-self-sufficiency can be a problem. The JFC often builds the initial stage of his operational design with the MAGTF in a key role because it is a scalable combined-arms force relevant across the range of military operations. Core to the doctrinal design of a MAGTF is the concept of self-sufficiency, bringing its own embedded logistics to sustain its operations for a specified period of time.[1] This seemingly makes the MAGTF more attractive for operations in an immature or hostile theater; however, self-sufficiency can decrease the MAGTF's effectiveness and undermine other JFC priorities. In the initial stages of an operation, the MAGTF is most effective and relevant to a JFC by planning for "responsive-logistics" instead of "logistics self-sufficiency."

Background

Logistics self-sufficiency is a fundamental element of MAGTF doctrine.[2] This design is intended to enhance the MAGTF's forcible-entry capability because it can hold ground without needing external infrastructure. The logistics required to support the MAGTF's anticipated needs during the initial operating period is integrated within each combat element. The ACE is the element whose combat power is most dependent on logistics, because the loss of one aircraft has a significant impact on the MAGTF's combined-arms capability, and literally thousands of different components on an aircraft must be functional for the aircraft to be mission-capable.

[1] U.S. Marine Corps, *Marine Corps Operations*, Marine Corps Doctrine Publication (MCDP) 1-0 (Washington, DC: Headquarters U.S. Marine Corps, 2001), 5-17. A MEF deploys with 60 days of sustainment (p3-16), a MEB is self-sustaining for 30 days (p3-17), and a MEU deploys with 15 days of supplies (p3-18).

[2] U.S. Marine Corps, *Tactical Level Logistics*, Marine Corps Warfighting Publication (MCWP) 4-11 (Washington, DC: Headquarters U.S. Marine Corps, 2000), 4-2.

A self-sufficiency logistics plan aims to anticipate the frequency of usage for these thousands of parts and co-locate them wherever the ACE is based. Unfortunately, Class IX(A)/aviation repair parts are notoriously difficult to forecast, because unlike some other classes of supply, they do not have a reliable consumption rate, even on aircraft with over forty years of maintenance history. Industry and technology may eventually provide an accurate way to predict what will break, but today, rate of consumption is an enormous source of variation.[3] Self-sufficiency-based aviation logistics doctrine, called the Marine Aviation Logistics Support Program (MALSP), compensates for this uncertainty with volume of parts. These parts, people and equipment to repair and manage them, and facilities are all moved to the point of need.

A responsive-logistics plan aims to mitigate a different source of variation: distribution. This is a much less complex problem because the ACE does not conduct distributive operations in the same way that the Ground Combat Element (GCE) does. Although a single section of aircraft can cover hundreds of square miles in a single sortie, squadron headquarters (and all organizational-level maintenance) are almost always consolidated at just a few Forward Operating Bases (FOBs) due to the requirement for some kind of airfield.[4] Therefore, with minimal investment in intra-theater distribution infrastructure, any Class IX(A) material the ACE requires can be delivered to a FOB within 24 hours from an Intermediate Staging Base (ISB).[5] Instead of trying to anticipate every potential mission-critical requirement, and bringing it forward with the maneuver elements, the majority of the intermediate-level aviation logistics infrastructure can be maintained at the ISB.

[3] 33% of items required by a MEB ACE are requisitioned only once in a 6-month deployment. LtCol Vince Clark, "MALSP II & Marine Aviation Logistics Enterprise Information Technology" (PowerPoint presentation, Mobile Facility (MF) Logistics Review Group (LRG), 15 June 2010).

[4] U.S. Marine Corps, *Aviation Operations*, Marine Corps Warfighting Publication (MCWP) 3-2, (Washington, DC: Headquarters U.S. Marine Corps, 2000), 6-2.

[5] Also called an Enroute Support Base (ESB) in some literature on Marine Aviation Logistics.

Much has been written on the value of maintaining a sea-base aboard carriers and amphibious ships (LHD). This works well in most situations because the ACE uses the Navy's supply-chain, which is oriented toward responsive-logistics. But what if an ACE must operate ashore without a sea-base? A new Marine Aviation Logistics Support Program (MALSPII) is being developed around the concept of responsive-logistics to partially address these situations.[6] However, although much has been done to reorient the concept of logistics at the tactical and strategic level, a gap remains at the operational level that the JFC can influence. Doing so holds revolutionary possibilities.

Accelerates Effectiveness

A responsive-logistics plan establishes an effective supply-chain faster than the self-sufficiency design, especially in a hostile or immature theater. The operational sustainment plan found in aviation logistics doctrine is scaled to provide self-sufficiency for a Marine Expeditionary Brigade (MEB) and relies on a combination of strategic airlift and sealift.[7] The intermediate-level logistics Fly-In-Echelon (FIE) consists of maintenance and supply personnel, ground support equipment, and a projected 30-day allowance of remove-and-replace Class IX(A) called a Fly-In-Support-Package (FISP).[8] While flying this material into the FOB is the fastest method available, the FISPs are prepackaged for deployment in 8-by-8-by-20-foot containers called "Mobile Facilities" and more than thirteen C-17 loads are required to deploy the FIE for a

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[6] See Appendix 1 for basics of MALSPII or for goals of MALPSII: Pierre Garant, "The Transformation of Marine Aviation Logistics." *Marine Corps Gazette* 88, no. 5 (2004): 33-36, http://search.proquest.com/docview/221455724?accountid=322 (accessed May 7, 2012).

[7] U.S. Marine Corps, *Aviation Logistics*, Marine Corps Warfighting Publication (MCWP) 3-21.2 (Washington, DC: Headquarters U.S. Marine Corps, 2002), 1-7. See Figure 1.

[8] *Ibid.*

MEB ACE.[9] As a point of comparison, it only takes twenty-six C-17s to airlift an entire Airborne Brigade with all of their vehicles and equipment.[10] Moving this amount of material to a FOB during the initial stages of an operation directly competes with the Ground Combat Element (GCE) for strategic airlift and throughput capacity of the aerial ports of debarkation (APOD). This may delay the FIE, as will the condition of the airfield, particularly if it must be secured or repaired.

Once the FIE is in place, intermediate-level facility equipment[11] and additional parts must be obtained from the Maritime Prepositioning Ships (MPS) for the complete 30 days self-sufficiency capability.[12] While the MPSs cut the transit time significantly, it still takes at least several days to arrive and offloading can only commence once a sufficient port facility is secured and support personnel have arrived. Then, whatever is offloaded must be moved from the surface port of debarkation (SPOD) to the FOB, which may take significant time depending on the road network and amount of ground support equipment and trucks available. The Maritime Prepositioning Force (MPF) program estimates that it will take ten days to be fully operational—after the offload begins.[13] Therefore, according to doctrine, beginning at D+10, the ACE is self-

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[9] Calculated based on number of Mobile Facilities able to be loaded on a C-17 and the number of Mobile Facilities designated for each FISP normally deployed with a MEB. Naval Air Systems Command, "Transporting MFs," accessed 27 April 2012, http://www.mobile-facilities.com/transp.htm. And: Commandant of the Marine Corps, *Management and Administration of United States Marine Corps Mobile Facility (MF) Program and Related Equipment*, Marine Corps Order (MCO) 13670.1 (Washington, DC: Headquarters U.S. Marine Corps, 2009), 7-14 to 7-16.

[10] Headquarters, 82d Airborne Division, *Division Readiness Standard Operating Procedure (RSOP)* (Fort Bragg, NC: 82d Airborne Division, 2011).

[11] Specifically, 2 MFs for battery lockers, 2 for battery charging, 4 for tire and wheel capability, and 14 Supply MFs. MCO 13670.1, 7-24.

[12] MCWP 3-21.2, *Aviation Logistics*, 5-5.

[13] U.S. Marine Corps, *Maritime Prepositioning Force Operations*, Marine Corps Warfighting Publication (MCWP) 3-32 (Washington, DC: Headquarters U.S. Marine Corps, 2004), 1-4.

sufficient until D+30. However, a supply-chain for long-term sustainment will not be established until an entire Marine Aviation Logistics Squadron (MALS) is operational at the FOB.[14]

In contrast, by redesigning operational sustainment to reposition assets, a MEB ACE will establish an effective supply-chain faster, and enable combat forces to be inserted more quickly. In hostile theaters, the self-sufficiency design necessitates that at least some combat forces be sequenced ahead of logistics elements to secure APOD/SPODs. Once secured, combat and logistics elements compete for the limited throughput capacity at what are normally immature APOD/SPODs. These sequencing and throughput challenges are alleviated by planning for responsive-logistics, since much of the infrastructure is placed at an ISB instead of the FOB, and because an ISB is accessible for buildup prior to D-Day.

The support equipment that was part of the FIE (mainly for parking or servicing operations and custody-coded to the organizational-level), will still have to be flown into the FOB; but this is only a small percentage of the FIE's lift requirement.[15] Most of the volume in the FIE consists of the 30 days of spare parts for each kind of aircraft. However, by specifically planning for, and investing in, regular and reliable transportation from the ISB to the FOB, the FIE can be tailored to fit into a single C-17 load. The FOB's intermediate-level aviation logistics footprint can be reduced to only the most essential and frequently replaced items without degrading aircraft readiness.[16] The remaining parts from the FIE and the equipment aboard the MPS can be delivered to the ISB using unique APOD/SPODs before D-Day.

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[14] The footprint required to establish full intermediate-level repair capability ashore is exponentially larger and also represents an obvious are of improvement; however, this paper is solely focused on the first thirty days of support. For a brief summary of the footprint required, see Figure 1.

[15] Commandant of the Marine Corps, *Aviation Supply Desktop Procedures*, Marine Corps Order (MCO) 4400.177F (Washington, DC: Headquarters U.S. Marine Corps, 2009), Paragraph 3200.5.

[16] See Appendix 2 for explanation of how MALSPII allowancing redistributes spares within theater.

This not only alleviates competition in time and space for lift/port capacity; it also means that a supply-chain will be in place almost immediately. After the delivery of the tailored FIE to the FOB, the dedicated intra-theater airlift links the limited logistics resources at the FOB to more robust capability at the ISB. In less time, and with less lift, this plan will sustain the ACE as effectively as what the self-sufficiency plan hopes to establish by D+10.[17] Long-term sustainment will be in place as soon as intermediate repair capability (a MALS) is established at the ISB or it is linked to the global supply system via inter-theater transportation. This could feasibly be accomplished on or before D-Day, because whatever parts, facilities, equipment or personnel were required at the ISB, could be pre-positioned prior to the commencement of operations.

Even if notification came too late for any preparation prior to D-Day, the ISB would be linked into the strategic supply system before a FOB, because it is more likely to be established at a site where communications/transportation infrastructure is already in place and movement can occur without opposition. Therefore, the logistics effectiveness of self-sufficiency at D+10 (under ideal conditions such as 30 days advance notification), can be equaled by responsive-logistics on D-Day—without advance notification. In fact, even without advance notification, responsive-logistics could have a supply-chain in place for long-term sustainment by D+10; self-sufficiency would take until at least D+40.[18] Responsive-logistics enables the MAGTF to accelerate the speed at which its combat elements can be in place and fully operational.

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[17] For an analysis of the competitive effectiveness of moving the volume of spares from the FOB to an ISB, reference: Luke Watson and Joshua Jabin. "Trading in the Iron Mountain." *Marine Corps Gazette* 94, no. 10 (2010): 54-58.

[18] Under self-sufficiency doctrine, an entire MALS is transported via T-AVB, it arrives in theater by D+35, is offloaded pier-side at the SPOD, and trucked to the FOB. With over 600 Mobile Facilities housing component repair workshops and full 90 days of supplies, a long-term sustainment plan can be in place by D+40 under ideal conditions. See MCWP 3-21.2, *Aviation Logistics*, 1-11. Also see Figure 1.

Maintains Flexibility

While the speed at which sustainment capability can be established is important, flexibility must be maintained; the JFC's operational design may require rapid adaptation despite the scarcity of key logistics resources. There are many instances where a single part, test-bench, or tool supports an entire Marine Aircraft Group (MAG) (the ACE for a MEB). This is of little concern when the ACE is located at one FOB because usage for these items is low; they can be shared. However, it is not uncommon for the JFC's operational design to call for at least two FOBs in order to increase operational reach. In this situation, there are not enough assets to make both FOBs self-sufficient.[19]

Doubling the resources allotted to the ACE is usually unrealistic; the single assets are too expensive to invest in redundancy or additional assets simply do not exist. This means that only one FOB gets that asset and the other FOB must depend on inter-FOB transportation to shift the asset to them if required. If the need for dual-sites can be forecasted, additional communications and transportation capability can be planned for in advance; but if a secondary FOB is established based on a branch or sequel, establishing reliable lines of communications between FOBs will be more challenging.

Under responsive-logistics there is no need to divide assets between FOBs since they are retained at the ISB. When required, they can be distributed to the point of need using a hub-and-spoke concept. The communications and transportation between a FOB and the ISB is almost always better than between FOBs; centralizing limited resources at the ISB permits superior responsiveness and management. When the majority of assets are retained at the ISB, no major shift of resources occurs if a third FOB is established; minimal assets are moved with aircraft

[19] MCWP 3-21.2, *Aviation Logistics*, 1-9.

from one FOB to another and some are pushed forward via the previously established intra-theater distribution infrastructure.

Conversely, the self-sufficiency construct complicates command and control of logistics. Since many assets simply cannot be split three ways, priorities must be established between sites to determine who will maintain the asset on site. Responsive-logistics permits the MAGTF to rapidly adjust the location of the ACE without requiring additional resources to maintain effectiveness. Responsive-logistics provides the JFC with a more flexible MAGTF, able to rapidly expand its operational reach by relocation of aircraft.

Expands Relevancy

Responsive-logistics also provides the JFC with attractive alternatives to a large footprint within the combat zone, increasing the MAGTF's effectiveness across a broader range of operations. A JFC operates under the strategic priority of minimizing risk to friendly forces while in pursuit of mission accomplishment. This is essential to maintain the political viability of the military operation and uphold trust with the nation. As a result, the JFC gives thought to operational protection during the planning process, trying to balance bringing enough forces to accomplish the mission without needlessly exposing them to danger. Self-sufficiency expands the number of forces in the combat zone and exposes key resources to attack. Although responsive-logistics does not change the number of people or resources in theater, it redistributes them so that the intermediate-level aviation logistics footprint at the FOB would consist of only the minority of parts normally in a FISP and a few Marines to issue and receive material. The majority of the parts and any component-repair capability would be retained at the ISB along with the corresponding majority of supply and maintenance personnel.[20]

[20] See Appendix 1 and Appendix 2 for more detailed explanation.

A JFC may also be concerned with reinforcing strategic communication in regard to the temporary nature of the military presence in the operating area. The larger the footprint, the more it communicates that the force will maintain a long-term presence. In reality, it may only take a few extra weeks to redeploy, but perception of what a large FOB means in regard to duration can undermine national strategic communication to the American people, the native population, or the international community. Responsive-logistics facilitates a much smaller footprint than self-sufficiency, making it the preferred option to a JFC concerned with operational protection or strategic communication.

A shift to responsive-logistics will also increase the MAGTF's effectiveness in specific operations constrained by force, time, or space. In a small-scale operation (a Marine Expeditionary Unit (MEU) or a Special-Purpose-MAGTF), the preferred method of deployment is to have the ACE operate from amphibious shipping where the Class IX(A) repair parts are maintained along with intermediate repair capability to replenish stock.[21] This provides tremendous endurance for the ACE while addressing nearly all of the concerns with self-sufficiency thus far. There are two problems. When fixed-wing aircraft lacking Vertical/Short Take-Off and Landing (V/STOL), are assigned, they cannot operate from amphibious shipping. Secondly, if the ACE deploys on amphibious shipping but is later offloaded for operations ashore, there is no doctrinal plan for how to transition the aviation logistics support ashore with it. There are no facilities for the repair shops to be set up in, no containers to repackage the spare parts, and even if the logistics communication suite could be taken ashore, it would leave the ship without capability for its own sustainment.[22]

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[21] MCDP 1-0, *Marine Corps Operations*, 5-18

[22] MCWP 3-2, *Aviation Operations*, 2-10.

To circumvent this problem, or when the MEU deploys to theater by air, a Remote Expeditionary Support Package (RESP) is flown into the FOB. This consists of the same support equipment in the FIE for parking and servicing operations, Class IX(A), and, if the MEU was not previously embarked, personnel. Recent coordination at the strategic level has created a Class IX(A) MEU Support Package (MESP), enabling the MEB-scaled FISPs to be re-scaled appropriately for a MEU.[23] Unfortunately, because FISPs are allowanced based on an economy of scale, removing any range or depth may induce a disproportional loss of capability.[24]

Despite having less Class IX(A) material available to satisfy the ACE's material requirements, the self-sufficiency logistics concept does not specifically plan for how parts will be delivered to the FOB if required later. As a result, it seldom takes less than a week, even in the most mature theaters.[25] In responsive-logistics, delivery of these parts to the ACE would be planned for and resourced so that the delay to the squadron would only be as much as 24 hours. The portions of the MESP could be maintained at the ISB instead of the FOB, and if reinforced in proportion to demand and replenishment time, these parts could support several MEU sized elements operating within the theater. This is superior to having to commit scarce resources to each FOB. Responsive-logistics is much more appropriate for small-scaled operations ashore.

Responsive-logistics also makes the MAGTF easier to employ for operations of short-duration. The bulky footprint required to be self-sufficient, combined with strategic lift's throughput constraints, might delay the ACE from having a functional supply-chain until after

[23] See Figure 1.

[24] MCWP 3-21.2, *Aviation Logistics*, 1-9.

[25] The time it has taken to provide aeronautical material to aircraft at a FOB was tracked by 3dMAW (Forward) Aviation Logistics Department in Operation IRAQI FREEDOM (OIF) from 2006 to 2008: "MALS–16 (Forward) was supporting a reinforced MAG at Al Asad, Iraq, using the MALSP self-sufficiency model and produced results typical of a mature theater: for every 100 aeronautical material requests, 75 were issued on location, 10 took as many as 5 days to satisfy, 11 took 6 to 10 days, 3 took 11 to 15 days, and 1 took over 16 days." Watson & Jabin, "Trading in the Iron Mountain," p 56.

the MAGTF has completed the mission. Undoubtedly, the JFC would prefer a plan that does not require the establishment of a large FOB, only to have to retrograde it shortly thereafter. Responsive-logistics would provide a viable alternative, not only helping to accelerate the insertion of the combat forces as discussed, but also simplifying the retrograde plan. This would significantly increase the effectiveness of a MAGTF for a non-sea-based rapid-insertion and withdraw operation.

Counterargument: Is Responsive-Logistics Feasible?

Considering this argument for responsive-logistics, proponents of logistics self-sufficiency will counter that responsive-logistics is idealistic and does not consider practical constraints. They would also assert that the MAGTF's logistical self-sufficiency is an investment that pays-off in combat power whenever it insulates it from the threats of an immature or hostile theater.

The claim that responsive-logistics accelerates the timeline of setting up effective sustainment is predicated on the unrealistic assumption that intra-theater transportation will be available. Even in mature theaters, there is not enough intra-theater airlift; anyone deployed to Iraq or Afghanistan could recount experiences of when they waited weeks or months for resupply that was available in theater.[26] Daily delivery from an ISB to a FOB can only be achieved through additional airlift capacity because current airframes will be otherwise tasked.[27]

The JFC could give direction to the Joint Air Operations Center (JOAC) to establish a joint channel flight from the ISB to the FOB every day, but this will be hard to justify, especially

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[26] For example: McLean, John E.,,II. "One Single Nail." *Marine Corps Gazette* 92, no. 2 (2008): 28-33, http://search.proquest.com/docview/221519966?accountid=322 (accessed April 30, 2012). Or: Rabassi, Christopher E. "What Happened to Class IX in Iraq-Revisited." *Marine Corps Gazette* 90, no. 3 (2006): 45-46, http://search.proquest.com/docview/221439284?accountid=322 (accessed April 30, 2012).

[27] MCWP 4-11, *Tactical Level Logistics*, 4-7. "Transportation is the most limited and limiting logistics capability in the MAGTF…supplies should be moved only as needed."

in the first 30 days.[28] During this period, C-17s will be fully occupied in their strategic airlift role moving forces into theater. Other cargo aircraft such as C-130s could be assigned the routine sustainment mission, but given the fierce competition for lift during this period, utilization will be a factor. Despite the fact that Class IX(A) material has a direct and significant impact on the ACE's combat power, a MAG can be supported with only one or two pallets of material on a typical day, wasting the majority of a C-17 or C-130's lift capacity. Although moving all of the material at once to a FOB requires a lot of airlift, it is a more efficient use of a limited asset.

In mature theaters, commercial delivery companies have stepped in to mitigate the deficiency in airlift. However, given the MAGTF's primary role as a forcible entry asset, practical limitations common to the first 30 days of an operation make routine airlift missions impossible. Many times, Marine rotary-wing aircraft will be operating from an austere FOB that does not have a runway capable of supporting delivery from a fixed-wing aircraft.[29] A similar challenge would be a viable enemy threat to the airfield. Marine combat aircraft may operate from such a site, but a JFC will be unlikely to risk flying large cargo planes with limited self-defense capability into an anti-access environment. These scenarios represent the most likely initial operating environments following a MAGTF's forcible entry.

Given these concerns with transportation, self-sufficiency is the best option, because delayed delivery of an aeronautical component could significantly degrade the MAGTF's combat potency. If fixed-wing airlift are not available or cannot make the delivery, a convoy can move the FISPs from a port to the FOB. In some cases, they can even be repackaged so they can be moved via organic Marine assault-support aircraft. With an upfront investment, the MAGTF

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[28] Chairman, U.S. Joint Chiefs of Staff, *Air Mobility Operations*, Joint Publication (JP) 3-17 (Washington, DC: CJCS, 2 October 2009), II-4.

[29] MCWP 4-11, *Tactical Level Logistics*, 1-9.

ensures it is effective even in the most challenging circumstances. A smaller footprint ashore may make the MAGTF more relevant for certain scenarios, but it also decreases its capability as a forcible entry asset.

Rebuttal: The Illusion of Self-Sufficiency

It is too simplistic to assume that a logistics plan designed for self-sufficiency is not also reliant on a distribution infrastructure. Failing to bring everything means that the end user will at some point be waiting for the supply-chain to deliver a requirement. Given the challenges of forecasting for Class IX(A), achieving true self-sufficiency is every bit as idealistic as expecting delivery within 24 hours. The self-sufficiency based MALSP doctrine sets allowances at three times the average monthly demand or slightly lower based on the expectation that on-site repair will be able to keep up with the demand.[30] Even with the maximum support available, and in the benign operating environment of garrison, a MALS is rarely able to satisfy more than 75 percent of flight-critical aircraft parts at the time of requisition.[31] This means that planning for self-sufficiency actually results in being dependent on a supply-chain for approximately 25 percent of all material requirements. Consider the examples in Charts 1 and 2. In these scenarios, although self-sufficiency is able to achieve ideal issue-rates and delivery time from the Continental United

[30] Repair parts are separated into two categories: consumable and repairable. Of the parts that can be repaired, only 33% are even capable of being repaired at the intermediate-level. LtCol Vince Clark, “MALSP II & Marine Aviation Logistics Enterprise Information Technology” (PowerPoint presentation, Mobile Facility (MF) Logistics Review Group (LRG), 15 June 2010).

[31] The Naval Supply system that funds all Marine Class IX(A) parts expects that retail level activities (such as a MALS) should be able to satisfy 65% of all demands from storeroom stock; a full MALS usually exceeds this goal and satisfies close to 75%. U.S. Navy Department, Afloat Supply, Naval Supply Procedures (NAVSUP) 485 Volume 1 Operational Forces Supply, Revision 4. (Mechanicsburg, PA: Naval Supply Systems Command, 2010), paragraph 6236, accessed 30 April 2012, https://nll.ahf.nmci.navy.mil/nll/getdata.cfm.

States (CONUS), it is not the volume of parts on-site but speed of the supply-chain that determines the duration of degraded combat power.

CHART 1	# Aircraft in ACE	# Aircraft needing parts	# Parts Required	# Parts available at FOB	# Aircraft down for parts	Days to deliver parts to FOB	Total Days of down Aircraft
Scenario 1	10	10	10	8	2	7	14

If a SPMAGTF consisted of a composite squadron of ten aircraft and ten flight-critical parts needed replacement, under the best allowancing model, only eight would be on site for issue. If one part was holding down one aircraft each, the MAGTF would be at 80 percent capacity until these parts were delivered (estimate 7 days for delivery from CONUS).

CHART 2	# Aircraft in ACE	# Aircraft needing parts	# Parts Required	# Parts available at FOB	# Aircraft down for parts	Days to deliver parts to FOB	Total Days of down Aircraft
Scenario 2	10	2	10	8	2	7	14

A second scenario is equally likely: that the ten parts required would be needed for only two of the aircraft, the other eight remaining mission-capable. If again, eight parts were available for immediate issue but one part on each of the two non-mission-capable aircraft was not anticipated and had to be obtained from the supply chain, the squadron would again be at 80 percent capacity until the remaining parts were delivered.

If complete self-sufficiency is unattainable, then the choice between self-sufficiency and responsiveness should be made based on the estimated center of gravity (COG) of operational sustainment. Planning for self-sufficiency assumes the COG is on-site attainability; this results in designing the supply-chain to have the majority of required parts ready for issue at the FOB. Responsive-logistics identifies the COG as logistics reaction time to the unanticipated; this focuses design of the supply-chain on accelerating the delivery of whatever is not immediately available at the FOB.[32] Responsive-logistics accepts that demand cannot be adequately anticipated, but ensures that it can react quickly; operational planning for the ACE should orient on this.

To further illustrate the point that on-site attainability has less bearing on aircraft availability than responsiveness, revisit Scenario 2 under a responsive-logistics design. Even

[32] Responsive-logistics differs from "just-in-time-logistics" as well. "Just-in-time" assumes that demand can be anticipated; replacing what is used ("pushing") before it is needed again will ensure that the force always has what it needs (replenishment is the COG). Although responsive-logistics will use this concept for the portion of aircraft parts that are so regularly needed that a buffer of inventory can easily compensate for small variations in demand, it is inherently a "pull" system.

though responsive-logistics would attempt to strike an appropriate balance between co-locating some spare parts at the FOB and ensuring expeditious delivery of the remainder, assume that the parts footprint in Scenario 2 were reduced to zero. The SPMAGTF would still have the same exact aircraft availability; there would be no benefit to the squadron's readiness by issuing any parts on the first day (see Chart 3). However, in Scenario 1, if none of the required aeronautical components were ready for issue, intra-theater distribution would have to be improved in order to maintain aircraft readiness (see Chart 4).

CHART 3	# Aircraft in ACE	# Aircraft needing parts	# Parts Required	# Parts available at FOB	# Aircraft down for parts	Days to deliver parts to FOB	Total Days of down Aircraft
Scenario 1	10	10	10	8	2	7	14
Scenario 2	10	2	10	8	2	7	14
Scenario 2b	10	2	10	0	2	7	14

Based on the extreme implementation of responsive logistics, two of the ten aircraft require parts (same as scenario 2) but none of them are available on site. Instead, all ten are delivered on the seventh day like in the first two scenarios. This would result in the same exact readiness, only less footprint; there would be no benefit to the squadron's readiness by issuing the eight parts on the first day.

CHART 4	# Aircraft in ACE	# Aircraft needing parts	# Parts Required	# Parts available at FOB	# Aircraft down for parts	Days to deliver parts to FOB	Total Days of down Aircraft
Scenario 1	10	10	10	8	2	7	14
Scenario 1b	10	10	10	0	10	7	70
Scenario 1c	10	10	10	0	10	1	10

In the first scenario reducing parts footprint to zero would negatively affect readiness; no aircraft would fly for seven days (1b). But, if Responsive Logistics was implemented and delivery time was reduced from seven days to one day (1c), the total number of days of downed aircraft for the period would drop from 14 to 10.

The key to developing a supply-chain that can react quickly is to plan for it at the operational level. Conceding that intra-theater distribution cannot be responsive is as short-sighted as assuming that it will not be needed. The challenges with intra-theater transportation laid out in the counterargument are very real, especially in the first 30 days of an operation, but this should not be the end to planning. In certain operations, maintaining a small footprint or flexibility may be important enough to the JFC that he is willing to invest scarce resources in a responsive-logistics plan.

If the planning process determines that fixed-wing cargo flights are not an option, Marine rotary-wing aircraft organic to the MAGTF can be used. This has historically worked very well and has enabled the ACE to conduct distributive ops from austere FOBs.[33] If the JFC approves a daily Marine rotary-wing combat-sustainment flight between the ISB and FOB in the Joint Air Tasking Order, it ensures reliable distribution and all the benefits of responsive logistics are possible. The cost of taking one or more tactical aircraft away from assault-support, casualty-evacuation, or combat-sustainment missions in support of the GCE will likely be offset by accelerating delivery.

The best option, however, for enhancing intra-theater distribution is a Cargo Resupply Unmanned Aerial System (CRUAS). A routine flight with a relatively small amount of payload, into or over hostile territory, lends itself well to a UAS. This frees manned ACE rotary-wing platforms to fly more dynamic primary missions in support of the GCE.[34] The CRUAS being tested in Afghanistan is a converted K-MAX helicopter (Lockheed Martin) and it already demonstrates the tremendous potential of this type of platform. With auxiliary fuel tanks it has the ability to carry 1,500 pounds 500 nautical miles (NM) without refueling.[35] This means it easily has enough range to make a delivery from an ISB to a FOB. The CRUAS is currently

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[33] One noteworthy example is how TF-58 was able to sustain operations at Camp Rhino, Afghanistan in November & December 2001. Marine CH-46E, CH-53E, and C-130 from HMM-163 (REIN) and HMM-365 (REIN) (respective ACEs from 15th MEU and 26th MEU) and shouldered the intra-theater sustainment responsibilities for shuttling supplies from the USS PELELIU and USS BATAAN to Pasni, Pakistan and on to Camp Rhino. See: Commanding Officer Marine Medium Helicopter Squadron 365 Reinforced, 26th Marine Expeditionary Unit, *Semi-Annual Command Chronology for the Period 01 July 2001 through 31 December 2001* (Jacksonville, NC, 1 March 2002), 7.

[34] Terry Robling, "Forward in the Fight." *Marine Corps Gazette* 95, no. 5 (2011), 24. http://search.proquest.com/docview/865920999?accountid=322 (accessed May 7, 2012).

[35] On external sling load cruising at 80 knots. Jon McMillen (Lockheed Martin), email message to author, 6 April 2012.

demonstrating over 95 percent readiness with less than 1.5 maintenance man hours per flight hour.[36] This means that without pushing the capability envelope, two CRUAS could make three round trips of 1,500 pounds every day between a FOB and an ISB 250 NM apart, and sustain this operational tempo indefinitely. This would be more than enough throughput to support a MAG (REIN). Being able to deliver within eight hours would mean very few supplies would need to be maintained at the FOB. Reliable intra-theater distribution is feasible.[37]

When operational sustainment can accelerate delivery, it creates revolutionary possibilities. It not only drastically reduces the logistics footprint needed at a FOB; it also improves aircraft availability. Consider a more likely responsive-logistics design where intra-theater distribution was reduced to one day and only the highest demand parts were available for issue at the FOB. High demand parts would account for roughly one third of the aeronautical material demand and the rest would have to be sourced from the ISB. In this Target Scenario, responsive-logistics will significantly improve aircraft availability with a much reduced footprint (see Chart 5). This translates directly into combat power not only for the ACE, but the combined-arms MAGTF.

CHART 5	# Aircraft in ACE	# Aircraft needing parts	# Parts Required	# Parts available at FOB	# Aircraft down for parts	Days to deliver parts to FOB	Total Days of down Aircraft
Scenario 1	10	10	10	8	2	7	14
Scenario 2	10	2	10	8	2	7	14
Target Scenario	10	5	10	3	4	1	4

The Target Scenario is the mostly likely scenario: 1) Half the aircraft require parts, not all or the minority. 2) Some parts would be available at the FOB for issue. 3) Parts requirements are unequally spread across multiple aircraft but it would be unlikely that at least one would not be able to be repaired with the parts on hand. Under these conditions but with better intra-theater distribution, aircraft availability can be improved by over 70%.

[36] Major Kyle O'Connor (VMU-1 CRUAS OIC), email to author, 30 March 2012.

[37] For additional information on CRUAS, see Appendix 3.

Recommendations

It is evident that redesigning the MAGTF's operational sustainment has the possibility of achieving a broad spectrum of improvements; however, as the counterargument rightly points out, its feasibility is based on the establishment of reliable and robust infrastructure for intra-theater distribution. The viability of intra-theater distribution can be addressed at the operational level by prioritizing intra-theater cargo flights and facilitating establishment of an ISB.

The JFC should plan for dedicated intra-theater cargo flights to support the MAGTF. This can be accomplished in one of three ways. The JFC could establish a joint channel flight from the ISB to the FOB every day. The second option would be to approve a daily Marine rotary-wing combat-sustainment flight between the ISB and FOB. The third option is to identify the requirement for CRUAS to the Combatant Commander. Advocacy at this level for the continued development of the program can ensure this low-cost solution is fielded. In the future, whether CRUAS are joint theater assets or are imbedded MAGTF assets, their use, or the use of other intra-theater airlift, should be prioritized by the JFC as he designs a theater sustainment plan to best employ a MAGTF ashore.

Secondly, a JFC should facilitate the establishment of an ISB within the theater. The JFC typically has influence over the availability and use of an ISB. This may involve negotiation with host nations, or anticipatory investment in infrastructure to ensure that an ISB is available when needed. In the commander's operational design, an ISB must be selected that is conducive for operational protection and good communications links to forward forces and CONUS. It should also be selected for efficient access to both an APOD and SPOD—different ones than the combat forces will use in order to facilitate expanded throughput and better sequencing. Once the ISB has been identified, the JFC should coordinate between component forces to ensure that there is a concentration of logistics power at the ISB. Concentration of resources will enable them to be most efficiently projected into the area of operations when required.

Then the JFC must ensure that the ISB is firmly linked to the strategic and tactical level. The ISB must maintain its inventory through replenishment from CONUS if it is to fulfill its role in responsive-logistics. It serves as a buffer between the warfighter and the myriad suppliers and means of transit to theater. It literally becomes a link between the tactical and strategic level. The JFC should ensure that lines of communication are open between the ISB and the strategic suppliers/managers. Finally, the JFC must ensure that the ISB remains connected to the FOBs and continually reassess this to ensure that the force can be sustained.

These recommendations are not solely the responsibility of the JFC and in most operations, the J4 undoubtedly does an appropriate job selecting and establishing an ISB. Marine logisticians however, have not been strong advocates of an ISB or been enthusiastic users of this infrastructure—because the MAGTF has been content to be “self-sufficient.” Therefore the JFC’s efforts to establish an ISB are only as potent as the MAGTFs ability to reorient itself on responsive-logistics.

Conclusion

In the initial stages of a land-based operation, the MAGTF is most effective and relevant to a JFC by planning for responsive-logistics instead of logistics self-sufficiency. Even when the operation is large in scale, long in duration, and may otherwise justify a big footprint, the illusion of self-sufficiency is detrimental to the MAGTF’s effectiveness. By acknowledging that the ACE’s combat power will be driven by the ability to accelerate the delivery of unanticipated requirements instead of maximizing the volume of what might be needed, the paradigm of the possible is reset. With minimal investment in intra-theater distribution, tremendous opportunities for the employment of the MAGTF become available to the JFC.

The effectiveness of the MAGTF in an immature or hostile theater is accelerated by permitting the offload of logistics capability without having to wait for combat forces to secure a port. This in turn alleviates limitations of strategic airlift and port capacity, permitting combat forces to be offloaded faster and be immediately linked to a functional supply-chain. Elimination of a big footprint expands the MAGTF's relevancy for operations of short duration or small scale as well as in areas that are hostile or difficult to access. Most importantly, the combined-arms combat potency of the MAGTF is increased by maximizing aircraft availability.

The challenge of sustaining the ACE with Class IX(A) parts was used as an example to illustrate the differences between an operational sustainment plan optimized for self-sufficiency and one that prioritizes responsiveness. However, it is expected that some of the merits of responsive-logistics have benefit and application to other types of supply, units, or scenarios.[38] For instance, as more and more weapons systems transition to performance-based-logistics (PBL) or contractor-maintenance-support (CMS), it may not even be an option to move parts to or set up intermediate-level facilities in a combat zone. What is certain is the persistent need for planning and for flexibility. Short circuiting operational sustainment planning to adhere to a single doctrinal design is as foolish as concluding that it will never be relevant again. Operational sustainment should be planned from a theater perspective, based on the infrastructure available, and tailored to the needs of the force.

[38] See additional discussion: Kevin Daniels, "The Distribution Dilemma: That Last Tactical Mile," *Army Sustainment* 40, no. 5 (2008), 39-43, http://search.proquest.com/docview/197296035?accountid=322 (accessed April 30, 2012).

Figure 1: Self-Sufficiency Class IX(A) Footprint[39] [40] [41] [42]

MAGTF LEVEL	ACE*	CLASS IX(A) FOOTPRINT									
		"Self-Sufficiency" First 30 Days Ashore					"Self-Sufficiency" D+31 to D+90				
			Parts	People	Equipm't	Facilities		Parts	People	Equipm't	Facilities
MEB	---MAG (REIN)---										
	36 x MV-22 (3 Sqdn)	FIE	FISP for 24 MV-22s	66 mostly Avn Supply	no component repair capability	7	T-AVB	PCSP for 36 MV-22s	660 mostly I-Level mainteance personnel	remaining individual material readiness list (IMRL) assigned to a RW or FW MALS, e.g. full IMA capability	6
	16 x CH-53E (1 Sqdn)		FISP for 16 CH-53Es			5		PCSP for 16 CH-53Es			8
	18 x AH-1W 9 x UH-1N		FISP for 27 H-1s			3		PCSP for 27 H-1s			13
	14 x AB-8B (1 Sqdn)		FISP for 14 AV-8Bs			5		PCSP for 20 AV-8Bs			17
	36 x F/A-18 (3 Sqdn)		FISP for 36 F/A-18s			7		PCSP for 36 F/A-18s			34
	5 x EA-6B (1 Sqdn)		FISP for 5 EA-6Bs			5		PCSP for 5 EA-6Bs			19
	12 x C-130J (1 Sqdn)		FISP for 12 C-130Js			6		PCSP for 12 C-130Js			12
		MPS			Facility Equipment: Battery, Tire&Wheel capability	22		CCSP (RW)			424
								CCSP (FW)			487
MEU	---VMM (REIN)---										
	10 x MV-22	FIE	MESP for 12 MV-22s	by air: 10 mostly Avn Supply	minimal component repair capability if any	unspecified supply containers. No other facilities	No doctrinal aviation logistics plan for a MEU operating ashore apart from a seabase for over 30 days				
	4 x CH-53E		MESP for 6 CH-53Es								
	4 x AH-1W		MESP 6 AH-1W								
	2 x UH-1N		MESP for 4 UH-1N								
	6 x AV-8B		MESP for 6 AV-8Bs								
	2 x C-130J**	Support provided by parent MALS									
SMAGTF	UNDEFINED	UNDEFINED					UNDEFINED				

FIGURE 1

*An ACE is a composite organization that is tailored to the mission. Specific numbers and types of aircraft are typical but not universal. Numbers of people and facilities are assigned based on the aircraft mix and are approximated based on aircraft mix shown here.

**C-130s are available for tasking if required.

[39] MCO 13670.1, *Management and Administration of United States Marine Corps Mobile Facility (MF) Program and Related Equipment.*

[40] MCO 4400.177F, *Aviation Supply Desktop Procedures*.

[41] United States Marine Corps, "Table of Organization Marine Aviation Logistics Squadron Fixed-Wing," Unit TO&E Report Number 8810 (Quantico, VA: Total Force Structure Management System, 19 January 2011).

[42] United States Marine Corps, "Table of Organization Marine Aviation Logistics Squadron Rotary-Wing," Unit TO&E Report Number 8910 (Quantico, VA: Total Force Structure Management System, 19 January 2011).

Appendix 1: MALSPII Basics[43]

Allowancing

Simply put, MALSPII will seek to mitigate the variation caused by erratic demand patterns and an unreliable supply system. This is aimed to delay the impact of system non-availability to the customer as well as protect against circumstances where a squadron ordered significantly more last week than ever before and none are available the following week. This is done by building buffers.

A buffer for a particular site is set by first determining how long it takes to replace an item issued from that site. It is very important to note that unlike MALSP, this is not an average time, it is supposed to be the maximum amount of time that it has taken. If the inventory manager can identify why the worst case happened, and be reasonably assured that it will not happen again, or there is known improvement in replenishment time, this time frame may be used. This time frame is called "Time to Reliably Replenish" or TRR.

The second step is to take a slice of historical demand that was created by the same Type/Model/Series (T/M/S) and number of aircraft over a similar period of time flying in similar conditions at a similar rate. Once this demand pattern is obtained, it must be evaluated for each individual part to determine the maximum quantity ordered during a period of time that matches the TRR. Again, the maximum quantity is used, not the average quantity; however, if the inventory manager can identify why the worst case happened and be reasonably assured that it will not happen again, the next highest quantity can be used.

The above procedures must be done for each site because the TRR between different sites will be different and will support more aircraft than others, thus changing the demand pattern

[43] Luke Watson, "MALSP II Basics" (Information Sheet for Aviation Supply Officer Basic Course, Athens, GA, 2008, entire.

used. Though this process can be performed manually, it is time intensive if it has to be done for hundreds of parts. Appropriate Aviation Information Systems are being developed to speed up this process.

Policy still needs to be developed for range determination. The above procedures do much to help determine the appropriate depth for a high demand item. However, for lower demand items where an item is only ordered once during the entire demand period, the resulting buffer will be one. This does not mean that it should be stocked at the forward-most buffer, especially if an attempt is to be made to keep the FOB agile, or if there are limited assets. In these circumstances, choosing to add the range at the MOB or ESB removes that management and storage requirement from the forward site, and places the asset at a site that can quickly push that part forward when required. Until then, it remains available to multiple downstream sites. However, a repeatable method has not been developed to determine how much demand should yield a forward buffer, and how little means that the part is retained at a parent site.

MALSPII Architecture

Parts buffers at some or all of the below sites are linked together to create a supply-chain capable of minimizing the footprint in country and being highly responsive to the customer.

FOB: Forward Operating Base

- Most forward deployed parts buffer
- Located where aircraft routinely remain over-night (RON)
- Only O-level repair
- TRR to parent buffer must be minimized
- More range than depth
- Demand fluctuation must be caught here

- Minimal manpower

MOB: Main Operating Base

- Similar to FOB but more established base, more aircraft
- Has capability for fixed-wing delivery from out of country
- Responsible for replenishing FOB buffer and for supporting local demand

PMALS: Parent MALS

- A garrison MALS designated to support the aircraft forward
- Deploys the initial pack-ups
- Financially accountable for all material in the supply-chain
- Has full IMA capability
- Has NTCSS (the aviation logistics information system)
- Senior logisticians located here
- Allowances set and modified here
- Sends replenishments forward
- Does all required communication with the supply system
- Monitors the success of the forward sites
- There may be more than one PMALS for a given FOB, but recommendation is that there is only one PMALS per T/M/S.

ESB: Enroute Support Base[44]

- An Enroute Support Base is at a minimum a parts buffer within the supply-chain.
- It is important that the ESB be co-located with a transportation node.

[44] Could also be called an Intermediate Staging Base (ISB)

- It is ideally located in a benign location in the region where force protection concerns are minimal, but close enough that the TRR it provides to the next buffer in country minimizes the amount of material required.
- An ESB may also have some limited repair capability and be a key resource pool for services (Depot Level Field Teams) or equipment (GSE, test equipment) where several forward deployed sites must share limited assets.
- One ESB could potentially support multiple AORs and can be linked to many PMALS.
- Benefits:

  - Minimizes material/assets that must be stored in country.

  - Reduces strategic lift required to establish/redeploy forward bases

  - Minimizes impact of a strike against a logistics base in country

  - Decreases amount of time aircraft is down for a part not carried at FOB

Sea Base

- Best used when MOB/FOB is less than 200 NM inland.
- Often possesses inherent IMA repair facilities as well as supply support. (ships such as CVN, LHA, LHD, TAVB are all current options).
- Often intrinsically possess it's own UIC. Practically this has the effect of either terminating the supply-chain, and thus losing direct access to the buffered retail level stock at the PMALS, and putting the burden for financial management on the ship; or adds significant complication to the supply-chain through reliance on OSO transfers, paybacks, repair and return, sub-custody, etc.
- Movement of assets on and off ship is often a problem as the MALS possesses no transportation capability. Requires coordination with Navy for Carrier Onboard Delivery

(COD)/or Vertical Replenishment (VERTREP) and Marine Corps for regular MARLOG flights or pierside pickup for overland transportation.

- A Sea Base is often the best ESB or even MOB depending on the operational details and if appropriate IT and transportation can be worked out.

Selecting Nodes

Most often, MOBs and FOBs are dictated by the aviation concept of operations in theater. In other words, since MOBs and FOBs are where aircraft will be bedded down and operate from, the logisticians seldom dictate where these sites will be. Logisticians at the MAW level should advise regarding facilities and other important factors but ultimate decision rests with the ACE commander. In a larger operations where there are numerous operating sites, aviation logisticians will have to decide which of these is most appropriate for a MOB and which ones should be set up as FOBs.

A recent Naval Postgraduate School Study showed that in order to optimize supply-chain performance (reduce total amount of time aircraft are waiting for parts) with the least number of parts, a buffer should be placed between the PMALS and the demand generating sites (MOB/FOB). The closer the site (ESB/Sea Base) is to the site in country, the better the expected performance.

Ideally, a combination of nodes would be selected when setting up the supply-chain where the FOB is separated from the MOB by less than 24 hours, the MOB is 1-3 days TRR from an ESB, and the ESB is 4 to 10 days from a PMALS. This will create a supply-chain with tiered buffers and minimize the amount of parts required in country without sacrificing operational capability.

Replenishment

MALSPII seeks to shift the focus of the deployed logistics system from "firefighting" to "fire prevention." As such, the logistics chain is set up to facilitate the flow of stock or replenishment requisitions, not Direct Turn Over (DTO) requirements. The foundation of this shift in focus is that timely replenishments enable the part to be back on the shelf just before the customer needs another one. Allowances are set such that when there are zero on the shelf, the replenishment that is in transit will arrive prior to the next customer demand. This means that demand and replenishment must be carefully synchronized.

Critical to this synchronization is that the replenishments are sent immediately; that as soon as an issue is made, the parent buffer is sending a part forward to replenish what was issued. In MALSPII there is no place for any policy that would slow this process down such as only doing "buys" (releasing replenishment requisitions) every other day, waiting for a full pallet before shipping, etc.

It is easy to be misled into thinking that speed is the most critical factor in this logistics chain. For instance, if there is repair capability available at multiple sites, it is more important to use the one that can provide consistent turn-around-time on components for the duration of the operation than the one that might be able to repair a single part much faster. Changing the repair site for every individual retrograde item means that each one of those repair sites is receiving an irregular demand pattern. This makes it much harder to for the inventory managers at these sites to predict the demand they will receive, leading to stocking too much or too little. Consistency leads to reliability, which leads to predictability, which leads to improved performance.

Appendix 2: MALSP II Asset Distribution[45]

GENERAL PRINCIPLES / PHILOSOPHY:

- Buffer sizing must distribute parts for the entire network instead of each node separately; NAVICP gives total allowance (constrains number of assets available for support) and buffer sizing optimizes placement of the limited resources.

CONFIGURATION OF SUPPLY-CHAIN:

- More than 2 intermediary buffers between PMALS and demand source will be wasted inventory.
- Conduct Mission Analysis to determine:
  - If space at FOB is constrained
  - If agility at FOB is valued (probability of relocating)
  - If survivability at FOB is a concern (is risk to people and parts high)
  - If PMALS is supporting more than one FOB with same T/M/S
  - If TRR from ESB[46] to FOB is 24 hours or less.
- If the answer to all of these questions is no, the value added of the ESB will only be to insulate the customer from variation in demand and system availability on high demand items. In this scenario, using less risk (more conservative buffer sizing) on these items at the FOB will likely produce the same benefit at significantly less cost (no need to maintain an extra layer of demand or man an ESB).
- If the answer to any of the above mission analysis questions is yes, then utilizing an ESB can ensure parts with limited availability are available to multiple sites as well as help

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[45] Luke Watson, "MALSP II Asset Distribution Policy" (presented to MALSPII Project Office, Patuxent River, MD, 2011), entire.

[46] Synonymous with Intermediate Staging Base (ISB).

keep the footprint at the FOB small without sacrificing responsiveness to squadron demand.

- The value of the ESB will be proportional to the magnitude of difference between TRR from PMALS to FOB and TRR from ESB to FOB. If the TRR from PMALS to FOB (or time it takes for a DTO to be delivered direct) is equal to TRR from ESB to FOB, the ESB is a wasted layer or supply.
- The value of the ESB is multiplied by the number of FOBs it supports.

TIME TO RELIABLY REPLENISH DETERMINATION:

- TRR between nodes is generally determined by transportation and material handling constraints; TRR to PMALS shelf is determined by system availability and or IMA performance.
- If buffers are sized using worst case (maximum) TRR, allowances will be much larger than current allowances (based on averages). While averages are not appropriate for determining TRR, neither are maximums. Both TRR should be viewed as a distribution.
- While determining buffer sizes for the entire network, it is important to remember that some items will have different TRRs if distribution of assets provides intermediary layers of inventory for some items and not others. (eg some items at FOB will use ESB to FOB TRR, others will use PMALS to FOB TRR.)
- While it is well known that TRR affects buffer sizes, material availability can affect TRR; the TRR at the child node lengthens when parent's inventory runs out even if transportation allows a 1 day TRR. However, for the purpose of buffer sizing at forward nodes, if part is unavailable from the supply system, the TRR should not be increased; increasing the buffer won't help.

RANGE DETERMINATION BY NODE:

- Build buffers as a network; not as individual nodes
- Range determination by site will vary significantly depending on whether ESB supports more than one demand node; the more nodes the ESB supports, the greater the range at the ESB and the less range at the FOBs.
- Inventory should be segregated into the following categories:
    - A. Higher demand/High availability
    - B. Higher demand/Low availability
    - C. Lower demand/High availability
    - D. Lower demand/Low availability
  - NIINs in category A should generally be placed at all nodes in accordance with the demand rate in the TRR period (goal: tiered buffer).
    - Exception: while unlikely for this population, if max demand in TRR from PMALS to FOB is the same as max demand from ESB to FOB, do not place at ESB.
    - Ensure parent node conglomerates demand from all child nodes.
  - NIINs in category B, if there is an asset available to deploy, should generally be placed at the ESB and not at the FOB.
    - Exception: if ESB only supports one FOB, asset should be placed at the FOB and not the ESB unless PMALS will source CONUS requirements from FWD or if ESB is very close and the Commander's desire for survivability/agility demands a very small footprint in country.
  - NIINs in category C should be placed in accordance with mission analysis.

        - If space, agility and survivability are valued, allocating part at ESB but not FOBs will lower issue rate but will not significantly increase CWT.
        - If space, agility, and survivability are not concerns, assets can be placed at the FOBs; because maximum demand during the TRR from PMALS to FOB will probably be equal to the demand during TRR from ESB to FOB, inventory at ESB will be redundant.
    - NIINs in category D will probably not be deployed if RBE contains more aircraft of the same T/M/S than those that are deploying.
        - Considerable thought should be given to how these types of items will be moved expeditiously from CONUS to FOB if required.
        - If the requirement to support RBE aircraft is minimal, the limited assets should be placed at the site where demand conglomerates (ESB if there are multiple FOBs).
- Determining range for a squadron sized or smaller FOB by ORG demand and expanding range of NIINs considered for placement at the ESB to TEC demand helps create the desired tiered buffer.

DEPTH DETERMINATION:

- When buffer sizing, each node’s demand must conglomerate all demand from child nodes. ESB and PMALS conglomerates all demand from forward nodes. Conglomeration does not mean that depth to support FOB1 is added to depth to support FOB2; the demand patterns must be overlapped.
- At FOB, depth should be minimized; at ESB a more conservative depth determination can be used.

- If buffers are sized using worst case (maximum) demand, allowances will be much larger than current allowances (based on averages). While averages are not appropriate for modeling demand, neither are maximums. Demand should be viewed as a distribution.
- The demand pattern chosen will determine depth. If the demand pattern for an ORG code is chosen, recognize that the proposed buffer size returned (demand within the TRR period) will represent the conglomeration of a full squadron's worth of aircraft. If buffer is only supposed to support a quarter of a squadron, the recommended buffer will generally have too much depth. While it is not appropriate to divide the suggested depth of the ORG search by 4 in this scenario, it should be manipulated. Searching by the next lower denomination (eg BUNO) may be helpful in determining how much depth to cut from the original search.

Appendix 3: Cargo Resupply Unmanned Aerial System (CRUAS)

The Cargo Resupply Unmanned Aerial System (CRUAS) being utilized in Afghanistan is a converted K-MAX helicopter (Lockheed Martin) and it already demonstrates the tremendous potential of this type of platform. With auxiliary fuel tanks it has the ability to carry 1,500 pounds (external sling load) 500nm without refueling cruising 80 knots at 10,000 feet density altitude.[47] This means it easily has enough range to make a delivery from an ISB to a FOB.

The rotary-wing design and sling-load means that it does not need to land in order to make a delivery, and its ability to deliver cargo reliably within three meters reduces the requirement for ground-handling equipment, thereby opening up many austere landing sites.[48] To complete the supply-chain, the CRUAS would also pick up retrograde to take back to the ISB for repair. Pick up and refueling would require it to land necessitating the FOB be manned by a Pilot, Air Vehicle Operator and a mechanic. An additional 18 total personnel would be required at the ISB to manage the fleet of CURAS.[49] This would permit 24-hour operation and would not significantly increase with each additional aircraft.[50] At a cost of 18 additional Marines (at the ISB), approximately 590 MALS personnel can be moved from the FOB to the ISB (or to CONUS if inter-theater transportation can replenish ISB buffers as quickly as an IMA could).

The CRUAS is a low risk option in an anti-access environment.[51] First of all, since there is no potential for loss of life if shot down, a commander is more likely to approve deliveries to hostile landing zones. However, it is designed to be quiet and present a small signature so even

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[47] Jon McMillen (Lockheed Martin), email message to author, 6 April 2012.

[48] Major David Funkhouser, "USMC Immediate Cargo Unmanned Aircraft System Update" (PowerPoint presentation, HQMC Combat Development and Integration, Quantico, VA, 22 March 2012).

[49] Email from Major Kyle OConnor, VMU-1 FWD DWR CRUAS OIC. 30 March 2012.

[50] Jon McMillen (Lockheed Martin), email message to author, 26 April 2012.

[51] Terry Robling, "Forward in the Fight." *Marine Corps Gazette* 95, no. 5 (2011), 24. http://search.proquest.com/docview/865920999?accountid=322 (accessed May 7, 2012).

the risk to the aircraft itself is low; it is very difficult to detect or attack with any surface to air capability.[52] Another advantage to a CURAS is not having to rely on optics. Weather has historically been another cause of unreliable intra-theater transportation either due to concerns about visibility and safety. Since a CRUAS requires no optics, so it can operate just as well in low-visibility and fly missions at night.[53] This has a positive impact on survivability in anti-access environments as well as reliability of delivery.

At $9 to 12 million dollars a copy,[54] and less than $1,200 dollars per hour to operate,[55] it can perform the mission much cheaper than any other aircraft (e.g. MV-22 is approximately $93 million[56] with a cost per hour of around $10,000).[57] The CRUAS is currently demonstrating less than 1.5 maintenance man hours per flight hour.[58] This means that without pushing the capability envelope, two CRUAS could make three round trips of 1,500 pounds every day between a FOB and an ISB 250nm apart and sustain this operational tempo indefinitely. This would be more than enough throughput to support a MAG (REIN), and being able to deliver within eight hours would mean very few supplies would need to be maintained at the FOB.

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[52] Kaman Aerospace Corporation, *K-MAX Unmanned Aircraft System Optionally Piloted Cargo Lift Helicopter for the Warfighter*, Brochure (Washington, DC: Lockheed Martin Corporation, 2010).

[53] Major Kyle O'Connor (VMU-1 CRUAS OIC), email to author, 30 March 2012.

[54] Major Jason Sharp, "The Cargo UAS," *Marine Corps Gazette* 96, no. 1 (2012), 16. http://search.proquest.com/docview/921343080?accountid=322 (accessed April 30, 2012).

[55] Jon McMillen, email message to author, 6 April 2012.

[56] U.S. Government Accountability Office, *Defense Acquisitions: Assessments Needed to Address V-22 Aircraft Operational and Cost Concerns to Define Future Investments*, GAO 09-482 (Washington, DC: GAO, 2006), summary page.

[57] Robling, "Forward in the Fight," 21.

[58] Major Kyle O'Connor (VMU-1 CRUAS OIC), email to author, 30 March 2012.

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