Beans, Bullets and Bandwidth: Sustaining Operational Maneuver from the Sea with Ship-To-Objective Logistics

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Subject Area - Logistics

Executive Summary

Title: Beans, Bullets and Bandwidth: Sustaining Operational Maneuver from the Sea with Ship-To-Objective Logistics

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Thesis: Ship-to-objective logistics (STOL) operations can leverage information and speed to replace logistics mass and sustain a force conducting ship-to-objective maneuver (STOM) within the overarching concept of OMFTS. This method of logistics support, executed primarily from a seabase, is possible through the application of innovative techniques and realistic technological advances.

Discussion: OMFTS provides a strategy for the Marine Corps to respond to future changing and dynamic threats. Its broad principles advocate use of the sea as maneuver space and the maximization of tempo and flexibility. STOM, its major supporting concept, envisions forces using these principles to project deep inland to operational objectives directly from the seabase. The high operational tempo of this force in a large battlespace poses significant physical challenges for seabased logistics.

Combat service support elements (CSSE), also using the sea as maneuver space, must integrate logistics operations with maneuver operations, matching their tempo and sustaining their warfighting capability. Using situational awareness and information fused from multiple functional automated systems, the CSSE will compensate for the physical challenges inherent with STOM support.

As a system of systems, STOL's processes and subsystems will interrelate with supply, distribution and command and control information. Inter-networked systems will link the seabase with the forces conducting STOM to enable the generation of predictive and near-real time logistics requirements, total asset visibility, reduced stores, and effective command and control of logistics operations.

Conclusion: The central vision of OMFTS provides conceptual focus but must be further developed and resourced by the Marine Corps. Continued direction toward STOL through documents like the recently-published Deputy Commandant of the Marine Corps for Installations & Logistics *Logistics Campaign Plan* will guide decentralized efforts throughout the Department of the Navy to create capabilities for OMFTS. Guided by the vision, technologies and systems can co-evolve and benefit from shared lessons and

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resources. Eventually, through time, all will mature and coalesce into a fully-realized system-of-systems and the Marine Corps will have the capability of STOL.

Table of Contents

Illustrations

Page

Tables

Page

Preface

This research project, initiated with the purpose of self education, forced me to examine *Operational Maneuver from the Sea* from its conceptual basis through its supporting warfighting concepts. For academic exercise, I tried to remain as objective as possible to analyze the concepts within their own context and to propose a form of operational employment for *Ship-To-Objective Logistics*. My research led me to conclusions supported by programs and agencies also in search of proposals for the employment of different aspects relating to OMFTS. Not until I finished this research did I realize the close correlation of this decentralized work into a central vision for OMFTS.

My work in this paper is the exploitation of developmental concepts and technologies officially supported by command direction and near-term plans. Not one proposed element separately wanders from the central vision of OMFTS but the sum of all proposed elements may collectively support a yet-to-be-defined aggregate system of systems, *Ship-To-Objective Logistics*.

Section 1

Sea Dragon: Changing the Marine Corps for the 21st Century

Sea Dragon, the term for General Charles C. Krulak's vision for the 21st Century innovation of the Marine Corps, is a derivate label of the Chinese saying, "change is a dragon." The saying states there are three ways to deal with the dragon of change. If you choose to ignore the dragon in the hope that it will go away, it will eat you. If you resist it, the dragon will eventually knock you down and eat you. But, if you ride the dragon you can successfully exploit it.[1] Stating that Marines have ridden "dragons of change" in the past with the development of amphibious warfare, Gen Krulak knew that Marines must embrace change to address the needs of the 21st Century.[2] As was the case with amphibious development between world wars, Marines would once again have to innovate to address future challenges.

Operational Maneuver from the Sea

Operational Maneuver from the Sea (OMFTS), the Marine Corps' capstone concept for future maritime power projection, identifies a full spectrum of challenges the Marine Corps will have to face in the near future and provides a strategy for effective response to

[1] Major Paul L. Damren, USMC, *Changing Our Corps – Will Sea Dragon Succeed?*, Masters of Military Studies Research Paper (Quantico, VA: Marine Corps University Command and Staff College, April 1996), 1.

[2] General Charles C. Krulak, "Embracing Change," *Marine Corps Gazette*, January 1996.

the world's changing and dynamic threats. OMFTS provides broad and general principles that affect all or most Marine Air-Ground Task Force (MAGTF) elements: operational objective focus; use of the sea as maneuver space; maximization of tempo, momentum and flexibility, etc.[3] Through the generality of these principles, OMFTS further provides operational directions and requirements for capability improvements to make its concept a reality. It leverages present and future technological capabilities (like tilt-rotor aircraft and battlespace digitization) to be prescriptive in implementing new operational maneuver warfare. Central in its concept is the rapid movement of "units from ships lying over the horizon to objectives lying far from the shore…(requiring the capability to) seamlessly transition from maneuvering at sea to maneuvering ashore and vice versa."[4]

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[3] Marine Corps Combat Development Command (MCCDC), "Operational Maneuver from the Sea," *United States Marine Corps Warfighting Concepts for the 21st Century*, (Quantico, VA: Marine Corps Combat Development Command, 1998), I-11.

[4] MCCDC, "OMFTS," I-18.

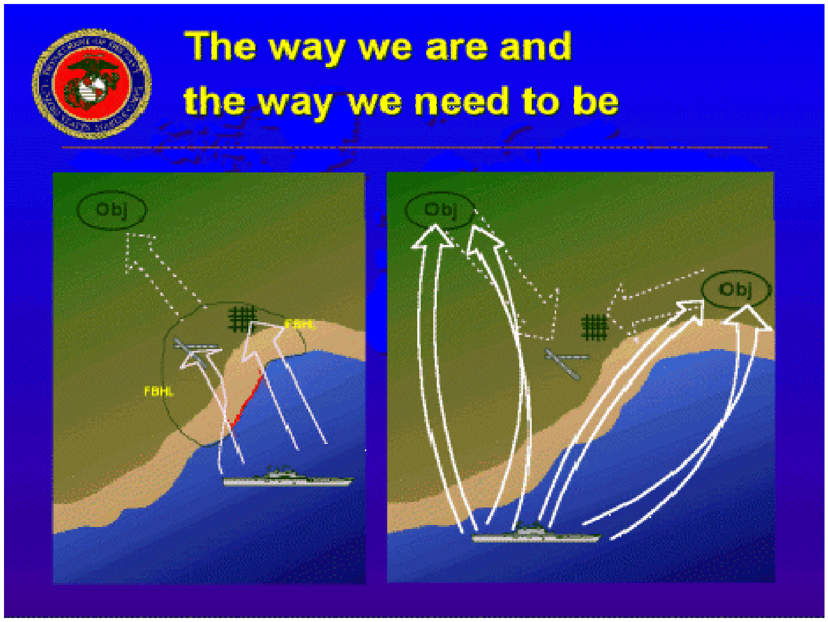

Figure 1. Operational Maneuver from the Sea (STOM Depicted).[5]

Ship-To-Objective Maneuver

Ship-To-Objective Maneuver (STOM) is the principal implementing concept of OMFTS. STOM exploits advanced technologies to maneuver amphibious forces from over-the-horizon attack positions "through and across the water, air, and land of the littoral battlespace directly to inland objectives."[6] Through speed and deep power projection, STOM applies the principles of maneuver warfare to the littoral battlespace.[7] Using ships as assembly areas, combined arms surface and vertical assault forces maneuver to objectives as far as 200 miles inland and 200 miles apart, a four-fold

[5] Warfighting Concepts for the 21st Century, Concepts Briefing, downloaded from http://www.concepts.quantico.usmc.mil on 27 December 1999, (Quantico VA: MCCDC, 1999), 25.

[6] MCCDC, "Ship-To-Objective Maneuver," *United States Marine Corps Warfighting Concepts for the 21st Century*, (Quantico, VA: MCCDC, 1998), II-7.

[7] MCCDC, "STOM," II-10.

increase over traditional operating ranges.[8] Conceived to create "overwhelming tempo and momentum"[9], STOM's potentially vast operating zones for assault forces pose physical challenges for logistics operations, which will principally originate from bases at sea.[10]

Seabased Logistics

Seabased Logistics, anteceding the concept of STOM and also itself a critical implementing concept for OMFTS, is a bold proposal for the Navy and Marine Corps to move toward more fully-integrated operations, logistics and information warfighting capabilities.[11] As its name implies, *Seabased Logistics* (SBL) proposes to reduce or eliminate the logistics footprint ashore while providing in-stride sustainment for forces conducting operations envisioned by OMFTS and STOM.[12] Eliminating a lodgment ashore by providing ship-to-objective logistics (STOL), seabased forces can shift lines of communication to rapidly support a variety of operational objectives.[13] For STOL to adequately support STOM-type operational requirements, the concept of SBL recognizes the need to fundamentally transform the functions of logistics to replace mass with information and speed. To enable such sweeping change, supporting innovations include

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[8] Naval Research Council, *Naval Expeditionary Logistics: Enabling Operational Maneuver from the Sea* (Washington, DC: National Academy Press, 1999), 19.

[9] MCCDC, "STOM," II-24.

[10] Ibid., II-22.

[11] MCCDC, "Seabased Logistics," *United States Marine Corps Warfighting Concepts for the 21st Century* (Quantico, VA: MCCDC, 1999) Cover page.

[12] MCCDC, "Seabased Logistics," XI-4, XI-5.

[13] Ibid., XI-4.

improved distribution and information technologies to reduce logistics response time and ease logistics management.[14]

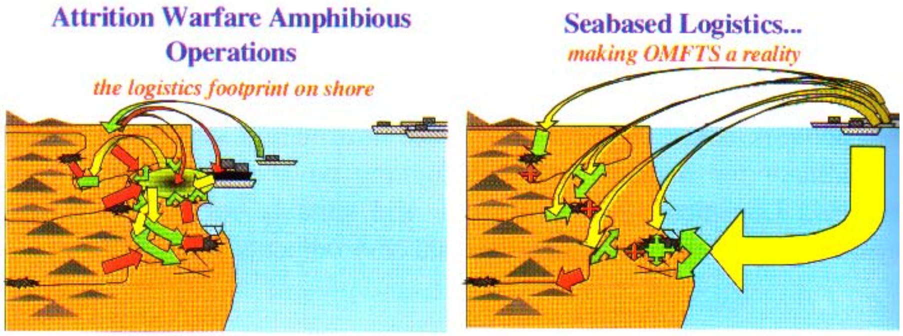

Figure 2. Seabased Logistics.[15]

Just as STOM changes the physics of maneuver warfare from the sea, the coinciding changes to the sustainment requirements of its assault forces are further compounded through the change in disposition of its now principally-seabased logistics support structure. Not only will assault forces conduct operational maneuver against objectives far inland, they will do so without close-trailing logistics packages and without logistics dumps of supplies ashore. Recognizing this as a "critical challenge", the STOM concept anticipates maneuver forces using a "logistics pull" method to leverage STOL's successful use of information and speed to compensate for the challenge posed by the physical distribution of logistics.[16]

This paper suggests how ship-to-objective logistics, as proposed by the *Seabased Logistics* concept, can replace logistics mass with information and speed to sustain a force conducting ship-to-objective maneuver within the overarching concept of OMFTS.

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[14] Ibid.

[15] Ibid.

[16] MCCDC, "STOM," II-22, II-23.

The application of innovative techniques and realistic technological advances can create new methods of operation achievable within the short term to revolutionize MAGTF sustainment. The resultant positive effects of information and speed can enable the concepts of *Seabased Logistics* and *Ship-to-Objective Maneuver* and help make *Operational Maneuver from the Sea* a reality.

What Has and Has Not Changed?

Although new concepts exist to provide vehicles for the further development of ideas, they are not changes within themselves. They eventually lead to the development of doctrine, organizational structures, training, education and systems to institutionalize change. It is important, therefore, to understand where the supporting OMFTS concepts depart from today's Marine Corps to appreciate the ramifications of their ideas for change. Only from that viewpoint are answers into conceptual application possible.

The size and nature of the force conducting STOM-type operations may be larger than a Marine Expeditionary Unit (MEU). Although the size and composition of a MAGTF conducting STOM-type operations will vary depending on its mission, it will have the capability to quickly and decisively achieve operational objectives.[17] Recent Navy and Marine Corps studies and analyses generally propose that this MAGTF (or operational maneuver element, OME) range in size between a 5,489-marine landing force to a much larger MEF(Forward)-type element.[18] In addition to the significant size of the force, the nature of its operation could also change by the likely nature of its

[17] MCCDC, "The MAGTF in Sustained Operations Ashore," *United States Marine Corps Warfighting Concepts for the 21st Century*, (Quantico, VA: MCCDC, 1998), IV-6-12.

[18] MCCDC, *Ship to Objective Maneuver Concept of Employment (DRAFT)*, (Quantico, VA: MCCDC, February 2000), 3-3. Also, *Naval Expeditionary Logistics*, 4.

employment. Not only simply maneuvering against an operational objective from sea, this force will maintain a high tempo of operations, maneuvering faster than the enemy can react.[19] This is largely due to the application of vertical (as well as surface) maneuver resultant from technological and operational changes.

Using vertical maneuver, assault forces can move on multiple axes over shore quickly to simultaneous littoral penetration points. The tactical agility and speed of movement provided by tilt-rotor and other rotary wing aircraft enables it not only to assault objectives deep inland but also to reembark and strike other objectives as the tactical or operational situation permits. This rapid and selective application of force can work in conjunction with surface assaults or act independently to maintain freedom of maneuver and diffuse decisive enemy reaction.[20] This grand change in operational maneuver changes the framework from which its support requirements are derived.

With logistics forces primarily sea based, they must be able to react to the requirements of the force they support. To provide effective support without a significant footprint ashore, logistics forces must employ correspondingly grand changes in methods of support. Seabased logistics forces must receive requirements over-the-horizon from forces employed deep inland and subsequently compete for deck space and air- and seaborne systems to begin the physical aspect of distribution. More than simply a continuous supply chain, logistics missions must be responsive, fast, and agile to precisely meet requirements with limited assets. The revolutionary application of information systems to integrate operational and logistics command and control can

[19] MCCDC, “STOM,” II-9.

[20] Ibid., II-16.

create situational awareness, a shared common picture of the battlespace, for logistics forces to provide rapid and agile sustainment without impairing operational tempo. Using ***information*** and ***speed*** to replace ***mass***, logistics forces can leverage technology and new techniques to enable new concepts of operations.

Is Ship-To-Objective Maneuver Supportable?

Several studies and analyses examine different elements of logistically supporting STOM. Most research focuses on system-related issues of capacity, consumption and the physical constraints of time and distance. Official government studies and independent research identify critical vulnerabilities and limitations of STOL and suggest offsetting system-related fixes to enable STOM. The fixes generally recommend strengthening critical system-related vulnerabilities and adding capability through increased resources while warning of the inherent risks associated with seabased logistics. Some studies addressing a MEU-sized landing force of approximately 1,400 Marines (although much smaller than a MEB-type landing force) provide a baseline for the analytical support of this research. Their key conclusions are:

- **STOL is possible for a MEU through lift maximization**. Seabased logistics ships from an amphibious ready group (ARG), through periodic underway replenishments (every 5-6 days), can sufficiently meet the logistics requirements of a MEU-sized combat force ashore for sustained periods of time through STOL. Keeping a battalion landing team generally within a 70% supply status[21] (in Class I, III and V(W)), a combination of vertical and surface lift assets can provide

[21] This and other comparable studies primarily examined three supply classes: Class I, Subsistence; Class III, bulk fuel and other petroleum products, oil and lubricants; and, Class V(W), ammunition for ground combat systems.

sufficient and sustained Class I, III and V(W) supplies over a combat-benign distance of 102 nautical miles (average).[22] Although this study established a limited feasibility for STOL, it addressed only the physics of distribution and not the high operational tempo and momentum of forces conducting STOM.

- **Sustained STOM/STOL (>7 days) for a MEU requires additional vertical capability**. Assuming long and sustained distances over water and ground require the primary use of vertical lift assets, combat attrition and usage profiles reduce available aircraft by 25% after seven days of operation.[23] Additional tilt-rotor MV-22 aircraft and shorter distances are required to logistically sustain operations of a far-inland force from over-the-horizon seabased carriers (shorter than the estimated threshold of 80 nautical miles at the end of seven days). Although this study did attempt to account for the effects of sustained operations to quantify aircraft availability to meet logistical requirements (Class I, III and V(W) only), it did not consider any other attribute of STOL or principle of STOM.

As with the previous study, ***information*** and ***speed*** did not replace ***mass*** as the concept of *Seabased Logistics* proposes. Although the studies did reveal the physical constraints of sustaining logistics sufficiency and continuity, they simply proposed the application of speed to offset time and distance requirements without addressing information. The study's evolutionary reinforcement of old methods of logistics operations to support new maneuver warfare fall short and illustrate the need for new

[22] Lieutenant Max A. Wiley, USN, *Demonstrating the Requirement for Amphibious Ready Group (ARG) Replenishment in Sea-Based Logistics Operations*, Masters of Science in Operations Research Thesis (Monterey, CA: Naval Postgraduate School, December 1997).

[23] Lieutenant Mark W. Beddoes, USN, *Logistical Implications of Operational Maneuver from the Sea*, Masters of Science Thesis (Monterey, CA: Naval Postgraduate School, March 1997).

methods to meet tomorrow's requirements for STOM. As Gen Krulak professed in the creation of Sea Dragon, "real innovation means more than just adding of a new layer of technology."[24]

Recent official studies contracted by the Marine Corps Combat Development Command and the Navy Studies Board more adequately address the revolutionary aspects of supporting STOM through seabased logistics. In addition to increasing speed and bolstering distribution assets, some of their innovative proposals to support STOM are:

- **Reduce the demands on seabased logistics.**[25] Reductions in the quantity of logistics consumers ashore relieve some burden on their support from seabased logistics forces. Not by simply employing smaller forces in STOM, the development of fuel-efficient vehicles and more lethal weapon systems reduces the required volume for Class III and V(W) supplies. By also reinforcing maneuver elements with increased logistics capability (i.e., bulk fuel transport and water purification systems within the GCE) eliminates or minimizes some seabased logistics requirements.
- **Integrate logistics operations and information into the overall command and control environment**. An advanced command and control system created through integrated information could enable efficient management and precise delivery supplies and services to forces ashore.[26] The resultant shared

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[24] Krulak, "Embracing Change."

[25] A B Technologies, *Sea Based Logistics and MPF 2010 and Beyond War Game Series*, (Quantico, VA: MCCDC, September, 1998), 7.

[26] Ibid., 9-10.

information will enhance the command and control of STOM and improve distribution responsiveness and flexibility.[27]

These proposed innovations and integrated systems do not attempt to improve existing systems as much as to replace them. New systems, not simply the incremental application of new materiel, are needed to meet the requirements of STOM's revolutionary approach to maneuver warfare. These new methods include not only distribution systems but also new technologies and methods of employment to truly replace ***mass*** with ***information*** and ***speed***. Old ways cannot be new ways.

[27] Ibid., 7.

Section 2

Ship-To-Objective Logistics: Building a System of Systems

The Changed Physics of Non-Linearity

The *Precision Logistics Concept* states "logistics is governed by immutable laws. Material has mass, and the movement of mass requires effort. The movement of mass over distance requires time, which is determined by the speed of movement."[28] The immutable laws of physics limiting the movement of ***mass*** by available ***speed*** simply apply a two-dimensional, origin-to-destination, transportation principle for sustainment operations. However, by adding ***information*** to the equation of ***mass*** and ***speed*** (as the SBL concept suggests), the three elements combine to make another dimension where requirements (not simply the physics of transportation) set into motion the logistic system that can operate non-linearly between supply sources and those generating demands. Just as national overnight delivery companies and World-Wide-Web-based businesses have discovered, ***information*** and ***speed*** redefine the requirements for ***mass*** above the consumer level. The immutable laws of logistics, the same laws that provide critical challenges to SBL, can be changed.

[28] MCCDC, *Precision Logistics Concept, The Spectrum of Logistics,* (Quantico, VA: MCCDC, 29 August 1995), A-8.

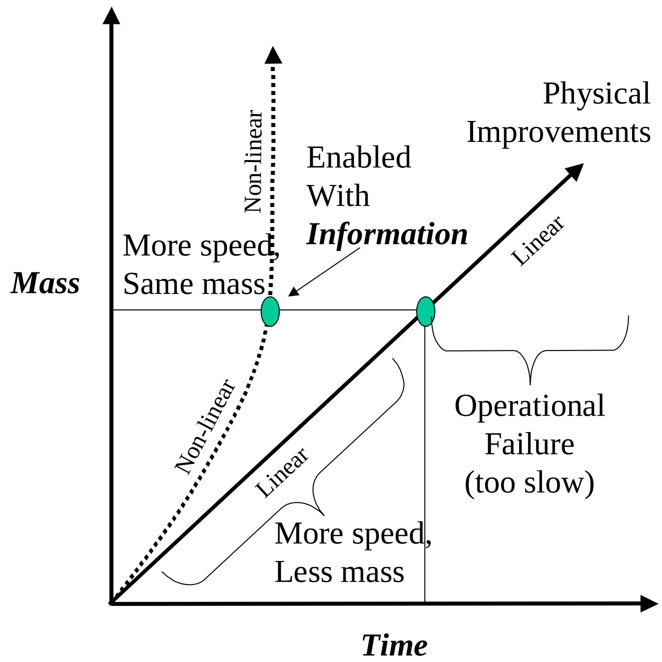

Figure 3. Relationship between mass, speed and information.[29]

Describing the STOL System of Systems

Ship-to-objective logistics must be more than a collection of incremental linear improvements to support the revolutionary requirements of STOM. Just as information can exponentially affect speed (see figure 3), STOL requires the integration of supply, distribution and command and control information systems to create a system greater than the some of its parts. The effective synergism of these functional systems creates the higher system of STOL. Only then, through the lens of the newly-described STOL system of systems, its interrelating lower systems reveal a network of processes that once used to be linear and relatively independent.

[29] Chart derived in concept from Metcalfe's Law where exponential effectiveness is possible through networking. From: David S. Alberts and others, *Network Centric Warfare*, 2nd ed., (Washington, DC: DoD C4ISR Cooperative Research Program, September 1999), 32.

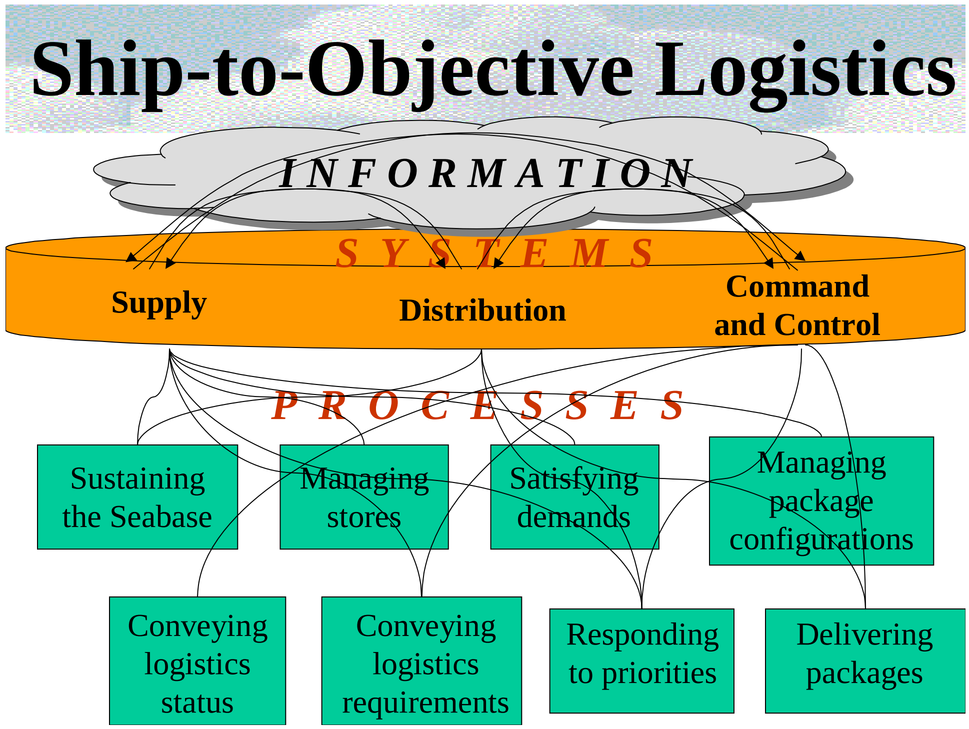

Figure 4. The Interdependency of STOL Systems and Processes.

As a system of systems, STOL consists of many processes that are also interrelated and sometimes belong to more than one functional system. An improvement to one process may or may not improve another process with which it interrelates or benefit the overall system to which it belongs. An example of this could be the tilt-rotor MV-22 Osprey aircraft. Although it improves the capability of STOL's distribution system, it only incrementally benefits the STOL system of systems through its improved aerial speed and range and does not inherently improve any other parts of the supply or command and control system. However, combined interrelated improvements of processes and systems can generate overall ***speed*** or reduce ***mass***. Those improvements when coupled with the benefits of ***information*** can have an exponential effect in achieving SBL's desired goal of replacing ***mass*** with ***speed*** and ***information***.

What Makes Information So Important?

Just as STOM redefines the conduct of maneuver warfare, information changes the perspective from which STOM (and not surprisingly, STOL) operates. Although not a functional system by itself, ***information*** provides the medium for connecting digital systems to share data to create more valuable information. This process, sometimes mislabeled as a panacea of "perfect knowledge", distributes information in a network-centric environment across functional systems to create a shared situational awareness. The two important pieces of the process are that **data travels in an integrated network** (not just mere functionally-networked logistics information singularly available on the Administration & Logistics voice radio network) and that a **common relevant picture of the battlespace is possible** beyond the nodes of a functional system (e.g., data from maneuver and fire support terminals sharing information on changes to fire support coordination lines). An integrated network with shared information is not simply the hinge to enable STOL, it also provides the framework for the direction of the Department of Defense's concept for *full spectrum supportability*.

Focused Logistics and Network Centrism

Joint Vision 2010 is the conceptual template for how America's Armed Forces will use innovation and technology to achieve new levels of effectiveness in joint warfighting.[30] A central operational concept of *Joint Vision 2010* is *Focused Logistics*, where the fusion of shared information and transportation technologies enable rapid crisis response, visibility and control of assets en route and the direct delivery of tailored

[30] Office of the Chairman of the Joint Chiefs of Staff, *Joint Vision 2010* (Washington, DC: Joint Chiefs of Staff, 1996), 1.

logistics packages.[31] The resultant expected full spectrum supportability includes integrated automation networks, automatic identification technology, asset visibility, in transit visibility, decision support tools for logistics operations, and logistic command and control.[32] A recurring theme and common enabling thread in the hierarchy of future visions is ***information***.

Chief of Naval Operations Admiral Jay Johnson characterizes this application of information as "network-centric warfare."[33] Affecting far more than just full spectrum supportability, network-centric warfare enables geographically dispersed Navy and Marine forces to communicate, move and project themselves against enemy weaknesses through shared battlespace awareness and self-synchronized operations.[34] The linking together of battlespace entities (to include logistics) will allow them to work in concert to achieve desired effects.[35] In network-centric warfare, the entity of logistics specifically joins accurate ***information*** between sources of supply and the end user, and all intermediate points, to generate ***speed*** and enable the reduction of ***mass***.

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[31] *Joint Vision 2010*, 24.

[32] Office of the Director of Logistics, *Focused Logistics* (Washington, DC: Joint Chiefs of Staff, 1997), 16-23.

[33] Vice Admiral Arthur K. Cebrowski and John J. Garstka, "Network-Centric Warfare," *Proceedings*, January 1998, 1 (downloaded from http://www.dodccrp.org/ on 26 December 1999).

[34] Alberts, *Network Centric Warfare*, 88.

[35] *Network Centric Warfare*, 92.

Section 3

Applying Information Systems to STOL

In a network-centric environment, a responsive STOL system based on requirements enables STOM and the overarching concept of OMFTS. Connected through near-real time information systems, all nodes of the supply system combine to create synergy between the end user and the source of supply to enable new, effective and efficient methods of support.

Near-Real Time and Predictive Requirements

Generating speed through information is possible through assured data communications, remote monitoring of equipment status and embedded prognostics/diagnostics devices. Conveying requirements through near-real time data communications eliminates pauses inherent from information stoppages in voice net relay or separate echelons between the end user and the source of supply. Such data communications is possible through manually-created logistics reports and requests within the software platform of C2PC and sent from end-user (platoon and company) levels through a data automated communications terminal (DACT) into a tactical data system.[36] Streamlined data communications prevents sluggish logistics radio voice

[36] Marine Corps Systems Command, *Mission Needs Statement for the Data Automated Communication Terminal No. CCC 11-26* (Quantico, VA: MCCDC, date unknown), 1.

communication and subsequently minimizes logistics response time (LRT). Further reductions are possible through assured data communications *without* direct human intervention to generate logistics requirements.

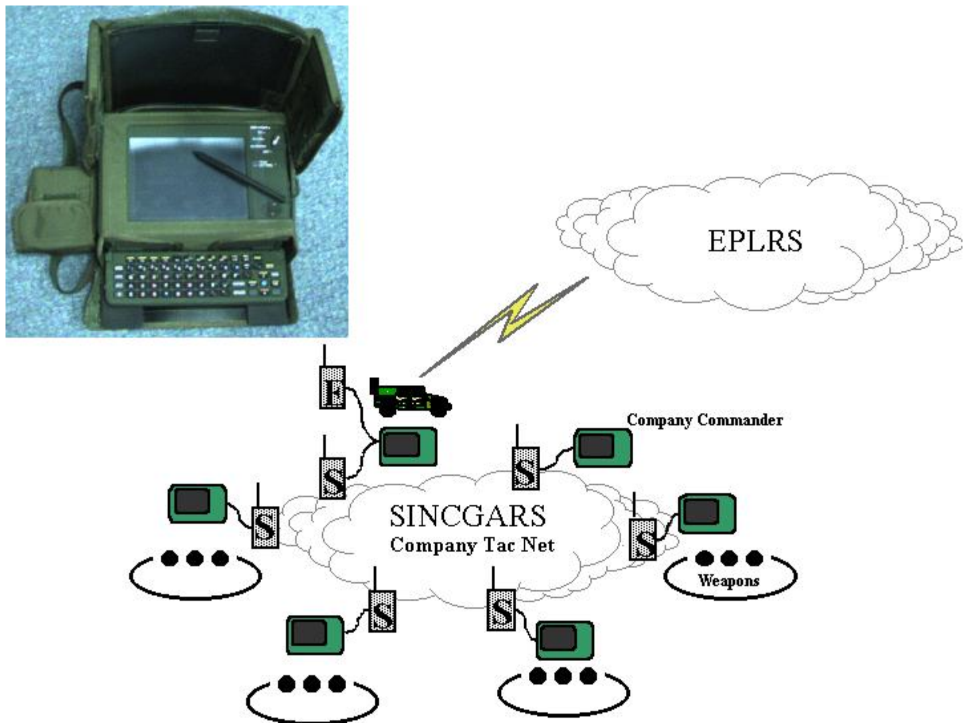

Figure 5. DACT, Company SINCGARS net and EPLRS gateway.[37]

Critical systems equipped with sensors can enable the remote monitoring of the system by mechanics or other logisticians to free the system's operator from pausing operations to inspect and report the status of the system. Weapon systems like the M1A2 tank currently have onboard automated systems for the remote monitoring of fuel and ammunition status. An onboard and embedded prognostics/diagnostics system for its turbine engine also predicts and reports the time nature of impending failures.[38] Other

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[37] Chart and DACT picture taken from DACT Overview presentation [unpublished] (Quantico, VA: DACT Project Office, MARCORSYSCOM, October 1999).

[38] *Turbine Engine Diagnostic Artificial Neural Network (TEDANN)*, Information Paper (Redstone Arsenal, AL: LOIA-LT, June 1998), 1-2.

combat vehicles currently in development attach to test connectors on system components for onboard diagnostics and interface directly into main information systems to transmit or enable remote monitoring of current vital statistics.[39] The ensuing time savings would collapse the repair cycle time (RCT) for critical systems by prompting action from the logistics system before failure. However, the value of any onboard technology to reduce LRT or RCT is dependent on its supporting communication architecture.

The Marine Corps recognizes the requirement for revolutionary improvement to provide high-capacity, on-the-move, over-the-horizon communications to fast moving and light but lethal combat units.[40] A draft architecture designed to support OMFTS by the year 2010 proposes the use of numerous low-power wireless local area networks (WLANs) tied together by a self-organizing backbone of Joint Tactical Radio Systems (see figure 6).[41] Such a capability would create a dynamic inter-network of systems for near-real time data communications across other connected autonomous systems (see figure 6). Although the proposed OMFTS communication architecture does not exist today, limited capability exists for passing information through digital systems ashore through EPLRS (enhanced position locating and reporting systems) and combat net radios (e.g., SINCGARS, single channel ground and airborne radio system).[42] This type

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[39] PEI Electronics, Inc., *Sidecar Brochure* (Huntsville AL: PEI Electronics, September 1999).

[40] LtCol M.E. Cantrell, USMC, *Overview of the Draft Marine Corps Operational Maneuver from the Sea Communications Architecture.* downloaded from http://archvision.quantico.usmc.mil, 17 November 1999 (Quantico, VA: MCCDC, October 1999), 1.

[41] Ibid.

[42] Erik J. Knutila, DACT presentation chart [unpublished] (Stafford, VA: Ocean Systems Engineering Corporation, October 1999.

of digital communications, although possible, is not network centric and over-the-horizon communication requires multiple cumbersome relays. However, once an OMFTS communications architecture is completed and operational in the fleet, the reciprocal benefits of network centrism will further enable logistics changes.

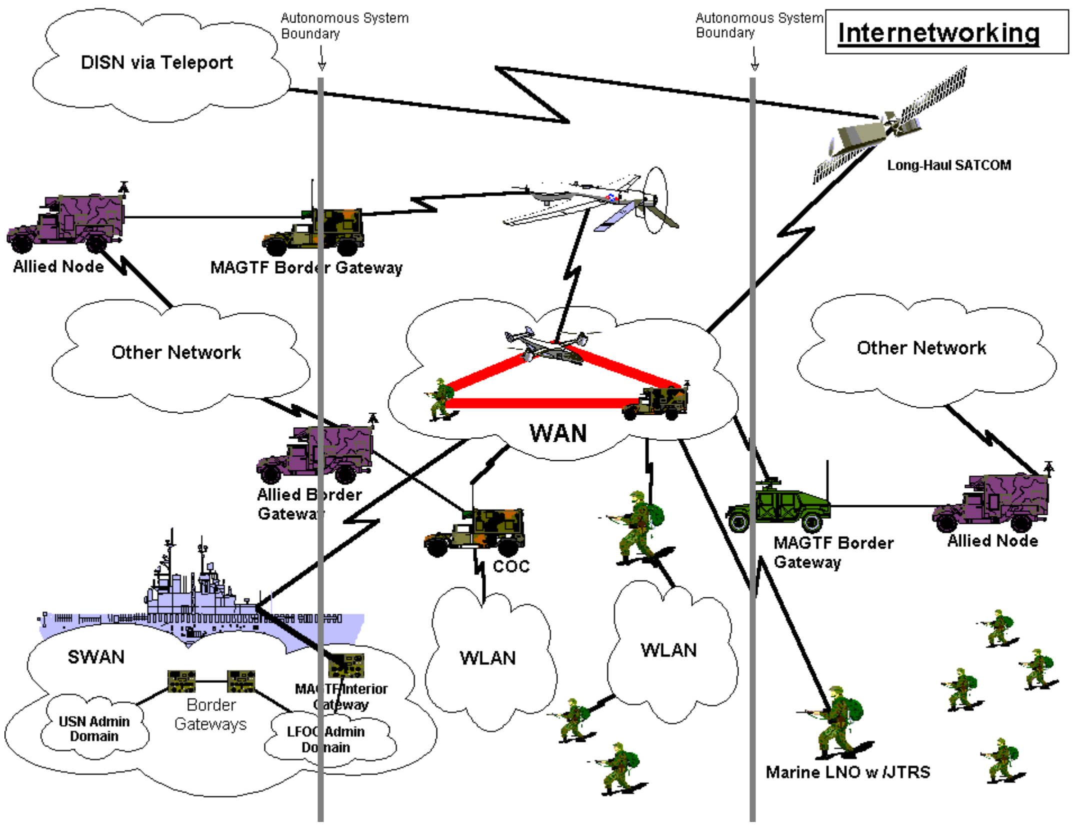

Figure 6. Draft OMFTS Architecture.[43]

Total Asset Visibility and Reduced Stores

Reductions in the overall quantity of supplies (i.e., ***mass***) seabased or ashore is a byproduct of networked information. Networked supply data through automated logistics systems can create a virtual warehouse of supplies with item storage locations aboard

[43] Cantrell, *Draft OMFTS Communications Architecture*, 18.

different ships, forward echeloned or en route in the distribution pipeline. Coupled with accurate, real-time supply status from end users, logisticians can gain a common logistics picture between supplies issued and supplies available for issue by type, quantity and store location to best influence material releases and logistics operations tasking. Excess supplies established to create a safety margin for inaccurate status and lack of supply visibility can be reduced, saving hull space and reducing management requirements. The Marine Corps' Asset Tracking Logistics and Supply System (ATLASS) Product Improvement Plan (PIP) will perform all of these functions and have a capability to maintain total asset visibility (TAV) of supplies on hand locally, dispersed throughout the seabase and en route in the logistics pipeline. Enabled through real-time and near-real time information inter-networked with ATLASS-PIP systems and external interfaces, ATLASS-PIP's functionality replaces six other automated logistics systems, contains decision support tools for the combat service support element (CSSE) and supports network centrism through its open architecture.[44]

The seabased CSSE not only leverages TAV information and external interfaces to support the MAGTF, it also links the tactical and strategic levels of logistics. Shared logistics information creates a new bi-directional data flow and asset visibility, joining together the strategic and tactical levels of logistics to compound the responsiveness of intermediate staging bases (ISBs), CONUS-based depots and even the nation's industrial base.

Other information-based systems important to TAV and enabling reduced stores are radio frequency automatic identification technology (RF-AIT) tags and radar response

[44] *Functional Requirements for the Asset Tracking Logistics and Supply System (ATLASS) Product Improvement Plan (PIP)* (Quantico, VA: Marine Corps Systems Command, November 1999), 1.

tags.[45] Supplies (or containers of supplies) tagged within the logistics pipeline can be queried through the use of higher TAV systems (i.e., ATLASS) and relay situation awareness information back to the requestor. This will facilitate predictability of incoming supply shipments and enable higher management of supplies outside the physical controls of logistics managers. The fusion of tag-based information among automated supply systems between services will provide universal access to logistics information through the Global Combat Support System (GCSS). The situational awareness generated between GCSS and its overarching Global Command and Control System (GCCS) will enable near-real-time logistics command and control, bringing the Navy and Marine Corps into full partnership with an integrated logistics capability.[46]

Command and Control of Logistics Operations

Using information to ensure effective logistics operations, however, involves much more than the simple management of supplies. The command and control of logistics operations ensures the efficient use of resources to provide effective time-critical support to maneuver forces and to avoid interruptions of combat operations. To meet these command and control needs, fused information from all warfighting functions creates a common relevant picture of the battlespace. In a network centric environment, this situational awareness provides key information to enable rapid decision making. The

[45] *Small Unit Logistics Command and Coordination Advanced Concept Technology Demonstration (SUL-ACTD) Implementation Directive* (Quantico, VA: MCCDC, facsimile dated 25 August 1999), 2.

[46] Naval Doctrinal Publication 4, *Naval Logistics* [Final Draft] (Washington, DC: Department of the Navy, September 1999), 46, 48.

benefit of such a system is that it also provides the capability (through its ***infostructure***) to react to dynamic situations and act on decisions to influence operations.[47]

A current Marine Corps Small Unit Logistics Advanced Concept Technology Demonstration (SUL ACTD) project addresses the specific *infostructure* requirements at the tactical and operational levels of logistics. The FY 00 "proof-of-concept" demonstration[48] intends to show the improved effectiveness and efficiency of integrated information systems to provide precision, s*peed* and agility to the logistics process.[49] Using existing and emerging logistics information systems, the SUL ACTD seeks to create a central data warehouse enabled by a network centric environment where data, created only once by independent information systems, can provide end-to-end visibility and enable rapid decision making.

As previously indicated through various research and analyses, command and control of logistics operations will make STOL viable in a SBL and OMFTS framework. Network centric warfare through the fusion of information across systems enables logistics responsiveness and flexibility during STOM. Making Joint Vision 2010 a reality, information fusion (combined with other technologies) provides logisticians the tools to respond rapidly to crises; deploy and sustain forces; track and shift units, equipment, and supplies even while en route, and deliver tailored logistics packages and

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[47] David S. Alberts and others, *Network Centric Warfare*, 90 and 92.

[48] MARCORSYSCOM, *Non-Acquisition Category (NON-ACAT) Program Definition Document (NAPDD) for Small Unit Logistics Advanced Concept Technology Demonstration (SUL ACTD)* [DRAFT] (Quantico, VA: MARCORSYSCOM, 27 May 1999), 2.

[49] MARCORSYSCOM, *Information Technology in Support of Logistics Command and Coordination* [001_logC2.ppt downloaded from http://iis/marcorsyscom.usmc.mil/actd/ on 10 February 2000] (Quantico, VA: MARCORSYSCOM, 24 November 1999), Slide 8.

sustainment directly to the war fighter.[50] Without command and control enabled through fused information, STOL would just provide for the speedy movement of the wrong supplies to the wrong location at the wrong time.

[50] Office of the Director of Logistics, *Focused Logistics: A Joint Logistics Roadmap* (Washington, DC: The Joint Chiefs of Staff, February 1999), i.

Section 4

Superimposing Information on the Operational Process of STOL

Establishing and Sustaining the Seabase

Seabased logistics is not a new concept for the Navy or Marine Corps. As early as 1964 with the Seaborne Mobile Logistics System, modern researchers explored various technologies and methods for providing seabased logistics.[51] Developmental commonalities of most systems include the necessity to enhance the physical capability for sustained logistics operations afloat. Authors of various studies and articles based on current (and planned) logistics sufficiency afloat, storage space, deck space, material handling equipment, and seaborne and airborne transportation claim that SBL limits the size of a supportable force to a MEU. They imply that a more responsive (and sufficient) logistics system is only possible through additional resources and significant enhancements in storage and distribution capabilities.

An ongoing study currently anticipates a 26-ship amphibious task force (ATF) carrying a MEB for OMFTS.[52] Its supporting Brigade Service Support Group (BSSG)

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[51] Byron F. Stebbins, *Sea-Based Logistics: Evolution of a Revolution*, Research Paper (Newport, R.I.: Naval War College, 14 June 1996), 18.

[52] MCCDC, *Ship to Objective Maneuver Concept of Employment (DRAFT 4)* (Quantico, VA: MCCDC, February 2000), 3-5.

will be organized aboard ship and in MCSSDs for support ashore with supplies dispersed throughout the ships of the ATF. With extensive storage provided through new ships like the LPD-17, increased numbers of helicopter spots and well decks, and advanced information technologies sharing logistics data, the combined ships of the ATF create a virtual dump of supplies and also serve as an advanced distribution center.[53]

Further enhancing the physical logistics capability of the ATF, an OMFTS force could also use ships of the maritime prepositioning force of the future (MPF(F)) for a variety of logistics roles. Designed for the capability to provide indefinite seabased sustainment, MPF(F) ships not only reinforce the overall logistics capability in the seabase but also add significant versatility for logistics operations.[54] When deployed and fully integrated with the ATF, MPF(F) ships create a combined virtual dump and distribution center and also have onboard container handling equipment and the ability for the selective offload of supplies, making these ships ideal for STOL.[55]

Logistics capability, however, is based on the requirements of the force it is intended to support. Additional ships with greater logistics capabilities only incrementally increase overall logistics capability in any amphibious objective area. To fully meet the requirements of a MEB-sized force in OMFTS over a sustained period, a seabased logistics system must be constructed not by an evolutionary application of additional and improved resources but by a revolutionary method of providing support. Constructing a requirements-based inventory of networked stores can make this possible. Replacing

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[53] Office of the Chief of Naval Operations, *Decisive Power from the Sea* (Washington, DC: Department of the Navy, October 1999), 52.

[54] MCCDC, "Maritime Prepositioned Force 2010 and Beyond," *United States Marine Corps Warfighting Concepts for the 21st Century*, (Quantico, VA: MCCDC, 1998), III-6.

[55] MCCDC, "MPF 2010 and Beyond," III-7.

inventories built on 15/30/60 days of supplies by commodity, small newer inventories dynamically supporting Marines afloat and ashore can be linked to a larger supply system with demand-oriented replenishment. Again, ***information*** and ***speed*** can replace ***mass***.

Ships from a combat logistics force (CLF) provide replenishment for carrier battle groups (CVBGs) and can also provide replenishment for ships of the ATF (with or without MPF(F) reinforcement)).[56] Underway replenishment (UNREP) from CLF ships could link the ATF to a sustained, requirements-based seaborne logistics pulse from a forward logistics base (FLB) or other operational or strategic infrastructure. Leveraging over-the-horizon and satellite communications, the CLF could respond to ATF requirements with timely and configured shipments. Ship design advances like an under-the-flight-deck overhang and gantry crane systems could enable UNREP without interrupting sustained STOL operations from ATF or MPF(F) ships.[57] Even more progressive concepts propose the use of a mobile offshore base (MOB) with an airstrip to land strategic airlift (C-17s) at sea to replenish a seabase.[58] Still, with any method of linking strategic sources of supply to operational logistics, near-real time and accurate logistics information from the ATF will exponentially save valuable replenishment time and cargo space. Without assured communications, the wastage of time and space through the increased mass of a push-oriented distribution system would gradually reduce the manageability of operational logistics and ensure its subsequent failure.

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[56] Max A. Wiley, *Demonstrating the Requirement for Amphibious Ready Group (ARG) Replenishment is Sea-Based Logistics Operations*, Thesis (Monterey, CA: Naval Postgraduate School, December 1997), 4.

[57] John Nance and others, *MAA for MPF Future Sea-Basing Concepts: Volume I, Final Summary Report* (Alexandria, VA: Center for Naval Analyses, June 1998) 87.

[58] Stebbins, *Sea-Based Logistics*, 13.

Logistics Preparation of the Battlespace

Fully as important as the intelligence preparation of the battlespace (IPB) and the tactical shaping of the battlespace normally conducted in a MAGTF campaign, planners can use LPB to assess and organize logistics capability within the framework of the amphibious objective area.[59] The planned use of available resources (supplies and distribution assets) and infrastructure to meet proposed requirements and maintain operational flexibility is key to LBP success.[60] To accomplish this, planners selecting STOL as a method of support must integrate logistics and STOM plans and also plan for a synergistic use of resources (where their interaction maximizes the effectiveness of their efforts). With a blend of current doctrine and innovative advances in information systems and other technologies, this integration and synergism are possible.

Accurate status reporting through integrated tactical, logistic and administrative systems can provide an aggregate force capability without cumbersome compilations of data. Using GCCS or other command and control systems, planners can manipulate pertinent near-real time data from networked sources through the application of filters with planning factors and other decision support tools. Knowledge of the logistics status of units, sufficiency and locations of stores, and availability of distribution assets can then enable rapid decisions made during the planning process regarding the organization of operational logistics assets.

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[59] Major General James A. Brabham, "Operational Logistics: Defining the Art of the Possible," *Marine Corps Gazette*, April 1994, 27.

[60] "Logistics preparation of the battlefield" is not a doctrinal term. Used in the broad context of this paper, it describes both the logistics assessment and organization to support proposed missions.

Planners then can tailor logistics capabilities to meet proposed mission requirements. These mission-based future requirements coupled with ongoing demand-based requirements from end users and along with other requirements derived from status reporting comprise the total requirements on the seabased logistics system. With visibility of the total requirements, logistics managers can effectively tailor the total logistics capability within the seabase by applying this ***information*** to shape the types and quantities of supplies (***mass***) available at locations within the seabase (or ashore) to minimize the logistics response time (LRT) to effectively support the end user (i.e., create ***speed***).

Existing tactical-level logistics doctrine (to meet OMFTS' new operational and tactical logistics requirements) provides the basic framework for tailoring supplies by purpose in different locations to: **landing force basic load supplies, prepositioned emergency supplies and remaining supplies**.[61] Tailoring supplies through logistics preparation of the battlespace meets the requirements of the concept of *Seabased Logistics* by using the "primacy of the sea"[62] without constraining supply operations to storage locations aboard some ships that transport supplies (among other things) which are best employed in other operations than seabased logistics (i.e., LHA or LHD). Also meeting an overall Marine Corps logistics objective to "have the right inventory at the

[61] MCCDC, Marine Corps Warfighting Publication (MCWP) 4-11, *Tactical-Level Logistics* [Final Draft] (Quantico, VA: MCCDC, June 1999), 5-1,5-2. Note: *Remaining supplies* are residual supplies left aboard ship and will not be specifically addressed as independent commodities because they are not peculiarly handled in LPB.

[62] MCCDC, "SBL," XI-4.

right place at the right time," tailoring supplies through effective LPB builds in responsiveness to STOL.[63]

Ensuring the landing force has its **basic load** of supplies is the first step in tailoring the seabase. Basic load, as operational plans dictate, may change between assigned missions for the landing force. Types and quantities of ammunition, vehicles, and basic sustainment stocks like water and rations cannot be standing operating procedures for assaults. Assuring a sufficient basic of load of required supplies will maximize the efficiency of air and surface transportation assets and also help before operations begin to tailor initial follow on supply configurations and set an expected time window for when replenishment is required. However, even with a mission-tailored basic load for landing forces, the undeniable elements of chaos and chance require the establishment of some sort of emergency resupply.

Prepositioned emergency supplies are also mission tailored (like basic loads) and are arrayed in **floating dumps** or **prestaged afloat or ashore** for immediate delivery to lessen the logistics response time (LRT) as much as possible.[64] Doctrinally, floating dumps are staged on landing craft during an amphibious assault for immediate delivery.[65] In STOM, floating dumps would apply the implied technique of shortening the distance between emergency supplies and their end user to increase responsiveness to immediate demands but not necessarily obligate landing craft as support platforms. To provide

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[63] Deputy Commandant of the Marine Corps for Installations and Logistics, *Logistics Campaign Plan* (Washington, DC: Headquarters Marine Corps, January 2000), 8.

[64] MCWP 4-11, *Tactical-Level Logistics*, 5-1.

[65] Ibid, 5-2.

illustration, a current vessel under development meets the needs of the Marine Corps for a floating dump in OMFTS.

A littoral expeditionary/modular reconfigurable support vessel (LX/MRSV) equipped with a trailer can provide close-in support to forces during STOM operations.[66] The developmental vessel with trailer (nicknamed SLICE) is capable of 30 knots with a full 50-ton load. As an intermediate seabased logistics vessel, the SLICE can operate in high sea states in deep or in littoral waters to serve as a floating dump for STOM forces. Supplies aboard SLICE vessels can be positioned and re-positioned quickly (using the sea as maneuver space), submerged for concealment or left remotely as caches to be serviced by tilt-rotor or other rotary-wing aircraft. The intermediate seabasing of SLICE vessels not only echelons stocks forward to areas closer to STOM forces than the seabase, it also provides additional landing points and deck space for loads of prestaged supplies.

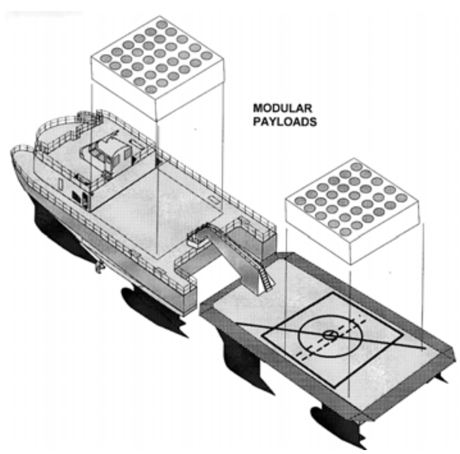

Figure 7. *SLICE*: Littoral expeditionary/modular reconfigurable support vessel (LX/MRSV).[67]

[66] White Paper, SLICE (Baltimore, MD: Lockheed Martin Launching Systems, sent to author from Jack Flanagan, 12 October 1999), 2.

[67] Ibid.

Prestaged supplies are planned and configured supply packages positioned usually afloat for immediate distribution. High-priority supplies prestaged on flight decks, barges or other surfaces for helicopter lift can be intended to replenish consumed emergency supplies on floating dumps or to make ready expected follow on supplies for STOM forces.[68] Tailored to meet mission-based requirements correlated with the capabilities of floating dumps, prestaged supplies extend the supply system forward and maximize the responsiveness of supply operations aboard ship.

Both forms of prepositioned emergency supplies (floating dumps and prestaged supplies) are designed to maximize the speed of a seabased supply system. The ***speed*** of a supply system, however, is not measured by incremental improvements to speed (e.g., prepositioning supplies closer to end users). From the identification of supply requirements to their satisfaction, sustained throughout operations, the end-to-end **s*peed*** of the supply system is more a product of the collective interaction of its processes (e.g., storage, distribution, etc.) guided through active management and command and control. Incremental benefits of fast distribution systems and methods to produce ***speed*** can be negated for the end-to-end supply system without their active management and command and control. For example, prepositioned emergency supplies, once left unaccounted on a landing point or derelict afloat are no longer part of a virtual seabased supply system and spent from viable management. Prestaged supply packages could not be identified or located to be reconfigured or moved. The contents of SLICE trailers once dispatched would become nondescript and any efforts to reposition or replenish them would add no

[68] MCWP 4-11, *Tactical-Level Logistics*, 5-2.

value to the supply effort. Efforts from prepositioning supplies to create ***speed*** would be forfeited by inefficiency and mismanagement wrought from an ***informational*** void.

An inter-networked seabased supply system, however, can manage all of these supplies by type, quantity and location to meet the changing requirements of STOM-type missions. With logistics information fused into a common operating picture (i.e., creating situational awareness), logistics merges into an aggregate set of operations at the seabase. Supplies aboard ships, SLICE vessels, barges and aircraft remain part of a virtual dump until distribution operations are completed. Stock management balancing requirements, missions, priorities and even supplies en route to the seabase enable logistics planners to tailor and organize the seabase for mission-specific, STOM-type operations in an OMFTS framework.

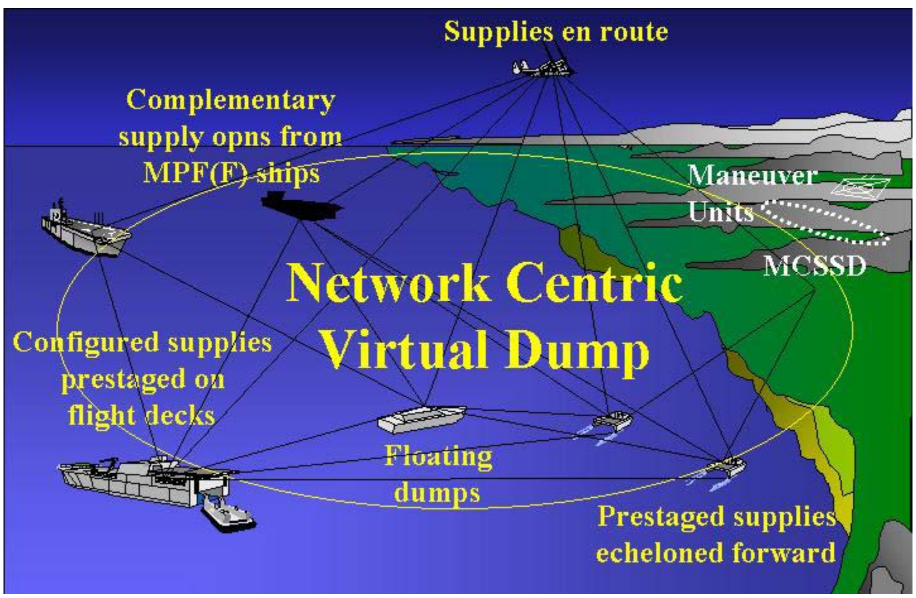

Figure 8. Seabased logistics organized to support STOM.[69]

[69] Figure created from original presentation chart from Precision Logistics Office, DCMC I&L.

Logisticians also conduct LPB beyond the seabase into operations ashore. The significant decision to conduct ship-to-objective logistics implies further decisions on the organization of seabased logistics capabilities and what, if any, MCSSDs will be landed ashore.

Some logistics assets must be employed with the maneuver force ashore, as a 1998 STOM War Game discovered.[70] The use of small MCSSDs to provide fuel and ammunition compensated for difficulties with resupplying from the seabase without constraining the operations of the maneuver element.[71] Another logistics function conceivably deployed ashore is a forward resuscitative surgery system (FRSS) or an aid station to provide emergency trauma care as close as possible to the point of injury for Marines. Enhanced forward health services and first responder capabilities are critical to offset potentially lengthy evacuation times and distances.

With planners attempting to meet requirements by providing the right logistics capability at the right place at the right time, they select locations for resources ashore, the security of their footprint and lines of communication. To support STOM-type forces dispersed within a nonlinear battlespace, planners may elect to position MCSSDs close to the units they support for added security. Highly mobile, the complete MCSSD must be capable of matching the tempo of the force it supports and also operate landing zones (LZs) and repair and replenishment points (RRPs) to sustain operational momentum.

Effective logistics preparation of the battlespace enables planners to organize logistics resources to best meet mission-based requirements. Having the right resources

[70] A B Technologies, *Sea Based Logistics Game Analysis Report*, 20.

[71] Ibid., 21.

configured at the right place in the battlespace enables speed from the onset of STOM operations. Logistics operators can then apply active management and effective command and control of logistics resources to generate end-to-end speed of the overall logistics system.

Operational Process

Starting the System with Requirements

Before and during operations, planners, operators and end users generate the requirements for STOM logistics. Through various inputs and planning factors, the supply system responds to aggregate requirements once filtered through command and logistics management channels (e.g., release authority of high-priority items can be held at various levels for prioritization or other reasons requiring human intervention). At the end-user level (company or battalion), requirements enter into the supply system as forecasts (i.e., expected requirements) or as direct requests on the supply system.

Forecasts from an end user are the difference between current status of supplies on hand and expected near-term quantity of needed supplies based on time or operations. End users can use DACT to directly input their supply status or allow a suite of sensors connected to the DACT to detect supply requirements. Based on thresholds, both preset and mission directed for on-hand quantities, DACT conveys supply data hierarchically to permit visibility through command and logistics channels. This organizational visibility permits satisfaction of some requirements through cross leveling between units, redistribution of internal supplies, reprioritization of supply capabilities and MCSSD interaction before entering the automated logistic system and being sent to the seabase.

Battalion and regimental staffs relay requirements beyond organizational and MCSSD capabilities to the seabase through ATLASS-PIP, conveyed through the OMFTS architecture (see figure 6).

End users can potentially make direct requests for supplies through either DACT or ATLASS-PIP. A direct supply request through DACT, possible through its C2PC software, can be also conveyed hierarchically. Once the request is approved through logistics channels and not able to be satisfied organizationally, logistics operators pass the DACT-generated request into the supply system through an ATLASS-PIP interface, creating a requisition.

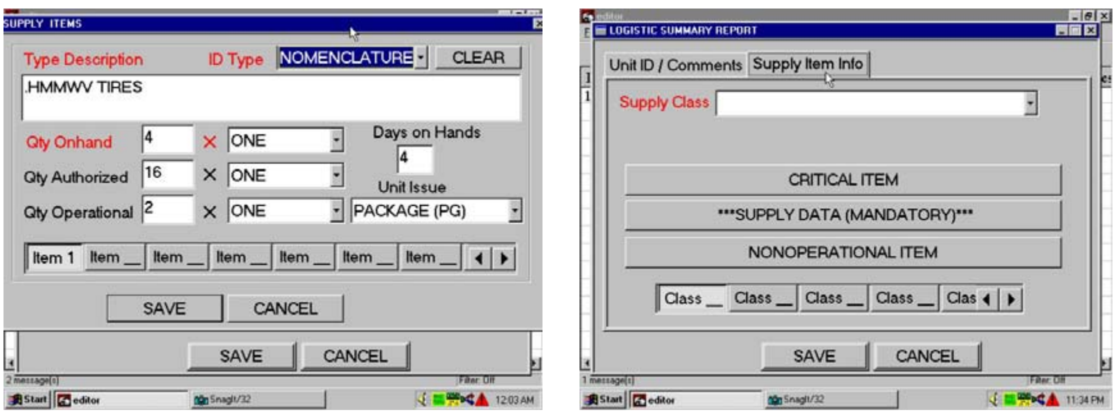

Figure 9. Example Logistics Report Through C2PC Software (DACT).[72]

Building the Package

Requisitions, from identified but unsatisfied requirements or on-hand deficiencies, create demands on the supply system. At the seabase, a centralized CSS operations center (CSSOC) receives all requisitions as well as other requests made through voice or data information systems. Through the application of a uniform prioritization system

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[72] DACT C2PC Screenshots (Oceanside, CA: Ocean Systems Engineering Corporation, emailed to author 7 January 2000).

(indicated on the request and approved hierarchically), CSSOC stratifies requisitions for further processing. This prioritization ensures the most-critical requisitions are satisfied first. For example, requisitions with “immediate” priorities are processed before all other priorities and delivered with the fastest distribution system available. “Urgent”-priority requisitions are later processed and assembled into a supply package for direct delivery by a fully-loaded distribution resource (to maximize lift) to the unit from the MCSSD or the seabase. “Routine”-priority requisitions are generally filled from the MCSSD on a schedule primarily to replenish logistics status report deficiencies in consumable supplies. Subsequently, the seabase replenishes the MCSSD in order to enable the MCSSD to carry one day of supplies (to meet consumable requirements) as a safety level.

Table 1. Example Requisition Priorities.

PRIORITY	INDICATES	REPLENISHED FROM	DISTRIBUTION MODE
IMMEDIATE	* Operational mission in progress fails without supplies	* Fasted supply source/distribution system combination	* Air-to-unit * Air-to-MCSSD (if tactical situation is restrictive)
URGENT	* Requesting unit cannot conduct planned operations without additional supplies (possibly ammunition, repair parts, etc.)	* Nearest supply source	* MCSSD ground * Air from seabase (fully-loaded aircraft packages only)
ROUTINE	* Sustained operational posture not possible without scheduled supplies (usually consumables like food, fuel, etc.)	* MCSSD (from seabase-to-MCSSD if not maintaining one day of requirements)	* MCSSD ground (scheduled once or twice daily)

Selecting Seabased Stocks and Distribution Mode

Once requisitions enter the seabased automated supply system, fused information populates other functional databases concerning the requesting unit's: ability to conduct its currently-assigned mission due to its supply status, short-term posture for additional operational missions and critical shortages affecting its readiness. Empowered with accurate knowledge of units' logistics status and mission-effecting priorities, the STOM-force's command element makes decisions based on current and near-term plans within the capabilities of its assigned forces and the dynamic tactical picture (through situational awareness). The CE, communicating to the TACLOG (the Tactical Logistical Group located in the Landing Force Operations Center (LFOC)), makes any necessary reprioritization of logistics efforts and allocates available distribution resources within the context of the overall operation (balancing tasking aircraft between logistics and other missions). Further coordinated through the CSSOC, these timely decisions are relayed through information systems to the CSSE facilitate logistics responsiveness.

CSSE logistics operators aboard ship select stocks, as required, and coordinate with MCSSDs and any end users for the planned logistics operation. Through the use of inter-networked ATLASS-PIP systems for asset visibility, CSSE operators select designated stocks in accordance with requisition priorities. They can then build supply packages within the operational prioritization parameters from the best available sources. Through selective offloading and configuration of supplies, combat cargo crew can use lighterage to consolidate packages between vessels and, as required, build and mark loads with radio frequency or radar tags (whichever is more practicable to meet the supply mission's need for situational awareness). The TACLOG then issues a logistics task order (LTO) to allocated distribution assets that includes operational instructions and locations for supply upload and delivery. RF/radar tag information of designated packages can direct distribution assets through onboard navigational systems to enable multiple upload and delivery locations through a common operating picture.

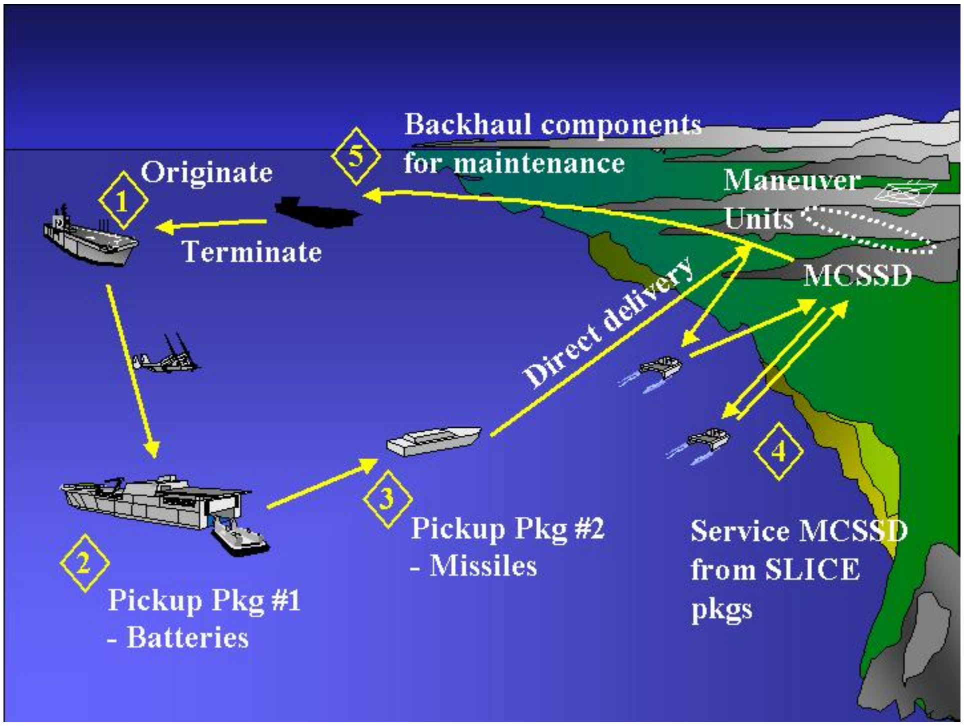

Figure 10. Example of Seabased Stock Selection and LTO Elements.[73]

Distributing the Supplies

Ship-to-objective logistics implies the direct delivery of supplies to end users, the combat forces conducting ship-to-objective maneuver. With seabased logistics, logisticians can use varied methods to distribute supplies in STOL:

- Delivered by tilt-rotor and rotary-wing aircraft from seabased sources (ATF or MPF ships or intermediate SLICE-type vessels and other floating dumps) to end users or MCSSDs.

[73] Figure created from original presentation chart from Precision Logistics Office, DCMC I&L.

- Delivered by aircraft or landing craft to intermediate locations ashore or landing zones operated by MCSSDs.
- Delivered by MCSSD ground transportation to end users from mobile stocks, intermediate locations ashore or landing zones.

Common required elements to all methods include the knowledge of the location and configuration of supplies, knowledge of the delivery location (and time, if requirements are time based or require time-definite delivery), and the ability to respond rapidly to changing requirements and battlefield situations. **Through the application of the seabased logistics formula, where *speed* and *information* combine to replace *mass*, logisticians generate the apparent responsiveness of the STOL system of systems.**

The essence of STOL, and seemingly the most difficult distribution method, is delivering supplies by aircraft from seabased sources to end users conducting STOM or to their supporting MCSSDs. Operational and tactical practicality as well as differing priorities may mitigate the effectiveness of this method into a more efficient combination of the last two distribution methods. Logisticians and operators, through maximization of the earlier parts in this system-of-systems process are able to combine distribution methods to responsively meet dynamic operational requirements.

Operational Scenario

The following scenario is an example of how a requirements-based supply system supporting STOM-type operations can leverage information to provide responsive STOL. This scenario is only one example and varied conditions and combat situations may require different techniques to be successful.

An AAAV company consolidates briefly after conducting an OTH landing into a littoral penetration point and refuels under the cover of darkness via assault hoselines connected to SLICE fuel trailers for continued operations. With all systems and Marines accounted for, the warning lights on two AAAV's commanders' panels indicate the stress of the amphibious operation degraded the engine torque by 30 percent and the engines on both AAAVs will fail within the next 24-28 hours of operation. After receiving the information through remote monitoring of the warning lights, the company executive officer and maintenance team initiate the requirement for a delivery of two engines within twelve hours to the MCSSD and inform the company commander of the expected loss of combat power. The battalion S-4 automatically receives the requirement, approves the priority of "urgent", and forwards a requisition for two engines through ATLASS. An instant status back to the S-4 and AAAV company trains indicates that only one engine is on hand at the MCSSD but another is aboard an MPF(F) ship. Weighing the importance of the current mission to advance inland 100 km before dawn, the AAAV company commander decides to plan for the replacement of both engines after the advance. The executive officer arranges through the S-4 for delivery and replacement of both engines with the next evening's scheduled logistics package.

The battalion S-4 assembles requirements for the logistics package. Through DACT logistics reports and other requisitions, the S-4 determines the composition of the scheduled package, confers with the S-3 for an expected location of the AAAV company, and forwards all requisitions (food, fuel and ammunition) to the BSSG (CSSE) aboard ship. With the engine aboard ship already identified for delivery, CSSOC prepares the AAAV company's logistics package, which includes the engine satisfying its prioritization *requirement of "urgent". The BSSG consolidates the completed package onto three ships and designates them as air requirements due to its tentative delivery location, 100 km inland. The CSSOC then forwards all information requirements through DACT (or some other digitized system) to the MEB's TACLOG in the LFOC for action.*

Table 2. CSSOC Information Elements Forwarded to TACLOG.

Package ID:	RF-C2/5
Description:	Log Pack 000607-1
Req Delivery Loc:	11R00144597
Req Delivery Time:	072000JUN ZULU
Supported Unit	C Co, 2/5
Supply Loc #1	*Nashville*, PKG ID: C2/5-1 - 432-01-7654, Oil, 30W, 2QT: 6 cans - 396-01-6994, Turboshaft, 1QT: 20 cans - 483-01-4567, 7.26mm, 4X1: 2 cases
Supply Loc #2	*Tortuga*, PKG ID: C2/5-2 - 987-01-2345, MRE: 5 cases - 123-01-1234, Water filters: 6 each
Supply Loc #3	*Sustainable*, PKG ID: C2/5-3 - 999-02-9999, Engine (FUPP), AAAV: 1 ea
Additional Inst	LZ PULLER marked with IR lighted Y Backhaul one INOP AAAV engine FUPP to *Sustainable*

Responding to all requirements in priority, the TACLOG works with the tactical air control center to manage the tasking of aircraft for logistics missions. The TACLOG, through the TACC/HDC, assigns aircraft to support the evening's logistics packages from the day's air tasking order (ATO) to satisfy the MEB's requirements. Creating logistics tasking orders (LTO) through the pairing of aircraft resources and logistics requirements, the TACLOG quickly assigns LTOs to aircraft and obtains mission approval from the G-3 and the direct air support center (DASC) for routing. Approved automatically with minor modifications to assign air corridors away from reported enemy SAM launchers, the TACLOG transmits the LTO to support C Company's logistics package to its assigned supporting aircraft.

Table 3. TACLOG Modified Data Elements in the LTO to Aircraft.

LTO #	000607-1-007
Delivery Time	072000JUN ZULU
Delivery Loc	LZ PULLER, 11R00144597
Supported Unit	C Co, 2/5
Route	*Blue-Brown-Tan-Green*
C2/5-1 Loc Wt/Cu Load	*RF designated* Nashville 400/23 Internal
Supply Loc #2 Loc Wt/Cu Load	RF designated *Tortuga*, PKG ID: C2/5-2 230/12 Internal
Supply Loc #3 Loc Wt/Cu Load	RF designated *Sustainable*, PKG ID: C2/5-3 5025/60 External, 10k sling
Additional Inst	LZ marked with IR lighted Y Backhaul one INOP AAAV engine FUPP to *Sustainable*

MV-22 007 receives the LTO while refueling on a SLICE trailer 15 minutes before its scheduled tasking availability window opens. The pilot, disappointed he will not get back aboard ship for hot chow that evening, acknowledges receipt of the LTO and pushes a button to load the order's navigational data into the aircraft's mission bank. Receiving the acknowledgment, the TACLOG forwards the mission data back through CSSOC and downward through the regiment to C Company and, as MV-22 007 lifts off the SLICE trailer, LTO 000607-1-007 is brought into air/ground/logistics systems for situation awareness.

Setting off for the first navigational carrot on its HUD, the pilot of MV-22 007 is guided toward the Nashville for package C2/5-1. With waypoints changing automatically after confirmed RF-tag receipt of packages, 007 eventually turns toward shore with a full load for its journey inland toward C Company.

In flight, the DASC amends the LTO for MV-22 007. One AAAV requiring its slung engine was destroyed by a land mine. The engine en route to LZ PULLER must now go to the MCSSD at LZ GEIGER as replenishment stocks. Again, pushing a button to load the changed navigational data, the pilot redirects the aircraft to LZ GEIGER. The pilot then queues to his next waypoint once on the LZ, simultaneously confirms delivery and deactivates the engine container's RF-tag identifying it to the LTO. Since receipt of the engine into the MCSSD stocks still retains it within the management of the BSSG, receipt confirmation back to the seabased manager through ATLASS merely changes the location of the engine within the virtual dump of supplies. The engine remains a visible asset within the inter-networked supply system of the seabase.

On approach to LZ PULLER, helicopter support teams assume terminal control of MV-22 007 to direct it onto a tactically-safer area five kilometers from its planned LZ. With the quick transfer of supplies and RF-tag deactivation, LTO-000607-1-007 terminates within the situation awareness displays, the supply transaction complete, and remains simply as an aircraft tract en route to the Sustainable to deliver an AAAV engine for repair. C Company then joins the air-delivered supplies with ground elements from the MCSSD for the food, fuel and other ammunition to complete their logistics package.

Linked from supply source to operational controller to end user, information enables the delivery of the right supplies at the right place at the right time. From the combat service support element to command and ground combat elements, each node in the STOL process benefits from fused information to increase operational responsiveness. Without accurate and timely information at each node, LTO-000607-1-007 could have been slowed to confused inaction between processes, or, continued haplessly on a bogus mission. The result would have been a lack of speed of the STOL system-of-systems with the degeneration of supply and distribution management. To compensate for slowness or mismanagement, well-meaning logistics operators and commanders may frantically order the movement of stocks to offset failed distribution. The void of information through the product of the systems within STOL would be a *perceived shortage of distribution assets* (because they are mal-tasked and misdirected) and a *shortage of supplies* (because they are not managed beyond the deck of the ship). Continued addition of distribution assets and supplies without the revolutionary application of information to create a STOL system of systems would serve only to compound operational failure.

So what happens when STOL breaks down? In war, if even the simplest systems are difficult to keep operational[74], how can STOM succeed if it is dependent on a complex system-of-systems like STOL? Both are good questions and should not be disregarded by optimistic *futurespeak* and charmed by technological possibilities. The only tough answer is to plan for chance and chaos to adversely affect STOL and to build in "graceful degradation"[75] to mitigate the risk of its total operational failure.

Mitigating Risk When STOL Breaks Down

As with any military operation, STOL is vulnerable to chance, chaos and other factors that could cause its failure. Enemy interdiction could diminish any of the logistics

[74] Paraphrased from Clausewitz, *On War*: "In war, even the simplest things are difficult."

[75] "Graceful degradation" is a non-doctrinal and popular term used by developers of technology. This concept reinforces and builds reliability into the most important functions of systems and leaves secondary or nice-to-have systems to fail first. The graceful degradation of a rifle's fire control system, for example, would ensure the rifleman could still aim through the rifle's scope or iron sights to fire the weapon although its a laser designator or thermal imaging device failed to operate.

capabilities of the CSSE and the seabase. Information systems could be rendered useless through electro-magnetic pulses and satellites providing communications relays and positional information could be disabled. All of these actions would cause a breakdown in the ability to sustain STOL, STOM or any operation for that matter.

As a system-of-systems, STOL is inherently not in danger of catastrophic failure if one or two of its elements fail. Graceful degradation, albeit unfavorable, is built in through the collection and interaction of processes and systems (see figure 4). If the information driving STOL cannot be inter-networked or fused, STOL becomes less efficient in its use of information and resources but its functional information systems can still operate and provide some measures of effectiveness (e.g. ATLASS-PIP processing continues if only portions of the wireless LANs connect to convey STOL-related information). If functional information systems totally fail; training, planning, logistics preparation of the battlespace and improved physical systems (e.g., improved material handling equipment aboard ship, or, the unprecedented speed and versatility of the MV-22 Osprey) can combine for operations to persevere through the uncertainty and chaos of war. Given the brutal and destructive aspects of its environment, however, it would be irresponsibly naïve to not expect the nature of war to cause operational impacts.

Degradation of capability during operations requires common-sense adjustments. Less aircraft available for delivery of supplies could cause the amphibious objective area to shrink into ground-supportable dimensions. Additional logistics forces could be landed ashore to establish a more centralized and controllable support system without the benefits of fused information in a network centric environment. Also, even superiorly-fused plans and autonomic operations require contingencies to minimize their critical vulnerabilities. In the end, there is no informational or technological substitute for the training, leadership and reaction of human forces within processes and systems. STOL, STOM and OMFTS survive and thrive within the capabilities of sailors and marines.

Seabased logistics as a *mode* and ship-to-objective logistics as a *method* are options available through the concept of OMFTS. They are not planned constraints designed to jeopardize supportability and imperil operations.[76] They provide capabilities for commanders to best decide from a broad range of plans how to employ available forces and win battles. Given the situation, SBL and STOL may simply not be viable but to plan without the options their capabilities provide limits operational possibilities. However, in situations where only SBL and STOL can enable STOM-type operations, a system-of-systems enabled through the application of information operated within the extent of human capabilities of sailors and marines can make new challenging warfare possible.

[76] A B Technologies, *Sea Based Logistics Game Analysis Report*, 22.

Section 5

Implementing OMFTS and STOL

"The fact that the future is uncertain is no excuse for failing to make adequate preparations." -- Operational Maneuver from the Sea.[77]

The central vision of OMFTS provides conceptual focus but must be further developed and resourced to be realized in the fleet. As a critical step in this process for STOL, the recently published Deputy Commandant of the Marine Corps for Installations & Logistics (DCMC I&L) *Logistics Campaign Plan* provides goals and direction for Marine logistics in the form of a six-year plan to realize expeditionary seabased logistics in support of OMFTS.[78] By 2006, the system-of-systems represented through STOL may not be in place in the fleet but the DCMC I&L is prepared to match the developing concepts of OMFTS and STOM with logistics capability. Some of his objectives, as related to this paper include:

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[77] MCCDC, "OMFTS," I-9.

[78] DCMC I&L, *Log Campaign Plan*, 2.

Table 4. Logistics Campaign Plan Objectives and STOL Correlation.[79]

Logistics Campaign Plan Objectives (Partial list, paraphrased)	**STOL Correlation**
Developing and implementing methodologies to anticipate and predict logistics requirements to reduce repair cycle times and increase equipment readiness.	***Near-Real Time and Predictive Requirements***
Developing and fielding an "Autonomic Logistics" capability that monitors and transmits critical weapon and support system information, to include essential location, diagnostics, and prognostic data, from the battlefield to remote monitoring stations.	
Fielding computer-assisted logistics decision support tools and reviewing and refining methodologies and tools for logistics planning.	***Logistics Preparation of the Battlespace***
Reducing logistical footprint by having the right inventory at the right place at the right time.	***Establishing and Sustaining the Seabase***
Developing technological capabilities to achieve total asset visibility of materiel within storage and distribution processes.	***Total Asset Visibility and Reduced Stores***
Participating in the development of an effective, responsive, and seamless distribution system extending from source of supply via CINCTRANSCOM strategic lift, through the CINC's theater distribution system, to forward deployed MAGTFs.	***Operational Process (all aspects)***
Developing and fielding a common operating picture and logistics command and control capability, which provides both the logistician and warfighter with the logistics picture he needs.	***Command and Control of Logistics Operations***

Closely correlated to STOL, the *Logistics Campaign Plan* provides the direction to build the systems and processes that comprise the system-of-systems represented through STOL. Once realized, the benefit of the successful campaign will be not just the satisfaction of its individual objectives, but the satisfaction of an objective greater than the sum of its parts, a true system of systems.

As the Marine Corps continues to develop concepts like OMFTS and STOM, supporting agencies like the Office of Navy Research's Future Naval Capability for

[79] Ibid., 6-9.

Expeditionary Logistics identifies enabling technologies to bring future concepts closer to the fleet. Advanced Concept and Technology Demonstrations (ACTDs) for Small Unit Logistics (Logistics Command and Coordination) and Extending the Littoral Battlespace functionally apply technologies into parts of concepts to demonstrate feasibility and practicality. Further modeling and simulation by the Center for Naval Analyses and war games sponsored by the Marine Corps Combat Development Command expand the applicability of concepts and technologies into the overarching realm of warfighting to holistically consider their future effects. Finally, the Marine Corps Warfighting Lab and Special Purpose MAGTF (Experimental) develop and execute experimentation in a live environment. All following the central vision of OMFTS and its supporting concepts, these agencies are actively pursing technologies and systems that can enable STOL. Some systems are already well into the fielding process while others are still in concept exploration.

Continuing a decentralized journey toward realizing STOL, these supporting agencies must maintain the central OMFTS vision guided by Headquarters Marine Corps-level documents like the *Logistics Campaign Plan*. The Marine Corps can then focus its resources for broad results while instilling a common vision for the future of the Marine Corps. Guided by the vision, technologies and systems will co-evolve and departments and programs will benefit from shared lessons and resources. Eventually, over time, all will mature and coalesce into a fully-realized system-of-systems and the Marine Corps will have the capability of STOL.

As Gen Krulak advised at the onset of his *Sea Dragon* initiative, the Marine Corps must embrace change to meet the demands of the 21st Century.[80] Without embracing innovation and pursuing a campaign toward a central vision, the Marine Corps of the near future would be bound to fighting with old but proven technologies and systems. Without comparable ventures like *Sea Dragon* throughout history, technological capabilities like the machinegun and new methods like amphibious assaults would have remained unproven and the dragon of change would have eventually prevailed against the force hesitant to innovate.

[80] Krulak, "Embracing Innovation", End.

List of Acronyms

AAAV	Advanced Amphibious Assault Vehicle
ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ARG	Amphibious Ready Group
ATF	Amphibious Task Force
ATLASS-PIP	Asset Tracking Logistics and Supply System – Product Improvement Plan
ATO	Air Tasking Order
BSSG	Brigade Service Support Group
C2PC	Command and Control Personal Computer
CE	Command Element
CINC	Commander-in-Chief
CINCUSTRANSCOM	Commander-in-Chief, U.S. Transportation Command
CLF	Combat Logistics Force
CONUS	Continental United States
CSS	Combat Service Support
CSSE	Combat Service Support Element
CSSOC	Combat Service Support Operations Center
CVBG	Carrier Battle Group
DACT	Data Automated Communication Terminal
DASC	Direct Air Support Center
DCMC I&L	Deputy Commandant of the Marine Corps for Installations and Logistics
EPLRS	Enhanced Position Locating and Reporting System
FRSS	Forward Resuscitative Surgery System
FUPP	Full-Up Power Pack
GCCS	Global Command and Control System
GCE	Ground Combat Element
GCSS	Global Combat Service Support System
HUD	Heads-Up Display
IPB	Intelligence Preparation of the Battlespace
ISB	Intermediate Staging Base
JTRS	Joint Tactical Radio System
LF	Landing Force
LFOC	Landing Force Operations Center
LHA	General Purpose Amphibious Assault Ship
LHD	Multipurpose Amphibious Assault Ship
LPB	Logistics Preparation of the Battlespace

LRT	Logistics Response Time
LTO	Logistics Tasking Order
LX/MRSV	Littoral Expeditionary/Modular Reconfigurable Support Vessel
LZ	Landing Zone
MAGTF	Marine Air-Ground Task Force
MARCORSYSCOM	Marine Corps Systems Command
MCCDC	Marine Corps Combat Development Command
MCSSD	Mobile Combat Service Support Detachment
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MOB	Mobile Offshore Base
MPF(F)	Maritime Prepositioning Force (Future)
OME	Operational Maneuver Element
OMFTS	Operational Maneuver From The Sea
OTH	Over The Horizon
RCT	Repair Cycle Time
RF-AIT	Radio Frequency – Automatic Identification Technology
RRP	Repair and Replenishment Point
SBL	Seabased Logistics
SINCGARS	Single Channel Ground and Airborne Radio System
STOL	Ship-To-Objective Logistics
STOM	Ship-To-Objective Maneuver
SUL	Small Unit Logistics
TACC/HDC	Tactical Air Command Center / Helicopter Direction Center
TACLOG	Tactical Logistical Group
TAV	Total Asset Visibility
UNREP	Underway Replenishment
WLAN	Wireless Local Area Network

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