Naval Aviation Enterprise Sustainment Vision 2020 (NAE SV2020)

Final Report

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Acronyms and Abbreviations

Term	Definition
AC3	Albion College Community Collaborative
ACTS	Aircraft Component Tracking System
AIPS	Artificial Intelligence Prognostic Steering Tool
ALE	Aviation Logistics Environment
ASI	Andromeda Systems Inc.
ASM	Advanced Skills Management
CBM+	Condition-Based Maintenance Plus
COMFRC	Commander Fleet Readiness Centers
COTS	Commercial Off-the-Shelf
CTMA	Commercial Technologies for Maintenance Activities
DLA	Defense Logistics Agency
DOD	Department of Defense
EAB	Expeditionary Advanced Base
EABO	Expeditionary Advanced Base Operations
GMM	Global Maintenance Management
I-Level	Intermediate Level
IT	Information Technology
ISAM	Integrated Supportability Analysis Methodology
ISSC	Integrated Support Service Center
JEDI-X	Joint Enterprise Data Interoperability
JIT	Just-inTime
LCM	Lifecycle Management
LIO	Logistics Innovation Office
LOCE	Littoral Operations in Contested Environment
LOGFAS	Logistics Functional Area Service
MHE	Material Handling Equipment
MILCON	Military Construction
MNLogCOP	Multi-National Logistics Common Operating Picture
MPEP	Multi-Purpose Expeditionary Platform
MRI	Michigan Research Institute
MTA	Maintenance Task Analysis
MxE2E	End-to-End Maintenance
NAE	Naval Aviation Enterprise
NASC	Naval Aviation Support Center
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NCMS	National Center for Manufacturing Sciences
ODASD-MR	Office of the Deputy Assistant Secretary of Defense, Materiel Readiness
RCM	Reliability Centered Maintenance
SCM	Supply Chain Management

SME	Subject Matter Expert
SOW	Statement of Work
STEED	Silent Tactical Energy Enhanced Dismount
SV2020	Sustainment Vision 2020
UDOP	User Defined Operating Picture
U.S.	United States
UTV	Utility Task Vehicle
WCF	Working Capital Fund

1. Executive Summary

Funding was secured for the collaborative initiative through the National Center for Manufacturing Sciences (NCMS) Commercial Technologies for Maintenance Activities (CTMA) Program and the Office of the Deputy Assistant Secretary of Defense, Materiel Readiness (ODASD-MR).

1.1 Results

In this multi-faceted project, the team developed a series of solutions to challenging logistics issues consistent with Sustainment Vision 2020 (SV2020). These included an agile comprehensive Naval Aviation sustainment environment; a study of available Commercial Off-the-Shelf (COTS) Supply Chain Management (SCM) tools; a Multi-National Logistics Common Operating Picture (MNLogCOP); and an evaluation of equipment that can provide sustainment support to Expeditionary Advanced Base Operations (EABO).

Reports defining the way forward to support the key Naval Aviation Enterprise (NAE) functional areas and tasks were delivered to the government. Specific subject areas included:

- Capability and Capacity Planning
- Global Maintenance Management
- Supply Support
- Workforce Proficiency
- Logistics and Engineering

During the project, the NAE Sustainment Environment team implemented capabilities to improve readiness and visibility, including:

- Expanded the foundation to capture repair and maintenance capability planning
- Established the Naval Aviation Support Center (NASC)
- Developed tools to integrate supportability data into a common view across supply and maintenance
- Defined and implemented standardization of training and certification requirements to enable maintainers at non-depot locations to perform typically depot level repair actions
- Defined, developed, and demonstrated tools to capture, aggregate, and optimize maintenance planning and scheduling

The SCM tool assessment team evaluated 95 of the leading commercial SCM tools currently available to determine their applicability in the Department of Defense (DOD) expeditionary environment. Multiple screenings narrowed the field to four contenders as well as two "Honorable Mentions" that contained specific capabilities believed to be potentially useful. In the final analysis, none of the commercial tools were deemed a complete, comprehensive solution.

The EABO concept is a departure from recent operational concepts. For this reason, equipment required to support it will necessarily be very different from that which has been employed recently. In coordination with the United States (U.S.) Marine Corps Logistics Innovation Office (LIO) the project team evaluated a suite of light but capable Material Handling Equipment (MHE) to assess suitability for the EABO effort.

Current major military operations are nearly always conducted with either joint or international partners or both. This has been true since America's founding as a nation. During the Revolution, the French Army and Navy fought by America's side and helped secure the victory at Yorktown. In the modern "high tech" world, data management is a powerful tool. Successful joint operations must share data

seamlessly. Data interoperability across systems is essential to collaboration and coordination between partners. The data interoperability team adapted their existing Logistics Common Operating Picture and successfully tested/ validated it in several joint U.S./North Atlantic Treaty Organization (NATO) exercises.

1.2 Benefits

The result of this project will enable the NAE and the Navy/Marine Corps EABO team to realize the multiple benefits of the SV2020 strategy. These forward leaning concepts will realize the long-sought benefits of Condition-Based Maintenance Plus (CBM+) which include improved availability, reliability, total ownership cost, and mean down between failure. The capabilities developed in this project facilitate improved readiness and agile response to changing requirements. Specific capabilities include:

- Increased real-time visibility of readiness and support services
- Identification of capability, capacity, and personnel to execute maintenance actions to ensure sustained readiness levels
- Visualization tools to enhance tactical strategic decision making
- Data aggregation from disparate sources to harmonize traditionally stove-piped communities of supply and maintenance

Although this project focused on military applications, the benefits apply across the aviation and logistics enterprise, whether commercial or military. The joint expeditionary logistics achievements have great value for industry. These included SCM tools evaluation; data interoperability; unique MHE; remote power storage, and an autonomous drone guidance system.

1.3 Recommendations

- Pursue the NAE SV2020 effort. Incorporate the lessons learned into standard aviation maintenance practices
- Continue and expand the EABO logistics work to include:
  - Examination of autonomous ship to shore connectors
  - Alternate fuels and power sources
  - Expeditionary additive manufacturing for parts replacement and expedient construction
- Implement a comprehensive SCM study to reimagine a single end-to-end application that would inform expeditionary logistics support to EABO using predicative analysis and a digital twin
- Fully adopt the Joint Enterprise Data Interoperability (JEDI-X) data interoperability solution to improve logistics support in joint and international operations

1.4 Invention Disclosure

Invention Disclosure Report(s):

DD882 Sent to NCMS ☐
No Inventions (Negative Report) ☒

1.5 Project Partners

- Naval Aviation Enterprise (NAE)
- Naval Air Systems Command (NAVAIR)
- F-35 Joint Program Office
- Naval Supply Weapon System Support
- Defense Logistics Agency (DLA)
- U.S. Marine Corps Logistics Innovation Office (LIO)
- Michigan Research Institute (MRI)

- Andromeda Systems Inc. (ASI)
- Nexus Lifecycle Management (LCM)
- Troika Solutions, LLC
- National Center for Manufacturing Sciences (NCMS)

2. Introduction

2.1 Background

SV2020 Strategy

The NAE developed the SV2020 strategy in 2014[1] to facilitate improved readiness throughout the enterprise. SV2020 breaks down barriers across the many specific business processes and information technology (IT) systems that have evolved over time. The improved interoperability of systems and processes allows for efficient use of resources, and improved maintenance and sustainment decisions. SV2020 fosters the use of commercially available IT applications, systems, and best practices where it is suitable and integrates them with specialized IT systems and processes where military-unique circumstances dictate bespoke solutions. The overall theme of SV2020 is "Readiness Recovery." In 2018, the director of SV2020, Rich Bomhold said "SV2020 takes on readiness recovery through a holistic, enterprise-level approach."[2] This approach creates an agile globally managed logistics environment in support of rapidly changing requirements. A major focus of SV2020 is to enable smart data-driven decision-making to improve readiness in an unpredictable and fluid environment.

The ability to collect, analyze, and interpret data is central to the SV2020 strategy. The knowledge derived from that data facilitates efforts to track maintenance, transportation, supply, human resources, and scheduling to synchronize progress across the enterprise. Such enterprise-wide integration of information is often lacking in large organizations creating friction and inefficiency that hinder operational success and increase cost.

EABO

America's influence in the world is dependent upon the ability to freely conduct trade and assure that all nations have access to international trade routes. According to the United Nations, 80 percent of world trade by volume and 70 percent by value is transported by sea.[3] Over 20 percent of world trade transits the South China Sea.[4]

Emerging threats in the IndoPacom area have caused the Navy and Marine Corps to explore strategies to counter potential aggression in international waters and littorals of the western Pacific Ocean. New concepts such as Littoral Operations in Contested Environments (LOCE)[5] and EABO[6] will require new sustainment paradigms.

The Marine Corps LIO is examining the techniques, methods and unique equipment that will be required to sustain Expeditionary Advanced Bases (EAB). This project joined that effort identifying and evaluating appropriate support equipment.

Supply Chain

Recent world events have revealed the fragility of many supply chains. Reliance on "Just-In-Time" (JIT) logistics by many has exacerbated the problem. JIT is susceptible to both supply and demand shocks that have ripple effects throughout the supply chain[7]. This effort investigated COTS SCM software applications.

Data Interoperability

Data interoperability is necessary to conduct joint operations with multiple services or allied partners. This enables central management of multiple logistics systems, each "speaking" its own "language." This project produced an

[1] (Naval Air Systems Command, 2018)
[2] IBID
[3] (United Nations Conference on Trade and Development, 2018)
[4] (Australian Economic Policy Institute, 2020)
[5] (US Marine Corps, 2017)
[6] (Marine Corps Warfighting Lab, 2018)
[7] (Investopedia, 2022)

MNLogCOP that shared logistics data between U.S. and NATO forces and presented that information in a usable form to decision makers at all levels.

2.2 Purpose

The goal of this project was to leverage the SV2020 strategy to integrate and align ongoing initiatives with new solutions to ensure the Navy and Marine Corps can achieve rational readiness and sustainment in complex operations. The improved interoperability of systems and processes enhances resources and improves maintenance and sustainment decisions for the DOD, U.S. allies, and industry partners. Focus areas were Naval Aviation business activities, EABO logistics support, SCM, and joint operational data sharing.

2.3 Scope/Approach

This wide ranging and complex effort followed separate paths to address distinct but related sustainment issues tied to the SV2020 strategy. The first addressed maintenance and sustainment issues in the NAE. The second explored logistics technology requirements and solutions to sustain small, mobile, austere EABs in a contested environment. The team also examined COTS SCM tools and produced a report analyzing those most suitable to expeditionary operations in remote locations. Finally, the MNLogCOP was developed and demonstrated with NATO forces to provide interoperable logistics data visibility to all allied participants in an international operation.

Tasks and deliverables for this project were provided by multiple industry partners under the direction of MRI. MRI worked closely with program managers in NAVAIR, U.S. Marine Corps C4 and the LIO to capture needs, define working relationships and identify and track project deliverables. MRI also coordinated the efforts of Subject Matter Expert (SME) providers – Troika Solutions, Andromeda Systems Inc. (ASI) and Nexus LCM in performing the required tasks, progress reports, financial management and delivery of prototypes. Additionally, MRI continuously monitored applicable commercial and university technology advancements that could be inserted throughout the project development cycle.

For the NAE Maintenance and Sustainment segment of the project, ASI provided SMEs to develop the software tools, policies, training regiments and materials that were implemented at the depot level. Troika Solutions was responsible for data capture of program outcomes as well as coordinating information from other relevant DOD data systems and programs. Troika Solution's interim report is included in Appendix F. Nexus LCM worked closely with other team members in data acquisition of maintenance records and planning efforts as well as the modeling of software and systems that applied this information into useful tools, policies, and procedures. Similar efforts to support the EABO, data interoperability and SCM were supported by ASI and Nexus LCM. The MRI team also coordinated insertion and adoption of the program deliverables into NAVAIR, C4 and the LIO activities and reported out outcome improvements as well as recommendations for further development and modification.

NAE Maintenance and Sustainment Business Activities

The NAE project team focused on integrating the Naval Aviation business activities that are critical to maintenance and sustainment. The team addressed five of the seven identified functional areas for analysis and implementation within an interoperable environment. Software tools were identified or developed. Programs and policies were proposed, and training regimens and materials were established.

The five functional areas addressed in this phase of the program were:

- Capability and Capacity Planning
- Global Maintenance Management

- Supply Support
- Workforce Proficiency
- Logistics and Engineering

Two other functional areas, financial management and services will be addressed in future efforts. Figure 1 illustrates the functional areas supported by the NAE.

The NAE effort included demonstration of software prototypes to facilitate the Systems Effective Analysis of Product Support for Naval Air Forces, with the ultimate intent of restoration and maintenance of flightline readiness. The target solution was to transform Naval Aviation sustainment into an integrated, predictive, data-driven, globally managed sustainment environment. The approach applied process reviews, data analysis and software that focused on the development of future-focused capabilities used in the maintenance and sustainment of fixed wing, rotary wing, and unmanned weapon systems.

The deliverables in this section of the project were presented directly to the government. They are described in Section 3.1 and listed in Appendix A but were not approved for public release and are not included in this report.

Logistics Technology Requirements in Support of EABO

In support of EABO the team evaluated an array of hardware solutions to facilitate support of EABs in distributed austere maritime environments. This included unique MHE suitable for the expeditionary environment, electrical power storage, and an autonomous guidance system suitable for use with light to medium weight drones.

Figure 1. SV2020 Functional Area Support to the NAE

Data Interoperability

In this effort, the team developed a methodology to easily map U.S. logistical data to NATO data for input into the NATO Logistics Functional Area Service (LOGFAS) system. The fused data populated the MNLogCOP that facilitated visualization and analysis. A report of this work is attached in Appendix D.

SCM Tool Survey

Because the supply chain is at the heart of readiness, the team evaluated 95 COTS SCM tools. The results of that study were published in a report which is presented in Appendix C.

3. Project Narrative

3.1 NAE (Statement of Work (SOW) Tasks 1, 3, 4, 5, 7)

Improving aviation readiness requires development of a broad range of tangentially related disciplines. To rapidly advance parallel initiatives, the SV2020 participants formed action teams aligned to the functional areas. Regular in-process reviews were conducted to ensure cross-team coordination.

NAE deliverables were provided to the government but were not approved for public release. That complete list, included in Appendix A, demonstrates the complexity of this project. A task and deliverables summary can be found in Appendix E.

Capability & Capacity Planning (SOW Task 1)

Capability and capacity planning is an activity that determines the throughput required by maintenance and sustainment organizations to meet changing demands and will be required to support operational requirements in the future. These actions can be performed at both granular and aggregate levels. The Capability and Capacity thread of SV2020 allows the NAE to measure the capability and capacity of the entire naval aviation sustainment system against required outcomes in order to conduct analysis of the necessary workload. The goal is to provide the necessary capability to optimize repair solutions and increase readiness.

The objective of this effort was a software solution to address the improvement of global Capability and Capacity Planning tools including analysis of the enterprise workload across organic military and commercial sites. This solution includes tools for cataloging enterprise capability, capacity, and infrastructure investment prioritization guided by Reliability Centered Maintenance (RCM) analysis. Additional efforts included development of draft technology and business roadmaps for capacity management tools as well as standardized templates for use by Commander, Fleet Readiness Centers (COMFRC) personnel.

A database was created to host capability and capacity data and expose them via web browser. The "Arena" modeling tool provided the ability to conduct "what-if" analysis of all workloads across the enterprise to allow COMFRC to estimate capacity requirements. The modelling tool also allows COMFRC to understand impact of workload changes in the execution year and into the future across the Future Years Defense Program. Specific achievements included:

- Developed templates that identified requirements, definitions, and business rules to align COMFRC's data solution with applicable commercial best practices
- Designed and conducted pilot demonstrations in which capabilities met required business rules and expectations to present opportunities to explore these functions
- Recommended organizational changes to include roles, responsibilities, processes, and a standardized framework to support program implementation

The overall objective of this functional area was to capture, document, collate and expose Naval Aviation capacity and capability. Visibility to this data was presented in "concentric circles" across the enterprise from Navy to DOD organic sites and finally to contract repair facilities. A prototype of how this information might be presented is illustrated in Table 1. This concept was briefed to Navy and Air Force leadership. Figure 2 is a graphical representation of the enterprise capacity management model.

Table 1. Prototype Capability Display

Aircraft | Engines | Components | Components Part Search | Manufacturing Equipment | Industrial Processes | MCE Manufacturing

Site: All
Eng Type: All
Export Engines Data to Excel

Site	Engine Type	Engine Desc	Part	Part Desc	NIIN	SM&R	Capability Description /Code	POC Position
NAS Norfolk	<ENGINEMODULE> POWERSECTION	T56 turbo prop engines	6887127		LLT56425P	PAGGD	Full Repair	MMCO
MALS-39	401CCSMODULE	T76 turbo prop engines (JSL items)	6064T26G01		LLL800004	AHHHD2	Limited Repair	Prod. Officer
USS Nimitz (CVN-68)	402AFTERBURNERMOD	F110-GE-400 jet engine	6084T06G01		LL404A402	PAGGD	Limited Repair	
USS Nimitz (CVN-68)	402AFTERBURNERMOD	F110-GE-400 jet engine	6084T06G02		LL404A402	PAGOD	Limited Repair	
USS Nimitz (CVN-68)	402HPCMOD	F18 fighter aircraft	6084T02G01		LL402C400	PAGHD	Limited Repair	
USS Nimitz (CVN-68)	402HPCMOD	F18 fighter aircraft	6084T05G02		LL402H400	PAGHD	Limited Repair	
NAF Atsugi	A/BMODULE	GE F414-400 Engine	5100T26G02		LLFOOY105	XAGOD	Limited Repair	Prod. Officer
MALS-12	ABMODULE-402	F104 jet engines	6084T06G01		LL9006195	PAGOD3	Full Repair	Prod. Officer

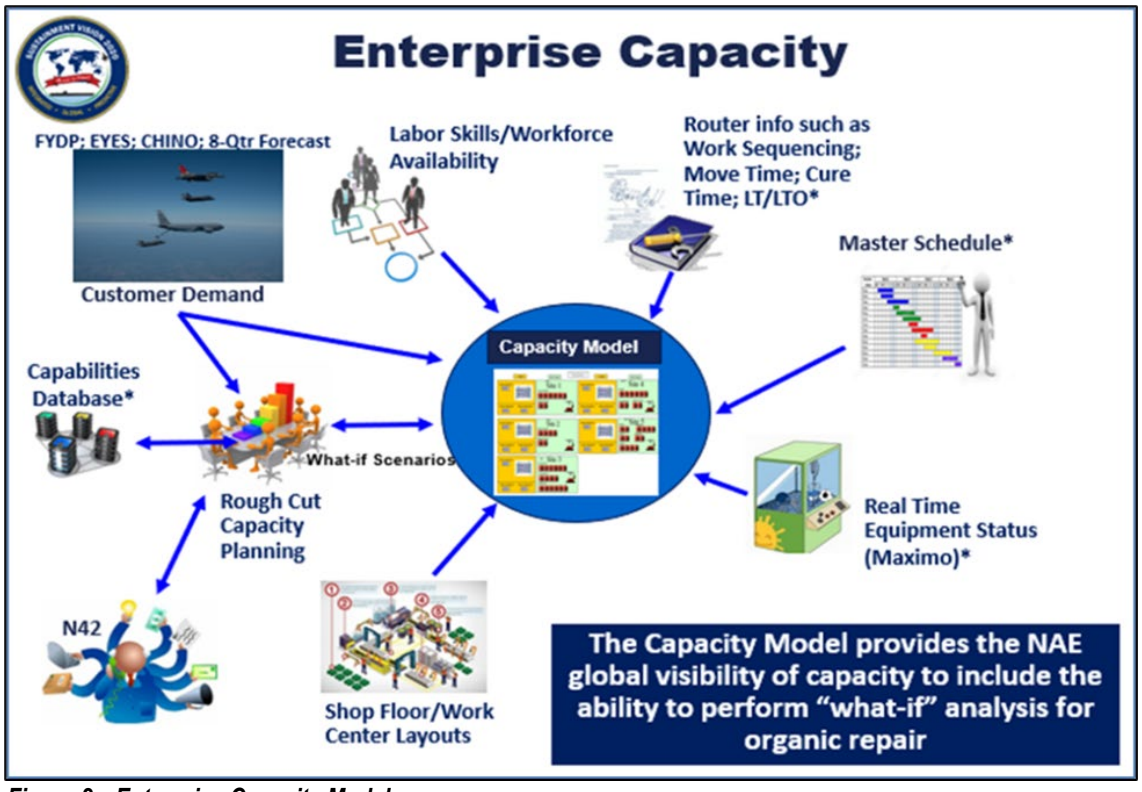

Figure 2. Enterprise Capacity Model

That model provided the NAE with global capacity to include the ability to perform "what-if" analysis. It was intended to aid COMFRC in development of their future plans including a Master Productions Schedule, Military Construction (MilCon), personnel skills reviews, and equipment purchases.

The model illustrates the various data sources that provide relevant and supporting information. The Capability and Capacity team identified standardization requirements of the data, providing real-time equipment status and standardized industry methods to develop Master Production Schedules.

Global Maintenance Management (SOW Task 3)

The Global Maintenance Management component of SV2020 addresses allocation and organization of maintenance resources worldwide. The objective of this part of the project was to develop a solution that provides a real-time, enterprise wide, actionable, and accessible ability to view, manage, and direct maintenance assets across the world.

The team created a globally managed maintenance environment to optimize aviation readiness by advancing enterprise sustainment strategies. The team focused on three key areas: the NASC capability, Total Resource Visibility, and End-To-End Maintenance (MxE2E).

Specific achievements included:

- Developed and demonstrated prototype solutions that support the stand-up of the NASC. Note that the NASC prototype was successful, resulting in full adoption by the NAE under the name Aircraft on Ground/Maintenance Operations Center
- Supported development of Total Asset Visibility solutions that enable the NASC to make critical decisions regarding scarce resources
- Developed a Global Maintenance Management concept of operations that supports the use of prototype capabilities for integration and interoperability of logistics resources across the NAE. Note that this concept of operations was superseded by the NAE's implementation of the Aircraft on Ground/Maintenance Operations Center
- Investigated and recommended tools and techniques for development or integration of knowledge management system dashboards that combined planning with models and simulation for performance prediction

Total resource visibility activities provided visualization and analytics using a new architecture to implement advance application. The visibility of the MxE2E process, from flight line to factory, ensures optimization of maintenance action across the enterprise. Figure 3 provides graphic representation of the Total Resource Visibility concept.

Supply Support (SOW Task 4)

Supply is a critical element of integrated logistical support. The goal of the Supply Support team was to establish an integrated maintenance and supply chain that linked component, engine, and support equipment repair to the flight-line demand signal. Management of the flow of materiel, labor, and service resources from point-of-origin to point-of-consumption is a basic tenet of the supply chain. The project team developed a prototype solution to facilitate the transformation of the supply chain to provide material solutions that meet end user needs and expectation. Its characteristics were:

- Globally responsive
- Sustainable
- Accessible
- Affordable
- Interconnected
- Auditable
- Agile

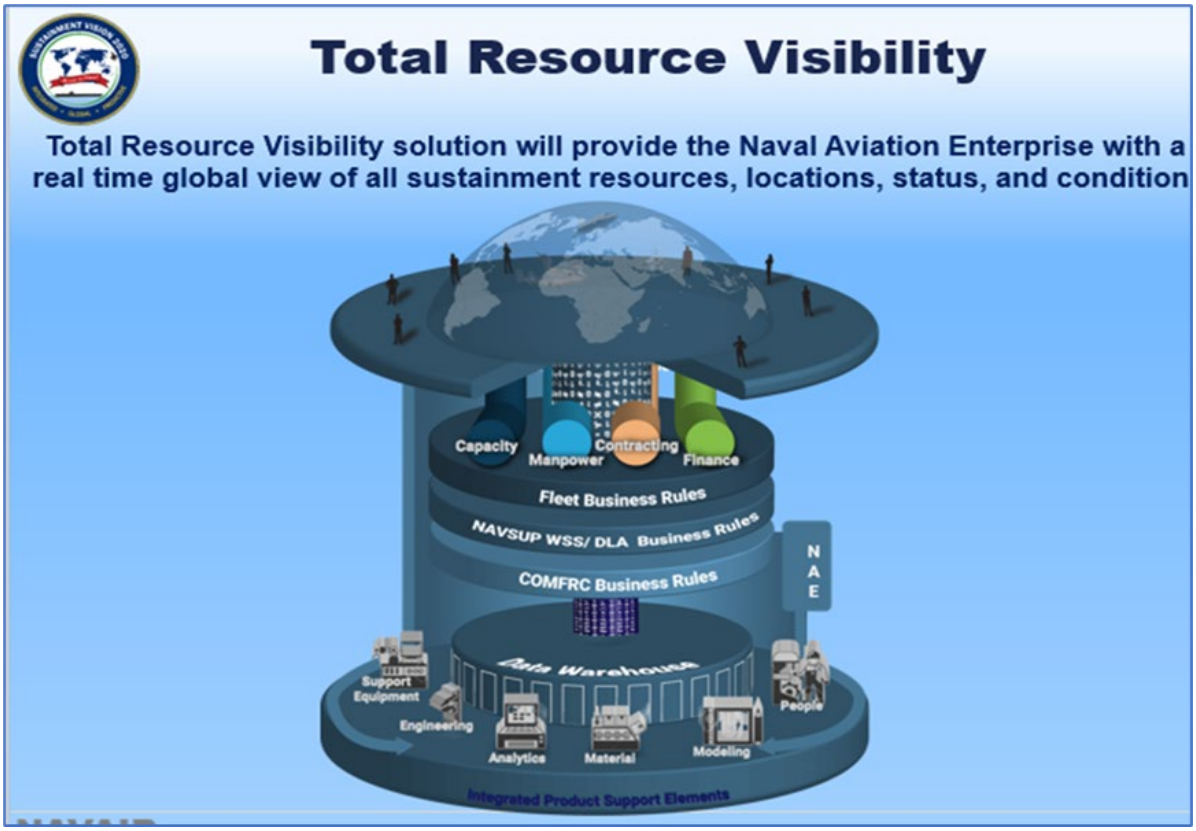

Figure 3. Total Resource Visibility Enables NAE Readiness

The team focused on developing capabilities to support processes that enable the supply chain to be more predictive and operationally sound. This permitted integration, interoperability, and collaboration while improving asset visibility across multiple interconnected supply chains. Specifically, misalignments in planning data and execution policy were identified through integration of maintenance and supply data. The team developed improved forecasting software tools for consumable piece parts. This put weapons system maintenance expertise into demand forecasting (rather than historical usage alone). The result was to better calibrate inventory investment and reduce non-mission capable status. Gaps were identified in original equipment manufacturer and DLA planning forecasts and considered in the supply support improvement recommendations.

A software tool was developed to demonstrate feasibility of an integrated and cross-functional operational picture between supply chain and maintenance management domains. To achieve the merged operational picture, data were consolidated into one location with drilldown capability. This allowed operational status to inform supply chain decisions. Such insight permits preemptive action to be taken to avoid shortages and delays.

A set of data analytics tools was developed to enable readiness modeling and parts forecasting. This facilitated establishment of processes that create visibility into aircraft system availability and supply provisioning. These tools accelerated harvesting of pertinent data and subsequent robust analysis to show gap areas in readiness availability. An experienced group of SMEs and data scientists participated in identifying the key data attributes. Figure 4 illustrates the interaction of the tools developed under SV2020 and the outcomes provided to the fleet.

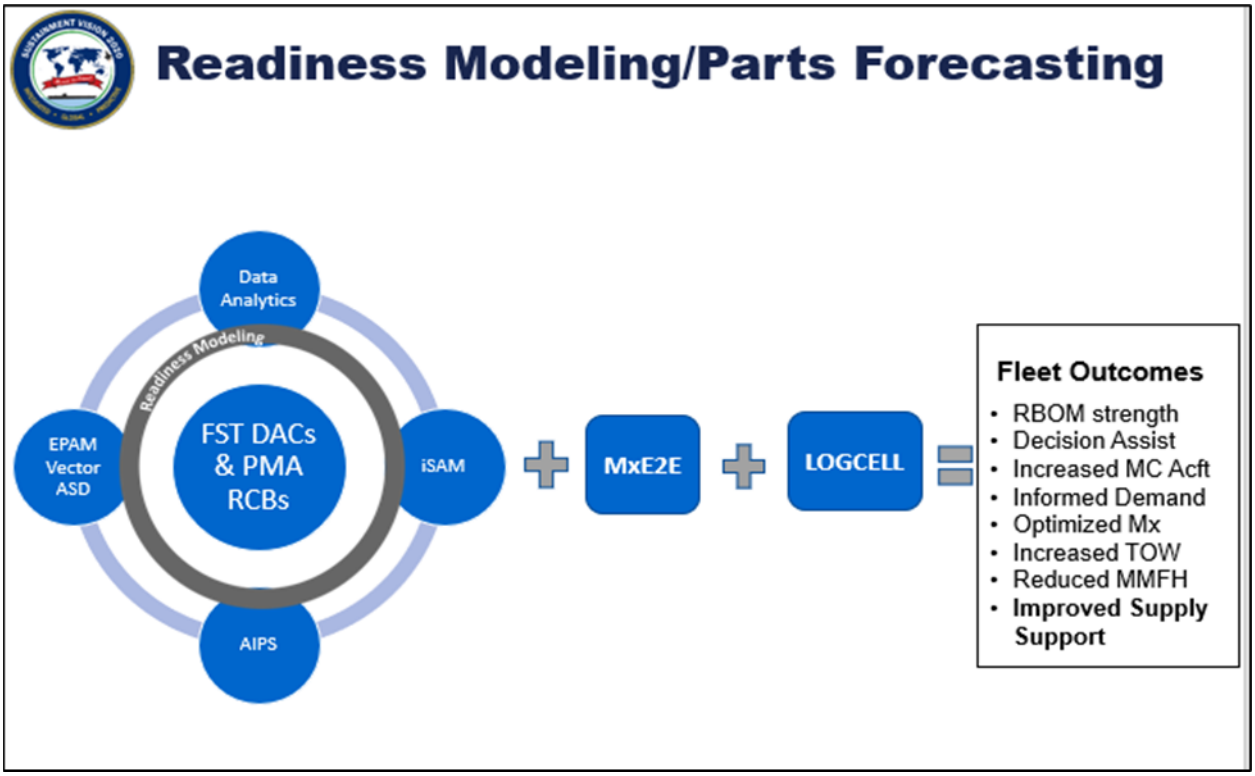

Figure 4. Readiness Modeling & Parts Forecasting

Workforce Proficiency (SOW Task 5)

Workforce proficiency represents a framework for demonstrating and documenting required skill sets, competencies, and capabilities for workers. The workforce proficiency team developed prototype software and non-software solutions to aid in identifying the right mix of labor qualifications, certifications, and training for military and depot sustainment personnel.

The SV2020 concept is to forward deploy certified depot level technicians to increase unit capabilities. Following this concept, depot level maintenance actions can be completed in the field, saving time and transportation costs.

The NAE needed a process to select the best candidates for training to perform depot level maintenance while ensuring the NAE employs their certification to the maximum extent possible. The goal was to certify a maintenance worker's skill globally rather than tie it to a particular location. To achieve this vision, the team developed a system to identify a qualified technician with the required skills and to confirm that person was available when and where needed. The team focused on:

- Implementation of the Advanced Skills Management (ASM) system at depot maintenance sites
- Standardization of ASM at the intermediate level (I-level)
- Depot certification of military personnel

ASM Training

ASM is a web-based training management tool that provides real-time assessment of skills and identifies deficiencies. ASM can be used to track technical training related to an individual's career. In the initial implementation of this concept, a skilled Navy maintainer was identified at Naval Air Station Lemoore, California. That maintainer received Depot Level II certification for advance composite repair. That maintainer has repaired several priority panels and doors, performing 80 hours of work on 18 different

parts resulting in cost avoidance of over four million dollars.

In addition, SV2020 provided a comprehensive and coherent view of workforce proficiency. This insight into workforce proficiency was accomplished by:

- Deploying the ASM into the depot sites matching the "O" level and the "I" level qualified sailors and Marines across COMFRC
- Demonstrating ASM at the depots to standardize processes, qualification, certifications, licenses, and documentation while enhancing opportunities for personnel mobility
- Using ASM to achieve a single proactive training system for supervisors and managers to assess training progression and identify certification gaps
- Providing real-time visibility for workforce members and supervisors into training requirements
- Replacing antiquated training record-keeping processes

Figure 5 illustrates the key inputs and results derived from employing the ASM system in a consistent manner across the NAE.

To achieve the benefits of ASM, the SV2020 team employed a standardized naming convention of the elements. Historically, there have been significant differences in nomenclature and terminology of like items within the NAE. For example, the team discovered 13,300 non-standard qualifications, certifications, and licenses with redundant or overlapping titles. That was reduced to fewer than 3,000.

Logistics & Engineering (SOW Task 7)

The Logistics and Engineering team focused on the planning, acquisition, and management of sustainment functions to include subject matter expertise, management, and operational support services. Included in this category were systems operations, automated tools, value chain management, inventory management, and distribution/transportation management.

The NAE uses many custom tailored and commercial software tools to transact, store, manage, and make decisions based upon logistics and engineering data. These systems and tools are poorly integrated, causing significant challenges in discovering and re-using data across the enterprise to identify and address issues.

Figure 5. ASM in the NAE

The team developed a concept demonstrator that fuses data from a variety of disparate systems. It facilitates visualization and analytics while minimizing impact to source systems data or business processes. They also developed solutions to modernize and grow the NAE sustainment suite of systems to rapidly respond to warfighter needs. This achieved optimized engineering and logistics processes and integrated IT systems. The engineering component of the team focused on driving solutions to improve readiness through improved sustainment.

The Integrated Support Service Center (ISSC) ensured that work performed by in-service support organizations positively impact readiness. Those activities illustrated in Figure 6 included:

- RCM analysis – "A process used to determine what must be done to ensure that any physical asset continues to do what its users want it to in its present operating context"[8]
- CBM+ – Perform proactive maintenance upon evidence of need[9]
- Dynamic Scheduling – Enables opportunistic maintenance to reduce maintenance burden at the O-level
- MxE2E
- Level of Repair Analysis
- Predictive Analytics

The team conducted process mapping to document and illustrate the efficiencies and gaps in integration between maintenance and supply chain operations. They then performed a functional sustainment logistics assessment identifying systemic issues across platform program management activities. The assessments identified gaps and provided recommendations including:

- Increased use of data analytics
- Incorporation of technical data for readiness improvements
- Incorporation of tools to identify readiness trends and opportunities

The ISSC provided insight into how maintenance planning could improve readiness treads by implementing readiness analysis and treading tools. Incorporating the Integrated Data Repair Network onto the Enterprise Service Bus enabled broader dissemination of information.

The Logistics and Engineering team employed digital enablers to implement the ISSC. The digital enablers established as the foundation of the ISSC are illustrated in Figure 7. They include IT system solutions that enable maintenance, supply, and readiness activities to include:

- Integrated Data Repair Network
- Product Lifecycle Management (PLM) application that houses engineering and logistics data and processes for aircraft systems and components
- Integrated Manufacturing & Repair – Using advanced and additive manufacturing

One of the key benefits of the ISSC is the ability to identify and execute Dynamic Scheduling (Figure 8). Dynamic Scheduling relies on planned maintenance based on RCM derived interval rather than current packaged maintenance intervals. It is flexible and permits opportunistic unscheduled maintenance performed when aircraft is undergoing other service. The Optimized Scheduled Maintenance five-digit Failure Mode Digital Code and accurate Logistics Product Databases enable Dynamic Scheduling.

[8] (Mourbray, 1997)

[9] (Department of Defense, 2012)

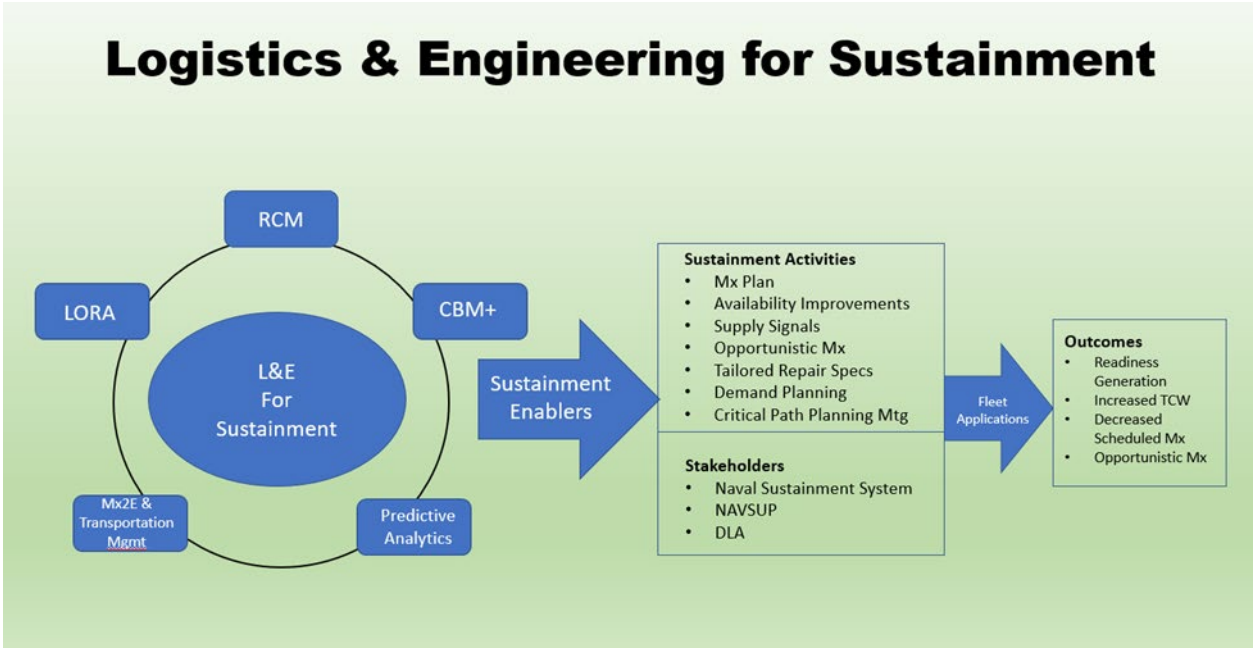

Figure 6. Logistics & Engineering Support to NAE

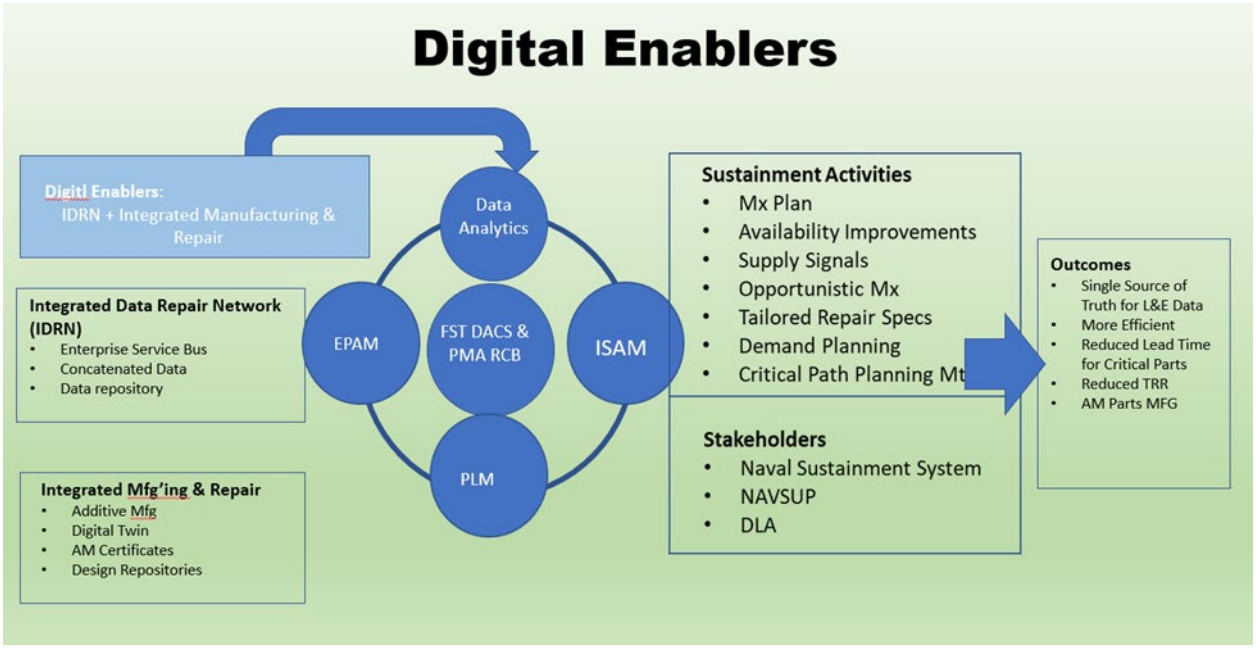

Figure 7. Logistics & Engineering Digital Enablers

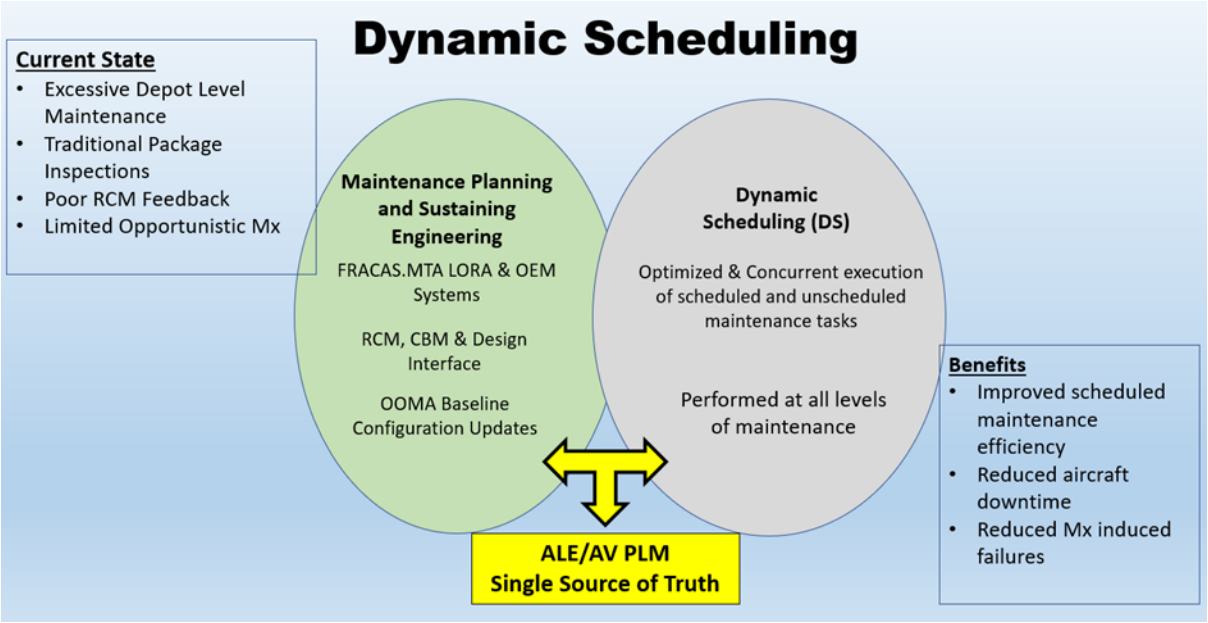

Figure 8. Dynamic Scheduling

3.2 EABO (SOW Tasks 3, 4, 7)

Background

In 2017 the Navy published "Littoral Operations in a Contested Environment (LOCE)." Along with "Distributed Maritime Operations," LOCE is intended to enable response to potential near-peer threats in the Indo Pacific region as described in the "Joint Concept for Access and Maneuver in the Global Commons."

In concert with the LOCE, EAB will provide land-based sensors, shooters, and sustainment in distributed, mobile, temporary, austere forward locations.[10] This concept marks a return to the traditional Marine Corps mission defined in Title 10 of the U.S. Code:

"The Marine Corps shall be organized, trained, and equipped to provide fleet marine forces of combined arms, together with supporting air components, for service with the fleet in the seizure of defense of advance naval bases and for the conduct of such land operations as may be essential to the prosecution of a naval campaign."

A potential obstacle to effective employment of the EABO concept is logistical support. Sustaining widely dispersed small units in isolated remote archipelagic locations threatened by a near-peer adversary will require a paradigm shift by the Marine Corps. For over 60 years, the needs of the nation dictated that the Marine Corps act as a second land based "Army." Notable exceptions were the brief conflict in Grenada and the initial thrust into Afghanistan.

Prior to that time, the Marine Corps, acting as naval infantry, grew a considerable knowledge base and level of expertise in amphibious operations and "small wars." Drawing, in part, on this experience, Black & Rossi published a white paper, "*Logistical Support for Advanced Base Operations: Lessons from History*"[11] offering insight into the challenges met and solutions employed by the U.S. and allies in the South Pacific during the World War II.

[10] (US Marine Corps, 2017)

[11] (Black & Appleton, 2021)

An Albion College report,[12] commissioned by Black & Rossi, described many of the logistics challenges to successful employment of the EABO concept. That report identified the importance of the IndoPacom theater to the world economy. In addition, using a proprietary mathematical model, the Albion team identified critical locations best suited to support EAB operations.

The foundational work represented in each of these efforts informed the EABO focused efforts accomplished in this project. The central features of the EAB will be risk-worthy, low cost, low signature, and mobile. Equipment for such bases will necessarily be significantly different from that which is found in the current Fleet Marine Force Table of Equipment. This study evaluated a range of equipment to assess applicability to EABO.

Logistics & Engineering Technology Assessment (SOW Tasks 3, 4 & 7)

Details of these technology assessments are provided in Appendix B.

The Marine Corps is in the process of adopting a new strategy to better position for operations in austere, contested littoral environments. As part of this strategy shift, the Marine Corps will need to examine what vehicles, tools, and platforms are available to be utilized to best support operating under this new strategy. Logistical support of distributed expeditionary operations in the most austere environments will require innovative logistical support tools and technologies. With this in mind the team explored a range of technologies to assess their applicability in the EABO environment. Specific areas of study included:

- Mobile energy storage and generation
- Logistics delivery methods/equipment
- MHE

Specific technologies assessed included:

- Silent Technology Enhanced Dismount (STEED)
- Multi-Purpose Expeditionary Platform (MPEP)
- Near Earth Autonomy, Firefly
- IAS MACH Utility Terrain Vehicle

STEED

The STEED is an electric, all-terrain, operational payload platform designed for multi-purpose use in military operations spanning significant distances to be traversed on foot. Designed by Hendricks Motorsports, the STEED, shown in Figure 9, serves as a self-powered platform which reduces the payload and exertion of each individual warfighter. STEED can also be used for rapid casualty evacuation and as a secondary power source that can import and export energy to other devices via integration with the “Squad Power Manager” (SPM-622) tool.

MPEP

The MPEP, shown in Figure 10, is an unmanned and remotely controlled vehicle with forklift-like capabilities built for defense operations by Tracks NA. The MPEP features a universal skid-steer attachment plate allowing for the utilization of any standard attachment tool such as pallet forks, an auger, variable material saws, and other tools.

[12] (Albion College AC3, 2022)

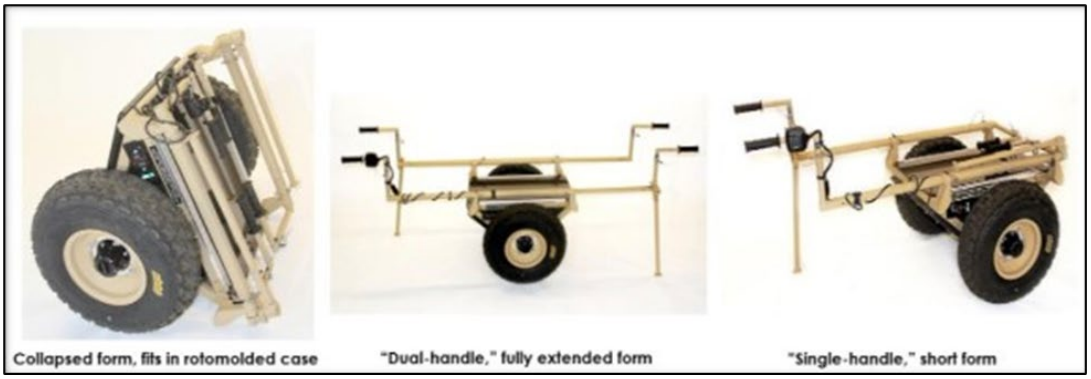

Figure 9. STEED Expeditionary Payload Platform

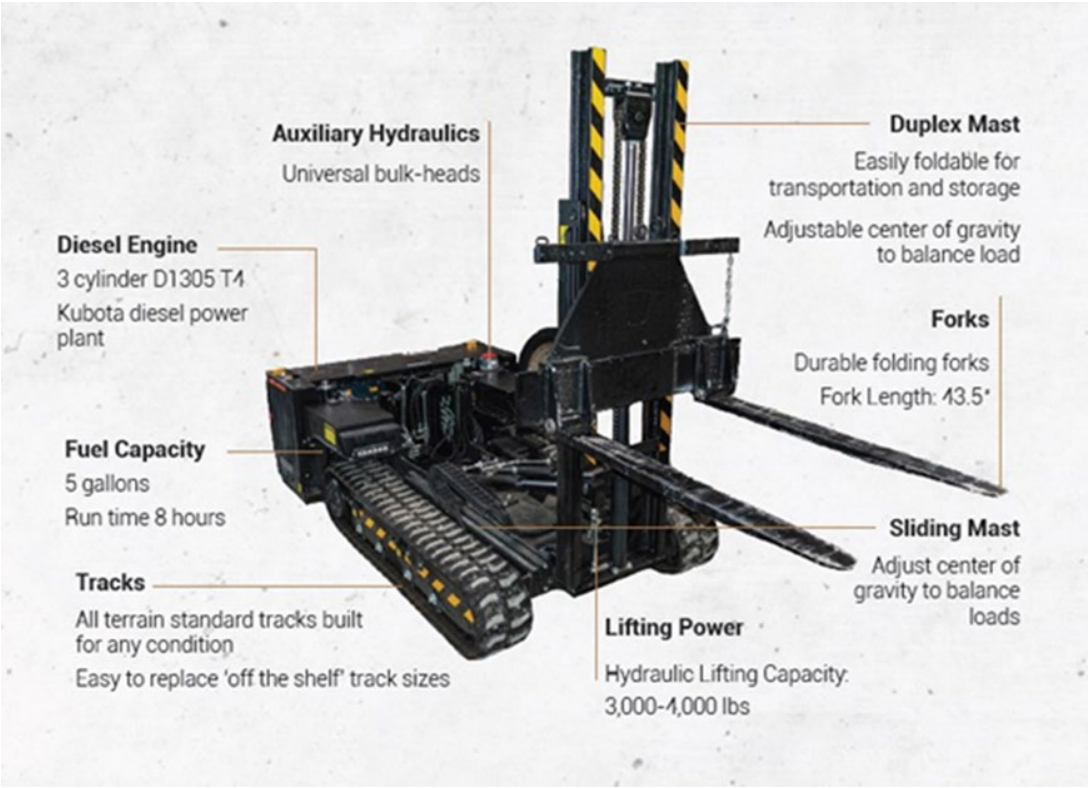

Figure 10. MPEP Expeditionary MHE

Firefly

The Firefly (Figure 11) is a lightweight (2.65 pounds), low-cost autonomous flight guidance system that can be affixed to many small drone platforms. It provides autonomous flight capabilities such as obstacle avoidance and takeoff/landing zone evaluation. This effort was undertaken in order to further the development of technologies and methods that would be required for successful deployment of such platforms in real defense operations. The report included in Appendix B provides an overview of the Firefly technology and its development roadmap. It also describes criteria for the technology to be evaluated against. This evaluation considers possible applications to the evolving Marine Corps needs and future fighting strategy. Finally, it provides a summary of the live demonstration of the technology that took place in May 2022. A summary of potential next steps for further evaluation is included.

Figure 11. Firefly Autonomy System Close-Up

IAS MACH Utility Task Vehicle (UTV)

The IAS MACH line of utility terrain vehicles was included as one of the platforms to be assessed for potential utilization in EABO environments and operations. The MACH UTV consists of a commercial vehicle that has undergone modification to make it better suited for operations in austere environment with unimproved road conditions. The MACH vehicle is available in several configurations that include additional passenger seating, a short cargo bed, and with the addition of a platform trailer that doubles as a compact battery storage and charging station. These attributes and configurations made it an attractive candidate for potential use in future EABO environments.

Due to supply chain delays stemming from the Covid-19 pandemic and challenges with the manufacturer, the selected MACH UTVs were not completed in time for demonstration and government acceptance prior to the writing of this final report and the conclusion of this project. It should be noted that a demonstration and government acceptance meeting took place in Wisconsin in July 2022 where IAS encountered technical difficulties with both demonstration vehicles indicating further work would be required by IAS before the government sponsor could accept the platforms. At the conclusion of the July 2022 meeting, IAS stated it would need several months to complete the two vehicles and the estimated completion date would be in the near future. At the time of the writing of this report, IAS is still working on the vehicles and have not communicated a target completion date. For this reason, there is no Technology Assessment Report for the IAS MACH UTV in Appendix B.

3.3 SCM Tools Assessment (SOW Task 4)

The team conducted an assessment of COTS SCM tools that could be used for supply support and analysis of supply disruption in an austere "EABO-like" setting. Technologies were evaluated for potential incorporation into the expeditionary environment. Stakeholders in a typical supply chain were identified along with a review of requirements and tools needed to manage that chain. Based upon the identified criteria, an assessment of available tools was assembled and ranked.

An initial curated list of 95 potential candidates was developed. A series of rigorous evaluations, based on the team's research and experience, distilled the original list to 29 candidates. A second round refined the list to 11 semifinalists shown in Table 2. Finally, a group of four tools that came closest to meeting all requirements was identified. Two more "Honorable Mentions" offered specific capabilities that could fill gaps. The team found that none of the COTS applications completely fulfilled the unique requirements of the identified expeditionary environment. That complete report is presented in Appendix C.

3.4 Logistics Data Interoperability/ Visibility (SOW Task 7)

One of the most common hindrances to efficient SCM is the inability of applications to "talk" to each other. This project team took on the challenge of data interoperability between the NATO Logistics system and the U.S. Army

European and African Command. The team developed a methodology to easily map U.S. logistical data to NATO data for input into the NATO LOGFAS system. This is illustrated in Figure 12. The fused date populated the JEDI-X MNLogCOP that facilitated visualization and analysis. The value of this capability was validated during NATO logistics operations. The associated reports describing this effort are contained in Appendix D.

Table 2 . Top 11 SCM Tools

	Product	Parent/Partner	Advertized Specialty	Website	Comments
1	Blue Yonder Sales & Operations Planning/ Luminate		Purpose Built/AI/End-to-end Visiblity	https://blueyonder.com	
1	Luminate Platform	Blue Yonder	Integrated Data Management	www.blueyonder.com	See Blue Yonder
2	Coupa BSM Platform	Llamasoft	t	www.coupa.com/platform	Continuous Supply Chain Design/Digital Twin
2	Llamasoft	Coupa	AI Powered Supply Chain	www.coupa.com	Simulation
3	Descartes Reporting Services Supply Chain Analytics		Global SCM	www.descartes.com	Widely used
4	Infor Supply Chain Management		DoD Readiness	www.infor.com	
5	Interos		Enterprise Vislibility	www.interos.ai	"See verything; do everything.
6	Logility Demand Planning and Optimization		End-toEnd SCM	www.logility.com	Digital Twin
6	Logility Digital Supply Chain Platform			www.logility.com	
6	Logility Voyager Solutions		Demand Sensing	www.logility.com	
7	Oracle Supply Chain Planning Cloud		S&R Focus	www.oracle.com	
8	SAP Advance Planning and Optimization		End-toEnd SCM	www.sap.com	Integrate with SAP ERP
8	SAP Ariba		Ariba network	www.ariba.com	Integrates buyers and suppliers
8	SAP Integrated Business Planning for Supply Chain Management			www.sap.com	
9	E2Open		End-to-end/Digital	www.e2open.com	
10	Epicor		ERP/Distribution	www.epicor.com	
11	Solvayo		Retail Focus	www.solvayo.com	very positive reviews

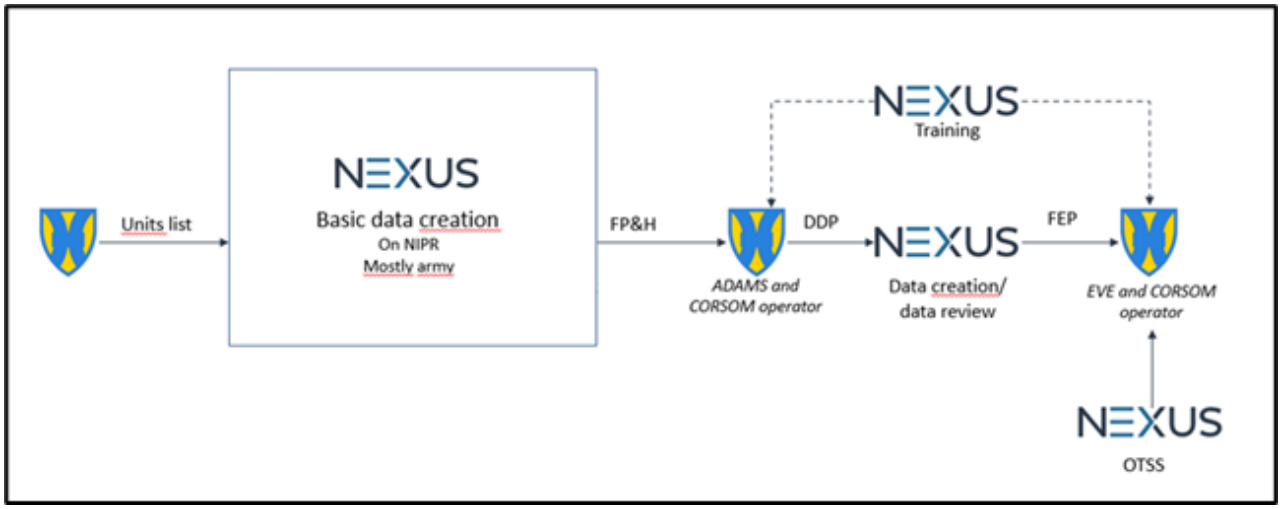

Figure 12. Nexus JEDI-X Data Mapping Process

4. Conclusions

Improved MxE2E

This wide-ranging project created improvements in maintenance and sustainment in the NAE. The various efforts succeeded in breaking down barriers across the varied specialized business processes and IT systems that have evolved over time. The improved interoperability of systems and processes allowed for optimization of resources at an enterprise level. The outcome was better maintenance and sustainment decisions.

Integration

The SV2020 project integrated commercially available IT applications, systems, and best practices with specialized built-for-purpose systems and processes where military-unique circumstances dictate bespoke solutions. This approach empowered an effective NAE work-force, streamlined maintenance practices, and improved asset visibility. The results of the SV2020 project were critical to maintaining affordable readiness of Naval Aviation weapon systems.

Solutions

This project also developed solutions to sustainment challenges brought about by evolving threats to the international order. In Europe a significant data interoperability effort by the NEXUS JEDI-X team produced the MNLogCOP enabling NATO LOGFAS to exchange data with U.S. data. This powerful capability has potential to rationalize complex maintenance and sustainment business practices throughout both DOD and industry.

Need

In the IndoPacom region, potential threats from the Peoples Republic of China demand that the U.S. respond. The DOD has proposed EABO as a promising operational concept. For this to be successful, logistics support will have to keep up. In this project the team searched out and evaluated a range of equipment to determine its value in austere, expeditionary environments. This study revealed several promising items that are worthy of further operational testing.

Alternatives

A “perfect storm” of events have conspired to create serious obstacles to an efficient supply chain. This has damaged the U.S. economy and hindered the defense of the nation. In order to better understand the issue and seek possible solutions, the team evaluated COTS SCM software tools for applicability to the needs of the DOD. That study distilled a list of nearly one hundred candidates. However, none were deemed totally sufficient to DOD requirements.

5. Project Benefits

5.1 Benefits to Industry

A key component of this project was proactive maintenance and sustainment. Industry sources claim that predictive maintenance can reduce budgets by 30-40 percent.[13] Lessons learned in the aviation maintenance management portion of this project have direct application across the entire aviation enterprise. Tools and techniques developed in this project offer direct application to the commercial aviation industry.

Supply chain disruptions are affecting every aspect of life. Limited availability and high cost are "sand in the gears" of the nation's economy. It has been conservatively estimated that supply chain disruptions in 2021 cost the U.S. $228 million.[14] For businesses and defense organizations alike, supply chain network visibility and the ability to analyze the impacts of disruptions, are more valuable than ever. The number and variety of SCM tools is daunting. There is no correct answer to the question "Which one is best for me?" Each individual enterprise has its own unique supply chain requirements. The work done in this project can help sort that out for industry. In an effort to better understand the complex systems that deliver goods all over the globe, and the challenges they face, this report offers a basic overview of supply chains. It also includes a review of available SCM tools that can aid organizations in understanding, predicting, and responding to supply chain disruptions.

Data interoperability is essential to implementing MxE2E management and supply chain systems. The data work in this project represents a significant step toward enabling enterprise-wide maintenance management and complex multi-party supply chains.

5.2 Benefits to the DOD

The product of this effort shows the path to modernize the maintenance and sustainment practices of the NAE. The SV2020 project provided stakeholders with improved insight into fleet readiness and established methods to address optimizing the NAE ecosystem. The enhanced information environment, achieved from aggregating previously disparate information, enabled decision makers to identify key readiness degraders and prioritize maintenance actions. This approach enabled an effective military and civilian NAE workforce, as well as created opportunities to adopt commercially available solutions. The SV2020 project was critical to maintaining and enhancing affordable readiness of Naval Aviation weapon systems.

In 2020 the DOD issued guidance on data strategy. Among the key principals is data interoperability.

"DOD is a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency."

"DOD must accelerate its progress towards becoming a data-centric organization. DOD has lacked the enterprise data management to ensure that trusted, critical data is widely available to or accessible by mission commanders, warfighters, decision-makers, and mission partners in a real-time, useable, secure, and linked manner. This limits data-driven decisions and insights, which hinders the execution of swift and appropriate action.

"Properly exchanging data between systems and maintaining semantic understanding are critical for successful decision-making and joint military operations. Achieving semantic as well as syntactic interoperability using common data formats and machine-to-machine

[13] (Bree, 2019)

[14] (Statista, 2022)

communications accelerates advanced algorithm development and provides a strategic advantage to the Department."[15]

The JEDI-X Logistics interoperability effort meets this guidance and demonstrated the capability with NATO partners in Europe.

Threats to international security and freedom of navigation in the IndoPacom region are increasing. The Navy and Marine Corps are developing EABO as one way to increase capability in that theater. In concert with the LOCE, EAB will provide land-based sensors, shooters, and sustainment in temporary, distributed, mobile, austere forward locations. Essential to the success of this distributed operational concept will be achievement of effective logistical support while maintaining a small footprint. This project leveraged the SV2020 concept to explore and investigate unconventional technologies that will facilitate effective support of remote expeditionary island bases.

[15] (Norquist, 2020)

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Appendix A – NAE Deliverables

The following is a complete list of deliverables provided to the government by Andromeda Systems:

1. Workforce Proficiency – Training Gap Analysis, created prototype dashboard for F-18 E/F
2. Workforce Proficiency – ASM I-Level Standardization, standardized GTETS accreditation, task lists, and titles
3. Workforce Proficiency – ASM I-Level Standardization, all objectives are complete, project complete
4. Workforce Proficiency – Training, fully understand the forecasted workload
5. Workforce Proficiency – Training, UH-1Y determine Level of Learning and Level of Interactivity criteria to build into TERE score
6. Workforce Proficiency – Training, AH-1Z determine Level of Learning and Level of Interactivity criteria to build into TERE score
7. Workforce Proficiency – Depot Certification of Military, Determine component repair requirements by FRC (North Island & Pt Mugu)
8. Workforce Proficiency – Training, submitted new LO files for the AH-1Z utilizing the Level of Learning (LOL) and Level of Interactivity (LOI) guide
9. Workforce Proficiency – ASM I-Level Standardization, Deliver standardized ASM Production Control titles (Model Manager)
10. Workforce Proficiency – ASM I-Level Standardization, Deliver standardized Production Control qualifications in ASM (Model Manager)
11. Workforce Proficiency – Depot Certification of Military, Determine component repair requirements by MALS (11 & 14)
12. Workforce Proficiency – Depot Certification of Military, Determine component repair requirements by MALS (16 & 24)
13. Workforce Proficiency – Training, Established an enterprise view of available current Depot Level training courses
14. Workforce Proficiency – Depot Certification of Military, Determine component repair requirements by MALS (26 & 29)
15. Workforce Proficiency – Depot Certification of Military, Determine component repair requirements by MALS (31 & 36)
16. Workforce Proficiency – ASM I-Level Standardization, Submit Change Control Board process to model manager
17. Workforce Proficiency – Training, Perform Learning Objective Analysis on UH-1Y, AH-1Z, CH-53E, EA-18G, FA-18A-D, MH-60S, MV-22, and AV-8B
18. Knowledge Management for Performance Benchmarking
19. Comprehensive Planning and Execution Framework
20. Monthly Operations Planning Framework and Work Instructions (Draft)

21. Equipment Ranking Process
22. Critical Spares Process
23. Work Order for Plant Mx Process
24. Material Procurement Process
25. FRCE Data Clean Up
26. FRCSE Data Clean Up
27. Retail Demand Planning Forecast Tool
28. FRCSW, I Level Model
29. FRCMA, I Level Model
30. FRCSW FE Component Model
31. FRCSE FE Component Model
32. FRCSE Rough Cut Capacity Model
33. Master logic Diagrams for JSF dock locations
34. SP2030 main body delivered to COMFRC PAO
35. Strategic Plan 2020-2030 – delivered
36. Strategic plan 2020-2030 Supplement – delivered
37. Supply Support Retail Demand Planning and Forecasting Tool
38. NIIN Integrity Playbook
39. Demand Planning Playbook
40. GMM – OCC Playbook
41. GMM – TRV CONOPS
42. NAVSUP/COMFRC MOU Revisions
43. Material Planning Playbook
44. Web-Based CAST Dashboard
45. ISCM MVP Version 1.0
    a. ISCM Commercial Drilldown MVP Version 1.0
    b. ISCM Commercial Drilldown NIIN Level MVP Version 1.0
    c. ISCM D-Level Drilldown (FRC Level) MVP Version 1.0
    d. ISCM D-Level Drilldown (NIIN Level) MVP Version 1.0
    e. ISCM I-Level Drilldown (Work Center Level) MVP Version 1.0
    f. ISCM I-Level Drilldown (NIIN Level) MVP Version 1.0
    g. ISCM Components MVP Version 1.0
    h. ISCM Overview MVP Version 1.0
    i. ISCM Navigation MVP Version 1.0
    j. ISCM Quad Chart MVP Version 1.0

46. Workforce Proficiency – Training Gap Analysis, update MQ-4C and MQ-8 Course Data files, LO Master file, and maintenance tasks
47. Workforce Proficiency – Training Gap Analysis, update KC-130J, MH-60R, E-2D, MH-60S, and P-8A files including ASM, OJT, Training gap
48. Commodity Scheduler training syllabus created and delivered to client
49. Aircraft MOP cycle 1 – Output and Action Items Report
50. East Utilization report and schedule modifications
51. Forecast Accuracy Report (Provided to J. Peed/R. Christopher) – BCM vs NAVSUP vs Actual Inductions
52. FRC East FE Components
53. FRCE, FRCSE, FRCSW Integrated Model
54. FRCSW Rough Cut Capacity Model
55. FY21 Financial Impact Analysis to R. Christopher (NAVSUP/BCM & GDP)
56. Delivered Forecast Metric Improvement Plan to R. Christopher
57. Monthly Operations Planning – January Report delivered to R. Christopher
58. Commander's Intent/Strategic Plan 2020-2030 Supplement delivered to Mr. Bauman
59. Commander's Intent/Strategic Plan 2020-2030 Supplement update delivered to Mr. Bauman
60. Strategic Objectives Future Reality Tree delivered to Mr. Bauman
61. WLP prep items (data analysis and brief) to R. Christopher
62. Metrics dashboard built and delivered in Tableau, delivered to R. Christopher April 21, 2021
63. SWP for COMFRC HQ Level Demand Planning delivered to R. Christopher April 29, 2021, via ROP Process Guide word document
64. SWP for COMFRC HQ Level Rough Cut Capacity Planning delivered to R. Christopher April 29, 2021, via ROP Process Guide word document
65. Workforce Proficiency – BIT Training, establish a list of all aircraft that have BIT components installed
66. V-22 Model
67. SP2030 FRT's delivered to Mr. Bomhold and Mr. Johnson
68. SP2030 Commander's Intent Focus Area Progress PPT presentation delivered to Mr. Bomhold and Mr. Johnson
69. Ten Year workload plan/diagrams and Hangar Layouts for all sites were delivered to Mr. Bomhold, Mr. Johnson, and Mr. Frank (Mr. Johnson's replacement)
70. Workforce Proficiency – BIT Training
71. Workforce Proficiency – List of components that have BIT
72. Workforce Proficiency – Identified components with highest A799
73. Global Repair Updates

74. Automated Data Feeds for Integrated Capacity Model
75. V-22 Model
76. Standardize Depot Level Training

Appendix B – EABO Technology Assessments

MULTI-PURPOSE EXPEDITIONARY PLATFORM (MPEP) EVALUATION REPORT

Technology Assessment for EABO Operations

EXECUTIVE SUMMARY

The United States Marine Corps (USMC) is in the process of adopting a new strategy to better position for operations in austere, contested littoral environments. As part of this strategy shift, the USMC will need to examine what vehicles, tools, and platforms are available to be utilized to best support operating under this new strategy. One innovative platform that could be valuable in this new operating environment is the unmanned forklift-like MPEP that has been developed by Tracks NA. Possessing a universal skid-steer attachment plate and remote-control capabilities, the MPEP could be invaluable to USMC forces undertaking small scale construction or temporary camp setup in undeveloped environments.

Before a new platform like the MPEP can be widely adopted, it must first undergo testing and evaluation by the personnel that will be tasked with using and maintaining the platform if it is adopted on a wide scale. Prior to the live exercise with the MPEP, a list of evaluation objectives was compiled in order to guide the evaluation process during the live exercise. These objectives included determining which specific tasks the MPEP could support as well as understanding the training requirements necessary for a user to become proficient in operating the MPEP. Although no formal evaluation data was available for analysis at the time of the writing of this report, the USMC is leveraging the evaluation exercises and additional resources to inform next steps on potential expanded procurement of MPEP units and fielding within future Marine forces. Additionally, Tracks NA reported continued development on the MPEP platform including exploration of autonomous piloting technology and an all-electric power source which would further expand the capability of the MPEP and make it an even more attractive tool for potential inclusion in the USMC's future operating strategy.

1. TECHNOLOGY OVERVIEW

The Multi-Purpose Expeditionary Platform (MPEP) is an unmanned and remotely controlled vehicle with forklift-like capabilities built for defense operations by Tracks NA. The MPEP features a universal skid-steer attachment plate allowing for the utilization of any standard attachment tool such as pallet forks, an auger, variable material saws, and other tools.

The vehicle is powered by an onboard diesel engine that makes 19 – 37 horsepower, depending on the configuration, and gives the MPEP a top speed capability of up to 22 miles per hour. The MPEP is manufactured with a fixed undercarriage and is driven by all-terrain tracks making it capable of operation in a wide range of improved and un-improved environments.

One of the major differentiating characteristics of the MPEP from other commercial solutions is the digital remote-control of the device. This allows for the use of the MPEP in austere and hazardous situations while keeping the operator protected from a distance. The MPEP can be controlled from a secure location up to 1,000 feet away from the vehicle.

Lastly, the MPEP's collapsible design allows the platform to fold down to 28 inches. This allows the MPEP to be stored and transported easily via common transportation channels including truck bed, trailer, intermodal container, and is fully sling loadable and compatible to be transported via helicopter.

MPEP Specifications	
Length: 91" x **Width:** 51"	**Standard Lifting Capacity:** 3,300 Lbs.
Total Weight: 3,373 Lbs.	**Vertical Lifting Capacity:** 5,000 Lbs.
Stowed Height: 28"	**Payload Capacity:** 10,000 Lbs.

MPEP Universal Attachments		
Auger	Backhoe	Bale Spear
Concrete Saw	Dozer Blade	Drum Handler
Pallet Forks	Snowplow	Tree Saw

2. EVALUATION OBJECTIVES

The USMC's expeditionary advanced base operations (EABO) strategy aims to move the USMC capabilities in the direction of being able to successfully operate in austere, distributed marine environments that exist within contested geographic locations. The challenges associated with operating in this environment are numerous with special difficulty in moving and organizing personnel, supplies, and equipment.

In consideration of this new strategy, it is possible that the MPEP could be a valuable tool for navigating and traversing uninhabited austere environments. The forklift capability could be useful in loading and unloading equipment as well as moving and clearing large debris. Additional MPEP attachments would allow for it to be used for cutting through trees and thick vegetation as well as stone, if necessary. It could also be used for small scale construction with digging, plowing, and lifting capacity in excess of 3,000 pounds. The MPEP's compact size and relative affordability may also lend favorability to the platform in operations where logistics and support comes at a premium or is unavailable. This evaluation exercise aims, in part, to assess the ability of the MPEP to complete these tasks in real-world use scenarios.

The MPEP is being evaluated along many different dimensions to determine its feasibility for broader use in future USMC EABO. Some of these evaluation criteria are generalized and apply to most new technology being evaluated for use while other criteria are more specific to the exact capabilities and expectations of the MPEPs use.

The objective of the evaluation aims to answer the following questions:

1. What tasks and activities can the MPEP support?
2. Does the MPEP significantly speed up or reduce the difficulty of these tasks?
3. How easy or difficult is it to remotely control the MPEP during these tasks?
4. How much training is needed to become proficient in piloting the MPEP?
5. What is required for the transportation, unloading, and storage of the MPEP?
6. How well does the MPEP operate in marine/saltwater-based operations?
7. What is required for maintenance and repair of the MPEP during extended operations?
8. What are the major strengths of the MPEP?
9. What are the major constraints or weaknesses of the MPEP?
10. How does the MPEP improve the efficiency and lethality of the USMC?

While this list is not exhaustive, it addresses the major objectives of the technology evaluation and the data gathered in response to these questions will be a key input into the subsequent phases of considering this platform for additional evaluation and potential broader adoption.

The MPEP is being evaluated at several USMC locations during minor and major training exercises that will take place in 2021 and 2022. These evaluation sessions will ensure a large number of Marines will receive broad exposure to the MPEP platform and will be trained and assigned tasks to complete with the vehicle. These exercises will generate a significant amount of evaluation data and feedback from the users that can be collected and analyzed to support potential expansion of the vehicle testing.

3. ASSESSMENT SUMMARY

A live assessment of the MPEP took place in Hawaii in July 2021 where Marines were given the opportunity to be trained on the MPEP and evaluate its capabilities through several field exercises.

During the assessment of the MPEP, the USMC Demonstration and Assessment Team (DAT) was present to collect data and record the outcomes of the MPEP evaluation activities. A request for a copy of, or access to, the evaluation data was sent to DAT following the assessment but at the time of writing of this report, unfortunately, no data had been received. Without the assessment data available for review, no formal evaluation of the MPEP's capabilities during the July 2021 exercise can be made in this report at this time.

Although no evaluation data from the July 2021 exercise was available for inclusion into this report, conversations with Tracks NA indicated that the MPEP was seeing broader use and evaluation by varied Marine Corps groups. Following the initial MPEP purchase by the Logistics Innovation Office (LIO), which was sent to Hawaii for the July 2021 exercise, Tracks NA confirmed that Marine Corps Systems Command (SYSCOM) purchased multiple additional MPEP units for further use and evaluation across the USMC. More recently, the LIO has placed a follow up order for three more MPEPs that is currently in-process with the destination for these additional units still undecided.

Of these additionally purchased units, one of them is currently located at the USMC Basic School in Quantico, Virginia where it sees daily use as part of the training of newly commissioned Marine Corps officers. The MPEP that was sent to Hawaii for initial evaluation ended up deploying with the Marine Corps unit that had received it. During the deployment, the MPEP was borrowed by a Navy SEAL team who used the platform during one of its exercises or missions before returning to the USMC unit. USMC stakeholders and Tracks NA have been excited about the expanded use of the platform and hope to see even broader adoption and evaluation going forward.

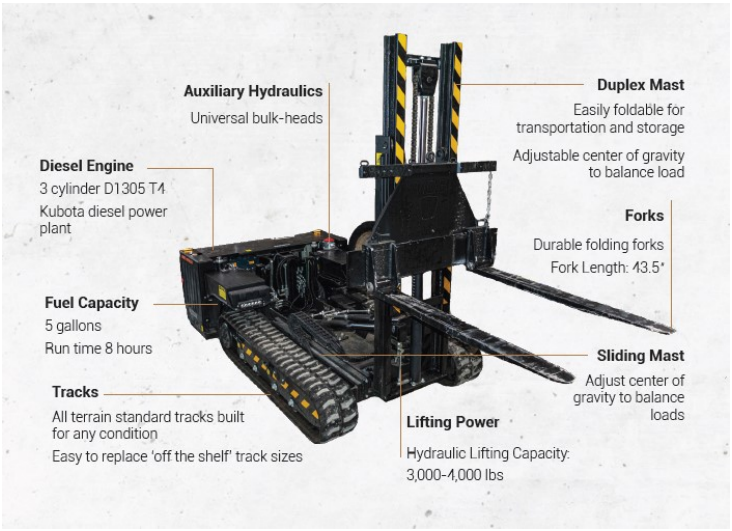
4. TECHNOLOGY NEXT STEPS

At the time of writing of this report, it hadn't been determined what next steps the USMC would be taking in terms of further evaluation or procurement of the MPEP. While several units are currently in-use across the USMC, data gathered during evaluations is still being analyzed and plans around further procurement are still in discussion.

Separately, Tracks NA has continued to evaluate the MPEP platform and examine further development opportunities. Tracks NA is engaged with the Center for Autonomous Vehicles and Sensor Systems at Texas A&M University to incorporate semi-autonomous functionality into the MPEP while retaining the remote-control features in the current design. These functions will include breadcrumbing and "teach and repeat" features for repetitive tasks. Tracks NA is incorporating LIDAR, visual & thermal cameras, inertial measurement units, and GPS-based systems for these features. Additionally, the company is upgrading to a digital remote-control system allowing end-users to track the machine's performance in real-time. These functionalities are currently being pursued through a Phase II solicitation with the U.S. Air Force.

Tracks NA is also investigating how to modify the device for enhanced operations in marine environments and are also pursuing an all-electric model that can be repurposed as a power source in austere environments. At this time these advancements are in the development phase, but Tracks NA would prefer to engage defense partners throughout this process.

5. APPENDIX & ADDITIONAL PHOTOS



SILENT TACTICAL ENERGY ENHANCED DISMOUNT (STEED) EVALUATION REPORT

Technology Assessment for EABO Operations

EXECUTIVE SUMMARY

The United States Marine Corps (USMC) is in the process of adopting a new strategy to better position for operations in austere, contested littoral environments. As part of this strategy shift, the USMC will need to examine what vehicles, tools, and platforms are available to be utilized to best support operating under this new strategy.

One innovative tool that could be valuable in this new operating environment is the all-terrain, operational payload platform known as the "Silent Tactical Energy Enhanced Dismount" or STEED, for short. Offering increased payload capacity, reduced injuries and exertion for operators, and transferable electric power, the STEED could prove to be a valuable addition to the arsenal of tools the USMC will need to leverage to be successful in difficult and undeveloped environments. The STEED could empower Marine forces operating in EABO environments to traverse further distances at a faster rate, increase their self-sustainment through higher supply payloads, and increase their lethality in distributed operations in contested areas.

Prior to the widespread adoption by the USMC of a new platform such as STEED, it must first undergo rigorous testing and evaluation by the personnel that will be tasked with using and maintaining the platform over the long term. These evaluations should be directed and organized to allow for collection of evaluation data and user feedback to help compare between similar platforms and support procurement planning.

Prior to the live exercise with the STEED, a list of evaluation objectives was compiled in order to guide the evaluation process during the live exercise. These objectives included determining which specific tasks the STEED could support as well as understanding the training requirements necessary for a user to become proficient in operating the STEED. Although no evaluation data was available for analysis at the time of the writing of this report, the USMC is continuing to evaluate the STEED by placing the units with varied groups around the country who will continue to experiment with the platform during EABO-focused exercises and training planned through FY23. Following this long-term evaluation cycle, the USMC will compile existing evaluation data and user feedback to inform decisions around further procurement of the STEED if it proves to be a valuable tool for use in the future operating environment.

1. TECHNOLOGY OVERVIEW

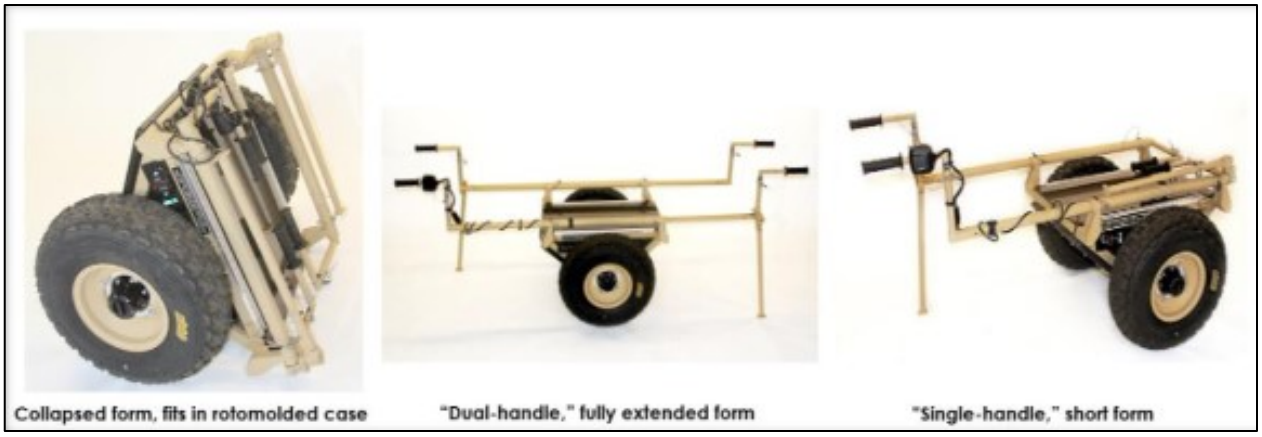
The Silent Tactical Energy Enhanced Dismount (STEED) is an electric, all-terrain, operational payload platform designed for multi-purpose use in military operations spanning significant distances to be traversed on foot. Designed by Hendricks Motorsports, the STEED serves as a self-powered payload platform which reduces the payload and exertion of each individual soldier. STEED can also be used for rapid casualty evacuation and as a secondar power source that can import and export energy to other devices via integration with the "Squad Power Manager" (SPM-622) tool.

STEED is powered by a 1500-watt electric motor that draws energy from two 12-volt lithium-ion batteries which can be fully recharged in 2 – 4 hours. The platform has a top speed of 6.5 MPH in both forward and reverse directions and an operating distance of 15 – 30 miles depending on the terrain and payload. STEED can be operated by a single person utilizing the thumb throttle control on the handle of the platform and can be adjusted to varying handle heights and single or dual handle configurations to support the needs of the user.

Designed with military operations in mind, the STEED possesses many characteristics that make it attractive for defense use including all terrain tires with sand and run-flat options, IP67-level fully submersible immersion rating, and multiple configurations that support the transport of everything from weaponry to personnel, as well as transportation of the platform itself. The STEED can be shipped within its rotomolded transport case, which fits on a NATO standard pallet, as well as via UH-60, MRZR rear cargo areas, Stryker exterior bustle racks, and more.

For small military units operating in austere and contested environments, standard vehicles and sustainment support will be limited or completely non-existent. Utilizing a platform like STEED would allow for these units to take extra supplies with them, without increasing the payload of individual soldiers, which would increase the amount of time the unit could self-sustain while decreasing the exertion required by the Marines to transport these supplies. This capability could also make it easier to change locations more frequently and the near-silent operation of the electric motor ensures stealth, when desired.

STEED Specifications	
Dimensions (Collapsed): 30" x 39" x 25"	**Range:** 15-30 Miles (single battery pack)
Dimensions (Extended): 93" x 39" x 37"	**Top Speed:** 6.5 MPH (forward and reverse)
Total Weight: 190 Lbs.	**Motor:** 1500W Electric (power import/export)
Payload Capacity: 500 Lbs.	**Charging:** 2-4 Hours (avail. secondary battery)



2. EVALUATION OBJECTIVES

The USMC's expeditionary advanced base operations (EABO) strategy aims to move the USMC capabilities in the direction of being able to successfully operate in austere, distributed marine environments that exist within contested geographic locations. The challenges associated with operating in this environment are numerous with special difficulty in moving and sustaining Marines and their equipment when normal resupply channels are not available.

With these challenges in mind, the STEED platform has the potential to be a valuable tool for small Marine forces operating in these extreme environments. Utilizing STEED, Marine forces would be able to traverse difficult terrains not passable by typical vehicles while also carrying significantly higher supply payloads than could be carried by several individuals on foot. They would be able to travel discreetly with almost no audible signature thanks to the STEED's electric motor. The reduced exertion will allow for faster and more regular movement to prevent detection by foes when operating in contested areas. An improvement in unit lethality, reduction in injuries, and extended self-sustainment are all key capabilities that the STEED could offer to the USMC if found to be a robust platform during evaluation.

The STEED is being evaluated along many different dimensions to determine its feasibility for broader use in future USMC EABO. Some of these evaluation criteria are generalized and apply to most new technology being evaluated for use while other criteria are more specific to the exact capabilities and expectations of the STEEDs use.

The objective of the evaluation aims to answer the following questions:

1. What tasks and activities can the STEED support?
2. Does the STEED significantly speed up or reduce the difficulty of these tasks?
3. How easy or difficult is it for an operator to pilot the STEED over varied terrain while carrying a payload?
4. How much training is needed to become proficient in operating the STEED?
5. What is required for the transportation, unloading, and storage of the STEED?
6. How well does the STEED perform in marine/saltwater-based operations?
7. What is required for maintenance and repair of the STEED during extended operations?
8. What are the major strengths of the STEED?
9. What are the major constraints or weaknesses of the STEED?
10. How does the STEED improve the efficiency and lethality of the USMC?

While this list is not exhaustive, it addresses the major objectives of the technology evaluation and the data gathered in response to these questions will be a key input into the subsequent phases of considering this platform for additional evaluation and potential broader adoption.

The STEED is being evaluated at several USMC locations during minor and major training exercises that will take place in 2021 and 2022. These evaluation sessions will ensure a large number of Marines will receive broad exposure to the STEED platform and will be trained and assigned tasks to complete with the platform. These exercises will generate a significant amount of evaluation data and feedback from the users that can be collected and analyzed to support potential expansion of platform testing.

2. ASSESSMENT SUMMARY

A live assessment of the STEED took place in Hawaii in July 2021 where Marines were given the opportunity to be trained on the STEED and evaluate its capabilities through several field exercises. During the assessment of the STEED, the USMC Demonstration and Assessment Team (DAT) was present to collect data and record the outcomes of the STEED evaluation activities. A request for a copy of, or access to, the evaluation data was sent to DAT following the assessment but at the time of writing of this report, unfortunately, no data had been received. Without the assessment data available for review, no evaluation of the STEED's capabilities by the USMC can be made in this report at this time.

3. TECHNOLOGY NEXT STEPS

At the time of writing of this report, the STEED units purchased and evaluated during the Summer of 2021 were still undergoing evaluation by varied groups within the USMC to gather additional data and help inform further fielding and procurement decisions by USMC leadership.

Specifically, the purchased units have been assigned to 1st Battalion, 2nd Marines in North Carolina and 1st Battalion, 3rd Marines in Hawaii, where they will be involved in follow-on Marine Littoral Regiment experimentation through FY23. This extended usage by different groups within the USMC will ensure broad exposure of the platform to different users and use cases while also allowing for the gathering of significant evaluation data and user feedback. Additionally, this long-term evaluation cycle will contribute to a better understanding of the long-term maintenance and repair requirements of the platform.

4. APPENDIX & ADDITIONAL PHOTOS

NEAR EARTH AUTONOMY FIREFLY UNMANNED LOGISTICS SYSTEM (ULS) EVALUATION REPORT

Technology Assessment for EABO Operations

EXECUTIVE SUMMARY

The United States Marine Corps (USMC) is in the process of adopting a new strategy to better position for operations in austere, contested littoral environments. As part of this strategy shift, the USMC will need to examine what vehicles, tools, and platforms are available to be utilized to best support operating under this new strategy. As sustainment of small, mobile Marine groups will be difficult in these austere environments, autonomous drone technology is being considered as a potential solution to this challenge. While manually piloted drones have been subject to difficult constraints in the recent past, technological advancement has improved the prospect of autonomous flight systems that can quickly, and without oversight, deliver food, medical aid, and general sustainment to Marines operating in extreme and difficult environments where standard sustainment channels can't reach them.

Over the past year, the Marine Corps Warfighting Lab (MCWL) and Near Earth Autonomy have partnered to develop a small footprint – low cost autonomous flight platform that could be affixed to many drone platforms and provide autonomous flight capabilities such as obstacle avoidance and takeoff/landing zone evaluation. This effort was undertaken in order to further progress the development of technologies and methods that would be required for successful deployment of these platforms in real defense operations. This report provides an overview of the Firefly technology and its development roadmap as well as providing criteria for the technology to be evaluated against. This evaluation takes into account applications of the technology to the evolving USMC needs and future fighting strategy. Lastly, it provides a summary of the live demonstration of the technology that took place in May 2022 and potential next steps or further evaluation that could be undertaken, as discussed by key project stakeholders following the demonstration flights.

This project demonstrated that autonomous drone platforms operating as unmanned logistic systems offer significant potential in becoming a valuable tool in the Marine Corps' arsenal as they look toward the future and redefine optimal operating strategies in novel and extreme environments.

1. TECHNOLOGY OVERVIEW

Figure 1: Firefly autonomy system close-up

The Near Earth Autonomy Firefly is an autonomous piloting system that, when affixed to a compatible drone, enables significant autonomous capabilities in the form of obstacle avoidance during departure and takeoff as well as landing zone evaluation which dynamically determines optimal landing zones.

Near Earth Autonomy had previously developed these capabilities in a larger autonomy system known as the "Peregrine" which was designed for autonomous operation of larger UAVs, specifically targeted to *ULS-A (Unmanned Logistic System – Air) Medium* applications. Discussions with the USMC and others in the defense space had made clear there existed an interest in determining if these same capabilities could be had on a much smaller scale. With a focus on reduced SWaP-C (Size, Weight, Power, and Cost), the company set out to try and replicate the Peregrine capabilities in a much smaller and cheaper package without significantly reducing performance.

The Firefly autonomy system (Figure 1) has two main components: the Firefly core module (containing cameras and the major computing hardware) and an adapted Lidar (Light detection and ranging) device. The Lidar device is shared between the Firefly and Peregrine but while the Lidar on the Peregrine rotates constantly to build a three-dimensional image of the surrounding area, weight and power restrictions on the Firefly led to a fixed Lidar mounting. Given that the Lidar could not rotate on the Firefly, Near Earth Autonomy engineered behavior into the Firefly that causes the entire drone to perform a pirouette or similar movement to imitate the rotation of the Lidar on the Peregrine and allow for full inspection of the area regardless of the fixed nature of the Lidar device.

Unlike manually controlled drones, a Firefly equipped UAV can be assigned a mission to depart from a given location and travel to a set destination without any previous mapping of the environment and without intervention from a human pilot during any part of the journey. Firefly allows the drone to evaluate its surroundings in real-time during takeoff, assess when it has reached an obstacle-free point to traverse the major length of the journey and then evaluate a landing zone and land safely, regardless of obstacles or debris that may be present in the area.

Given these capabilities, coupled with a lower cost and smaller footprint (Table 1) than alternative autonomous drone platforms, the Firefly platform has the potential to be utilized in a wide range of defense applications. For the purposes of this project, special emphasis is placed on opportunities to use Firefly to support logistics operations in austere, marine environments where sustainment and re-supply activities will be difficult to carry out through standard methods.

Firefly Specifications	
Dimensions(LxWxH): 6.8"x6.3"x4.6"	**Targeted Payload Applications:** 60-150 Lbs.
Total Weight: 2.65 Lbs.	**Targeted Distance Applications:** 10-20 km. radius
Platform: ULS – A Small	**Landing Zone Evaluation:** Avoids >45cm obstacles

Table 1: Key Firefly characteristics

2. EVALUATION OBJECTIVES

Figure 2: Firefly mounted on drone during live demonstration

The USMC's expeditionary advanced base operations (EABO) strategy aims to move the USMC capabilities in the direction of being able to successfully operate in austere, distributed marine environments that exist within contested geographic locations. The challenges associated with operating in this environment are numerous with special difficulty in moving and organizing personnel, supplies, and equipment.

In consideration of this new strategy, the USMC must examine innovative solutions to some of the novel challenges that will be faced in an EABO environment. For example, it will be difficult to provide sustainment support to small groups of Marines that are constantly moving, potentially from island to island, in contested territory. It will be too risky to bring large supply ships close to the operating environment and any standard resupply aircraft will quickly reveal the position of any covert units. Small, autonomous drones could be a potential solution in this vexing scenario. An autonomous drone could depart a remote supply base or even a distant supply ship with a small sustainment package and deliver it to a covert unit quickly and quietly. The low cost of the drone makes it a risk-worthy asset that the Marines can be prepared to dispose of, and the autonomous capabilities do not require full-time input from a human pilot, potentially allowing for multiple drones to be running simultaneous resupply missions without need for any manual oversight.

In addition to providing sustainment support, autonomous drones could also provide medical support and deliver lifesaving items such as first-aid kits, blood, and medication to wounded Marines in austere environments much more quickly than any other form of standard support. Absent the need for these previously mentioned applications, the onboard cameras and manual flight options make it possible to use a platform such as the Firefly for piloted or autonomous reconnaissance activities in situations where on-foot reconnaissance is too dangerous.

Unlike the other COTS platforms evaluated as part of this project, the Firefly platform was developed directly in response to a request by the USMC MCWL (Marine Corps Warfighting Lab) and LIO (Logistics Innovation Office). Due to this fact, the evaluation of the Firefly platform was primarily focused on how well the technology met the objectives that were outlined at the beginning of the project. Further determination and testing regarding the training, deployment, and long-term maintenance of the platform within the USMC will need to be examined in future projects.

Drawing from the original requested requirements of the Firefly platform and knowledge about potential use cases in an EABO environment, the Firefly technology was evaluated against the following criteria.

1. Can autonomous flight capabilities be implemented on ULS-A Small platforms?
2. Can autonomy-enabled platforms takeoff and land safely in areas where obstacles are present?

3. Can autonomy-enabled platforms avoid obstacle collision during takeoff, flight, and landing?
4. What tasks and activities could Firefly potentially support?
5. Would the Firefly platform significantly speed up or reduce the difficulty of these tasks?
6. What are the major strengths of Firefly?
7. What are the major constraints or weaknesses of Firefly?
8. What improvements, if any, could be made over the current version of Firefly?
9. How could the Firefly platform improve the efficiency and lethality of the USMC?

While this list is not exhaustive, it addresses the major objectives of the technology evaluation and the insights gained from answering these questions will help determine potential technology applications, improvement opportunities, and feasibility of broader deployment in the USMC.

At the outset of the project, it was determined that the initiative would conclude with a live demonstration of the developed autonomy platform. The demonstration would consist of multiple live drone flights, or "missions", which would allow key project stakeholders to evaluate the technology capabilities, gather data about the platform, and better determine defense use cases for the system.

3. ASSESSMENT SUMMARY

A live assessment of the Firefly platform took place at Nardo Airfield, just outside Pittsburgh, PA on Wednesday May 25th, 2022. Several project stakeholders from both defense and industry were present with representation from USMC MCWL, USMC LIO, Office of Naval Research, Michigan Research Institute/Black&Rossi, SURVICE Engineering, and more.

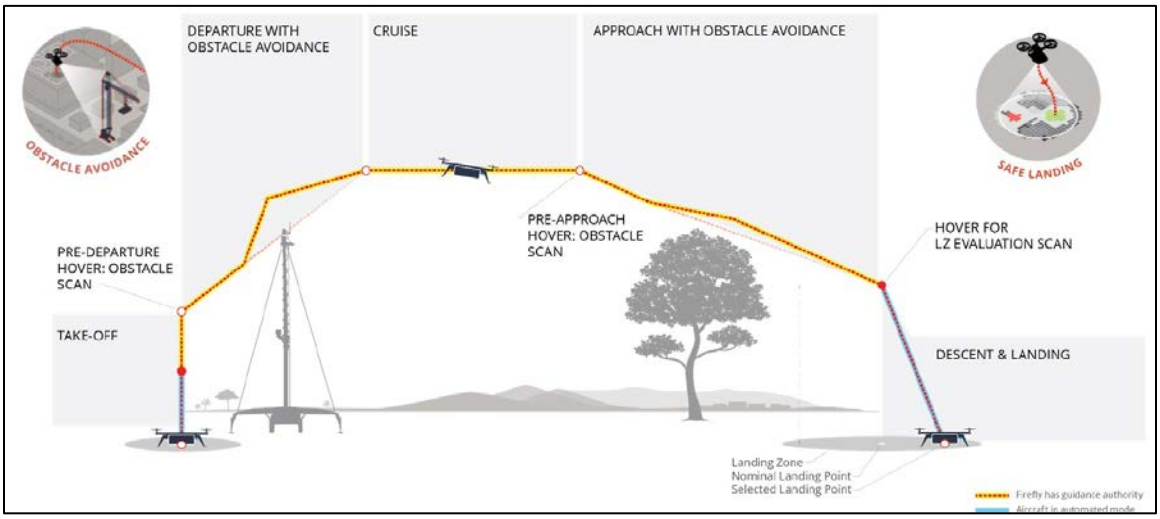


Figure 3: Autonomous capability and flight path visualization

The demonstration consisted of three "mission" flights (Figure 3) where the Firefly enabled drone would safely takeoff while evaluating its surroundings for obstacles, cruise through a pre-determined mission path loop that would then bring it to its landing zone where it would once again avoid obstacles and evaluate its approach to the landing zone and then autonomously evaluate and select a landing location based on obstacles present in the landing area. For each flight, the takeoff and landing location were modified so that Firefly would demonstrate its ability to operate in varying conditions.

Given the targeted application of using the Firefly platform for logistics support in austere environments, each of the test flights began and ended in a forested section of the airfield entry drive (Figure 4) which offered limited open space for the drone to depart from and return to while avoiding obstacles. This congested flight area was selected in order to demonstrate the ability of the Firefly to successfully navigate and operate in an environment that could realistically be encountered in defense operations.

Figure 4: Live demonstration takeoff/landing area

The three mission flights were completed flawlessly by the Firefly platform. The technology managed the varying takeoff locations and the ever changing field of obstacles upon each landing, always successfully evaluating the landing field, and selecting a safe place to land. The demonstration confirmed that significant autonomous flight capabilities (takeoff and landing evaluation, obstacle avoidance) could be integrated into a smaller form factor. The demonstration also confirmed for the stakeholders that, in theory, the Firefly platform or something similar could be used for autonomous logistics support in the USMC EABO environment as well as similar defense scenarios.

4. TECHNOLOGY NEXT STEPS

The live demonstration of the Firefly platform immediately generated conversations and questions among the project stakeholders about the potential of further developing the technology. Questions regarding platform performance in saltwater environments as well as a capability to depart from and/or land on a moving ship were also raised. Near Earth Autonomy stated that many of these capabilities were likely possible but would need to be distilled into specific requirements so that Near Earth Autonomy could better estimate the feasibility, funding requirements, and timeline to develop these additional features.

At the time of writing of this report, conversations are still ongoing among the MCWL and other defense stakeholders about what the official next steps might be for this technology in terms of further testing or further capability development. While further technology maturation will need to take place before a platform like the Firefly can be put in the hands of operating Marines, it nonetheless has proven that it could be a valuable platform in the future EABO environment in which the USMC plans to operate.

5. APPENDIX & ADDITIONAL PHOTOS

Figure 5: Drone shortly after landing safely following third demonstration flight

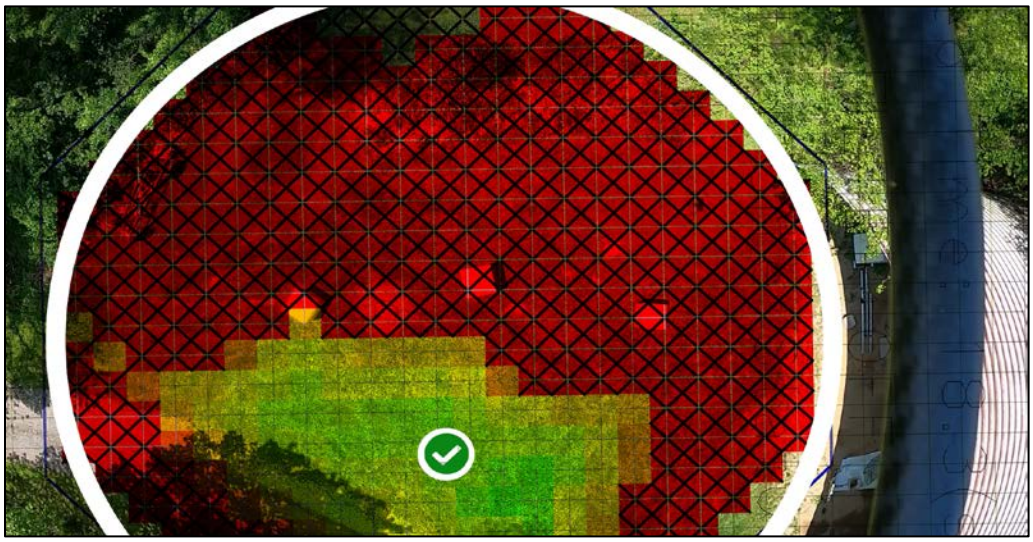


Figure 6: Computer augmented image of landing zone evaluation by Firefly

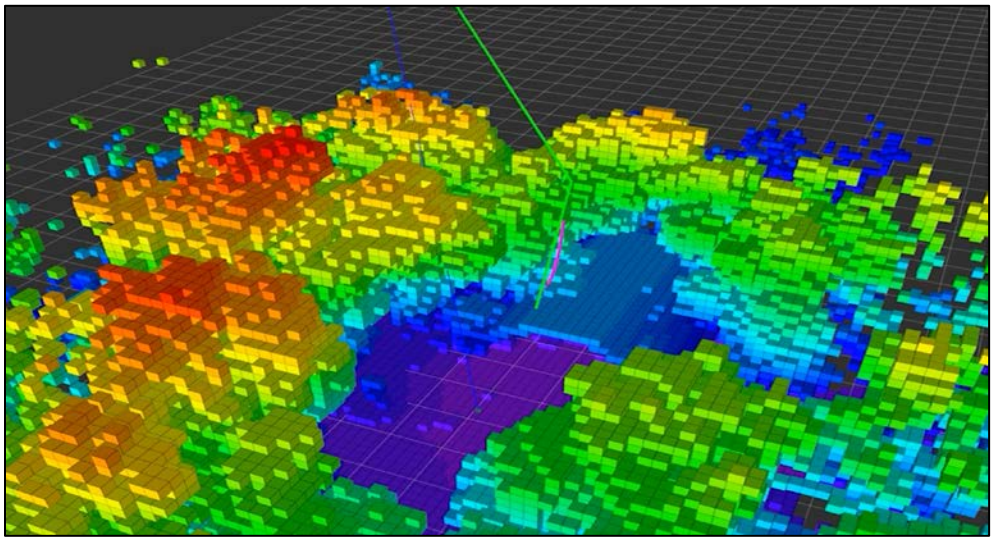


Figure 7: Computer generated image of obstacle avoidance mapping by Firefly

Appendix C – Supply Chain Management Tools Assessment

SUPPLY CHAIN DISRUPTION SOFTWARE MARKET REPORT

Assessing Digital Tools to Support EABO Operations

EXECUTIVE SUMMARY

The United States Marine Corps (USMC) has recently formulated and begun to experiment with a new operating strategy known as Expeditionary Advanced Base Operations (EABO) that focuses on forward deployment and force projection in austere environments. In order for these operations to be carried out successfully, the strategy requires robust and predictable supply chains to provide materials to the distributed forces operating in austere environments. This paper reports the results of an assessment of Commercial-Off-The-Shelf (COTS) Supply Chain Management and Analysis tools that could be used for supply support and analysis of supply disruptions in an austere "EABO-like" environment. Technologies were evaluated for potential incorporation into the Naval Aviation Enterprise (NAE). Stakeholders in a typical supply chain are identified along with a review of requirements and tools needed to manage that chain. Based upon the identified requirements, criteria by which to make a realistic assessment of available tools are listed and described. An initial curated list of ninety five potential candidates was developed. A series of rigorous evaluations based on the team's research and experience distilled the original list to twenty nine candidates. A second round refined the list to eleven semifinalists. Finally a group of four tools that came closest to meeting all requirements were identified. Two more "Honorable Mentions" offered unique capabilities that could fill gaps.

This study did not identify an application that met all requirements to fit the complex task assigned in the Statement of Work.

1. INTRODUCTION

1.1. PURPOSE

In recent years, many nations and their defense organizations have recognized the need to expand their defense capabilities beyond the land based operations that have been the basis of most conflicts in recent history. This includes exploring new ways to operate in austere maritime environments which presents challenges not present in ground based defense activities. One of these strategies currently being developed by the United States Marine Corps (USMC) is Expeditionary Advanced Base Operations (EABO). EABO aims to provide sea denial and projection of naval power by forward deploying expeditionary forces in potentially contested austere maritime areas.

Given that these expeditionary forces must operate as small, mobile units in potentially contested areas, mission planning and organization are of the utmost importance to ensure successful operations. This importance on planning and organization is further emphasized by the fact that support forces for these expeditionary units is often not close by or readily available and communications between forces will be limited or unavailable at times.

One of the most pivotal components to successful EABO activities will be robust and predictable supply chains. Without supplies being reliably available to forces operating in these environments, mission success will surely be in jeopardy. In order to operate effectively, forces working within an EABO environment will need to be able to map out their supply chains and analyze supply chain disruptions that may arise due to weather, workforce interruptions, acts of nature, or other disrupting events. The purpose of this report is to document the assessment of Commercial-Off-The-Shelf (COTS) supply chain analysis and management tools for potential incorporation into the operating environment described above. Given that these tools are developed and used for mainly commercial purposes we will provide a basic overview of commercial supply chains and then discuss the similarities and differences present in military supply chains. This will be followed by an outlining of assessment criteria and the actual examination of the tools eligible for the use-case.

1.2. SUPPLY CHAIN OVERVIEW

A supply chain is a network of resources, organizations, activities, and technologies involved in the creation, sale, and delivery of a product, from the supplier of source materials through the manufacturer, to delivery to the end user. This paper is intended to help focus efforts to select promising supply chain management (SCM) software candidates.

In its most basic form, a supply chain follows a path from obtaining raw materials to fabricating components to assembling a product to delivery of the product. Various modes of transportation connect the manufacturing stages and storage is often required between stages. Ordering, invoicing, and payment may also be considered part of the supply chain. For the purpose of this paper those sections will be omitted. A disruption at any point will cause the entire chain to fail.

1.3. WHY IS THE SUPPLY CHAIN BROKEN?

At present, supply chain disruptions are affecting every aspect of life. Limited availability and high cost are "sand in the gears" of the nation's economy. For businesses and defense organizations alike, supply chain network visibility and the ability to analyze the impacts of disruptions are more valuable than ever. Secondary effects will magnify the disruption. For instance, in 2021 a ship ran

aground in the Suez Canal, delaying the material on that ship. It also delayed a parade of ships behind it. Other ships were forced to take longer, more time-consuming routes. When the backup was relieved, a flood of ships arrived at their destinations at the same time. The ports were unable to accommodate them all in a timely fashion, further delaying the merchandise. This was exacerbated by a shortage of longshoremen caused in part by the Covid pandemic.

As of this writing, there are seventy (70) container ships outside the Port of Los Angeles awaiting their turn to be unloaded. Meanwhile those seventy ships are not moving any new cargo. They are storing merchandise. Back at the point of origin, merchandise is piling up for lack of shipping.

When the containers are finally unloaded, they are stored until they can be picked up by truck or rail. In the meantime, the merchandise is delayed, again. And the containers themselves are not available to be loaded with new merchandise. There is a worldwide imbalance in twenty-foot equivalent (TEU) shipping containers; too many in consuming nations and not enough in producing nations.

Railroads may carry the containers to a regional center close to their destination, but ultimately the containers must be delivered the "last mile" via truck. In another Covid related labor shortage, there are not enough truck drivers, currently. Another shortage in North America is the chassis that carries the TEU. In the past they have been manufactured in Asia and shipped to North America. In hopes of accelerating the pace of replacement, American manufacturers are attempting to build the chassis near home. However, the components still come from Asia and are delayed by the same broken supply chain.

1.4. FOR WANT OF A NAIL…

The effects on the nation are wide ranging. Since the supply chain has become unreliable, many businesses are shifting from a "Just in Time' philosophy to "Just in Case," ordering ahead to ensure they will weather the next shortage. This is similar to the issue observed at the beginning of the Covid pandemic when people rushed out to buy toilet paper. That created the illusion of a shortage that did not really exist. In any case, it imposes an additional strain on the supply chain.

Shortages of needed supplies, material, and equipment create friction in the economy. They hinder technological progress. The auto industry is the poster child for this phenomenon. As Ford and General Motors rush to implement technological innovation, they are stymied by their inability to obtain the computer chips they need to develop clean electric vehicles. The defense sector's efforts to explore technological innovation are likewise impeded. This writer recently participated in two potentially valuable defense related projects that were delayed by supply chain disruptions.

Inefficient, sluggish supply chains create high prices leading to inflation, reducing the value of the dollar leading to higher prices. The resulting damage to the economy causes distress to nearly all citizens, but most especially to the one in seven Americans surviving below the reported poverty line.

1.5. COMPLEXITY

Modern supply chains in support of manufacturing are often extremely complex. The components that go into an end use product may come from many diverse sources. A relatively simple example is a Dell laptop computer. Table I shows the number of different sources for each component of a Dell computer. Table II shows the thirteen nations providing components.[1]

Table I Dell Laptop Components

Dell Multiple Sources	
Component	Number of sources
Battery	3
Carrying Bag	2
CD/DVD Drivve	3
Cooling Fan	2
Graphics Card	2
Hard Disk Drive	3
Keyboard	3
LCD Monitor	3
Memory	4
Memory Stick	2
Microprocessor	4
Motherboard	4
Power Cord	3
Power Supply	2
Wireless Card	2

Table II National Sources of Components

Dell Laptop Computer Components		
National Sources		
	Nation	Number of Compnents
1	China	10
2	Costa Rica	1
3	India	1
4	Germany	1
5	Indonesia	1
6	Israel	1
7	Japan	2
8	Maylasia	4
9	Phillippines	3
10	Singapore	1
11	South Korea	3
12	Taiwan	6
13	Thailand	2

Multiple sources enable a resilient supply chain by providing alternate suppliers in the event of production or transportation stoppage or delay at any one source.[2] However, this complexity presents a challenge to manage.

2. SUPPLY CHAIN MANAGEMENT TOOL CAPABILITIES & FEATURES

The purpose of this study was to examine the large number of existing commercial tools that aid organizations in analyzing and predicting supply chain disruptions and assess which tools would be best fit for potential use in austere military operations. This included defining the criteria by which the tools were judged. Given the size of the commercial marketplace not all tools could be considered but a large initial inventory was assembled and then down-selected based on the tool's ability to meet the pre-defined criteria. Before exploring the results of the assessment, further information regarding supply chain management, military operations, and supply chain analytical capabilities must be discussed.

2.1. MILITARY SUPPLY CHAIN/LOGISTICS

In the military logistics community Value Chain Management (VCM) is often seen as superior to

[1] (ResearchGate, n.d.)
[2] Examination of Table II reveals that only three components of the Dell laptop are sourced outside of East Asia. This may negate the advantage of dispersing suppliers in the event of conflict in the IndoPacific region

SCM. While SCM focuses on the "top down" flow of needed products from source to consumer, the VCM approach is to view the chain from bottom up to bring added value to the consumer. From the perspective of this paper, this is a distinction without a difference.

The military is supported by two parallel supply chains: the commercial supply chain briefly described above and the remarkably complex military supply system, headed nominally by the Defense Logistics Agency (DLA). Beneath that, a byzantine web of subordinate logistics commands provides supply support. Every service branch, every major subordinate command, and nearly every operational unit has its own supply section.

The military views supply as one component of logistics which also includes maintenance, transportation, and combat engineering. Due to the unique nature of military logistics, it is unlikely that commercial SCM applications would be optimal. In order to provide the greatest benefit, such an application should be networked and interoperable while remaining secure to military standards. It should accommodate Item Unique Identification (IUID) and interface with a maintenance management program.

A robust IUID program is essential to identify and verify the provenance of components and subcomponents. This information is necessary to ensure that quality and information security meet military requirements.

Those at the consumer end of the military supply chain are often mobile, aboard ship, deployed, or engaged in an operation. Expeditionary Advanced Base Operations (EABO) and Distributed Operations add yet another dimension and challenge to the supply chain. Location and mapping should also be included in any military SCM program.

2.2. COMPONENTS OF A SUPPLY CHAIN MANAGEMENT TOOL

To the extent possible, effective supply chain management tools must be able to alleviate the most difficult challenges of supply chain disruption. When assessing available supply chain management tools, it is important to remember that there are many different components in a supply chain. Most SCM tools specialize in just one or two of these areas. The elements of SCM are:

- Plan
- Source
- Make
- Deliver
- Return

The first of those elements is rigorous planning. Given that supply chain networks are often linear and interdependent, any disruption in one component of the supply chain can cause downstream disruptions as well, as was discussed in the introduction. This is what makes supply chain planning such a vital part of the operation. These are the components of effective supply chain planning:

- Supply planning
- Production planning
- Inventory planning
- Capacity planning
- Distribution planning

In a search for supply chain disruption analysis tools, the above are not a strict checklist, but one of the capabilities that must be taken into consideration.

2.3. SUPPLY CHAIN MANAGEMENT STAKEHOLDERS

SCM might better be called Supply Chain Information Management. SCM does not mine, make, transport, store or deliver anything. However, if properly constructed, an SCM application can provide the information that each stakeholder in the chain needs to accomplish the mission.

By definition a supply chain contains many links from production to consumption. Each stakeholder in the chain is reliant on the link above and accountable to the link below. The following is a very brief walk along the chain.

Manufacturing

- Materials Availability
- Manufacturing Capacity
- Workforce

Often, the supply chain starts at the mine. Manufacturing capacity is constrained by materials availability. If the lithium supply is limited, the factory output of batteries will be reduced. Factory output may also be constrained by the capacity of the facility. Manufacture of sophisticated machinery requires complex equipment and multiple factories. Note the intricate Dell computer supply chain described above. Each of the fifteen subcomponents listed was the product of its own supply chain. Once assembled, the laptop described moves on to the next stop in its supply chain. An effective SCM application must reach as far back as possible in the process to offer an accurate picture of end product availability and schedule.

Importantly, and often overlooked, qualified workforce availability is essential. The rote assembly lines of Henry Ford's era are slowly being replaced by robots. However, the tasks to be accomplished by humans are technically demanding, essential to the operation and often in limited supply. This is even true of what were once considered "blue collar" jobs.

Inventory Management

Frequently, at the end of the chain or at waypoints in the journey, items are warehoused. Without effective inventory management the chain can break down. Think of the closing scene of "Raiders of the Lost Ark". The military laments the 'Iron Mountain" of supply which, like the weather, everybody talks about, but nobody does anything about. The following is a look at the inventory management link in the supply chain.

- Availability
- Tracking
- Just in Time/Just in Case
- Order Flow
- Warehouse Management

An effective inventory management component to SCM must include Item Unique Identification (IUID) for appropriate items. As part of the overall SCM, interoperability with related data sources is indispensable. As mentioned above, the SCM must always be able to answer the question: "Where's my stuff?" It must also be able to demonstrate the ability to answer anticipated demand as identified by the methods briefly described in the "Demand" section.

In recent years, the popular "Just-in-Time" logistics has replaced the "Iron Mountain" theory of stocking. It is far more efficient except when it isn't. When the supply chain experiences a delay, users quickly sense a shortage. Production is delayed awaiting supplies. Panic ordering sets in

creating a demand spike as described above. Often, the needed items are available in inventory, but not properly accounted for. An SCM should be able to identify a "false shortage" such as this and recommend measures to cope.

The SCM must be able to compare demand (including predicted demand) with available inventory to identify potential delays and shortages. It should prioritize shipments when not all can be filled, and determine when needed inventory will be available. It should identify alternate sources for high priority items not in stock.

Shipping/Distribution

This is the link that most people first associate with the supply chain.

Transportation Methods

- Ports
- Rail yards
- Railroads
- Roads
- Maritime

Constraints

- Capacity
- Velocity
- Environment
- Choke points

The SCM must be able to identify the optimum shipping method for a particular commodity (any item in the inventory, that is) between likely origin and destination. It should offer alternate choices, based on speed, cost, likelihood of delay. Particular attention must be given to known choke points. It should be able to identify potential unplanned delays in much the same way Waze or Google Maps do for drivers. It should be able to estimate arrival date/time when appropriate.

Inputs from external sources should include world weather reports, news, shipping status from railroads, airlines, trucking companies, maritime shipping and ports. Once shipped, items must be tracked for detailed in-route status in a similar manner to United Parcel Service.

2.4. SUPPLY CHAIN MANAGEMENT TOOL REQUIREMENTS

Analytical & Predictive Capabilities

- Forecasting Demand & Supply
- Forecasting Inventory Levels
- Root-Cause Analysis (RCA)

A feature that is pivotal to a valuable supply chain management/disruption analysis tool are built-in predictive and analytical tools. In order for these SCM tools to function properly, they have to collect data on each component of the supply chain, from planning activities all the way through to distribution and delivery. Along the way, the tool will have access to, and collect, a plethora of data points about products, operations, vendors, and more.

The centralized availability of these data makes it possible to run analyses and even build predictive

models to help inform future supply chain decisions and alert supply chain operators to potential challenges[3].

For example, historical data on customer orders in different geographical locations could be used to build a demand forecasting model to help anticipate raw material and manufacturing requirements in different locations or strategies for distributing inventory to warehouses near customers with the greatest demand. Additionally, following the late delivery of an order, the tool could be used to perform root-cause analysis (RCA) and isolate a transportation leg that took twice as long as normal, which led to the late delivery. The tool could even alert operators when the transportation leg extends beyond the normal expected time so that they may pro-actively take action.

These capabilities are a must-have for any enterprise managing a supply chain as they're vital to making sense of the growing volume of data and increasing complexity present in today's modern supply chain networks.

Responsive Network Management

- Anticipate Demand & Supply
- Sense & Respond Logistics
- Reliability Centered Maintenance (RCM)
- Digital Twin/Modeling & Simulation
- Real-time Tracking

From the user's perspective, the most important attribute of an SCM application is information and predictability. "Where's my stuff and when's it going to get here?" Unanticipated spikes in demand, are disruptive to the supply chain. Sensing such a spike can enable appropriate response to adjust in time to alleviate the trouble.

The same is so for other unforeseen supply chain disruptions such as natural disasters, international conflicts, or accidents such as the closing of the Suez Canal due to a grounded ship. Stephan Haeckel, in his book *Adaptive Enterprise* describes the Sense and Respond model.[4] If such events can be identified and responded to quickly, peaks and valleys in the flow of goods can be moderated. Modeling and simulation in concert with an analysis method similar to RCM as described by John Moubray in *Reliability-centered Maintenance*, can identify potential demand spikes and points of failure to be readily "sensed" or modified to reduce the risk[5].

In order to fully understand the impact of disruptions on the entire supply chain network, an organization must possess an accurate model or "digital twin" of their current supply chain. Modeling a simulated disruption in the digital twin enables the manager to analyze and address the root cause. The model can also reveal down-stream impacts so they can be acted upon before they become disruptions.

The concept of creating a digital twin and running simulations on this network model is something that has only recently become achievable for most organizations thanks to advancing technology. Nonetheless, it is difficult for many organizations to develop this capability due to the complex and ever changing nature of their supply chain networks. The use of digital twins and simulation offers

[3] (PAT RESEARCH, 2020)
[4] (Haeckel, 1999)
[5] (Mourbray, 1997)

significant value and builds robustness into the network so that it may withstand disruptions that normally would present significant challenges to the organization.

3. ASSESSING SUPPLY CHAIN MANAGEMENT TOOLS

Using the above identified requirements for SCM and supply chain disruption analysis tools, we set out to define the universe of tools for consideration.

Given that the assessment was aimed at determining the appropriate tool for analyzing the impact of supply chain disruptions on military operations in austere environments, special consideration was given to certain assessment criteria which determined whether a certain tool was a good fit for the use case or whether it was eliminated from the assessment. These included the following:

1. **External System Integration Capability:** Given the myriad other systems currently in use by the military, this system must be able to integrate with existing logistics and supply systems.
2. **End to End Supply Chain Management:** The correct tool will need to be able to manage the whole supply chain process, tools that focus on singular components of the supply chain will be insufficient for this use case.
3. **Feature Requirements:** At a minimum, sufficient tools will include sense and respond, digital twin, simulation, and analytical/predictive capabilities as defined earlier in this paper.
4. **Hardware & End User Requirements:** Given that this tool would be under consideration for use in austere military operations, it must possess cloud operating capabilities and ease of use for end users who will likely be distributed and unable to support significant hardware or complex training and software support.

Given our initial list of tools, we examined the characteristics of each and compared them against our above criteria. This resulted in multiple rounds of down-selecting, re-examing, and further downselection of the list until we arrived at the tools we felt adequately met the criteria.

4. ASSESSMENT OUTCOME & FINDINGS

Our assessment began with a broad list of ninety-five (95) different supply chain management tools and services from a varied number of vendors and providers. This list was curated based on information gathered from technology research firms, such as Gartner, and other peers as well as through internet research and the experience of the authors in using some of these tools.

Applying the criteria outlined above, this list of ninety-five was initially distilled down to twenty-nine (29) tools that provided some of the capabilities required of the proposed use case. A further analysis of these twenty nine tools was then performed and the list was once again refined to eleven (11) for further consideration (see table III). These remaining tools were then examined closely and their unique strengths and weaknesses were documented so that each tool could be compared against our assessment criteria while also allowing comparison against the peer tools in the list.

Table III Semi Finalists

	Product	Parent/Partner	Advertized Specialty	Website	Comments
1	Blue Yonder Sales & Operations Planning/ Luminate		Purpose Built/AI/End-to-end Visiblity	https://blueyonder.com	
1	Luminate Platform	Blue Yonder	Integrated Data Management	www.blueyonder.com	See Blue Yonder
2	Coupa BSM Platform	Llamasoft	t	www.coupa.com/platform	Continuous Supply Chain Design/Digital Twin
2	Llamasoft	Coupa	AI Powered Supply Chain	www.coupa.com	Simulation
3	Descartes Reporting Services Supply Chain Analytics		Global SCM	www.descartes.com	Widely used
4	Infor Supply Chain Management		DoD Readiness	www.infor.com	
5	Interos		Enterprise Vislibility	www.interos.ai	"See verything; do everything.
6	Logility Demand Planning and Optimization		End-toEnd SCM	www.logility.com	Digital Twin
6	Logility Digital Supply Chain Platform			www.logility.com	
6	Logility Voyager Solutions		Demand Sensing	www.logility.com	
7	Oracle Supply Chain Planning Cloud		S&R Focus	www.oracle.com	
8	SAP Advance Planning and Optimization		End-toEnd SCM	www.sap.com	Integrate with SAP ERP
8	SAP Ariba		Ariba network	www.ariba.com	Integrates buyers and suppliers
8	SAP Integrated Business Planning for Supply Chain Management			www.sap.com	
9	E2Open		End-to-end/Digital	www.e2open.com	
10	Epicor		ERP/Distribution	www.epicor.com	
11	Solvayo		Retail Focus	www.solvayo.com	very positive reviews

This final screening helped arrive at the final list of four supply chain management tools with two tools receiving an honorable mention for specific capabilities that will be required for the outlined use case.These final tools are described in detail in the following sections along with a discussion regarding the degree to which they satisfy the needs of the use case.

1. **Oracle Fusion Cloud Supply Chain & Manufacturing**

   One of the most capable platforms examined during this assessment, Oracle's suite of tools truly embodies "end-to-end" supply chain management with systems dedicated to manufacturing and procurement, as well as product lifecycle management, transportation management, warehouse and inventory management, and finally, distribution and sales/operations. Oracle also has rare offerings not provided by many other vendors including platforms dedicated to maintenance, internet of things (IoT) devices and blockchain[6], and has a standalone analytics platform to leverage data generated from these other systems to drive operational improvements.

   Oracle is a large player in the enterprise software industry and has a long track record of supporting large-scale implementations and operations, as would be required in a defense organization use case. Their ability to integrate with existing systems and end to end breadth would allow for the visibility necessary to map a whole supply chain network and begin to understand how disruptions in that network would impact downstream operations. It's unclear how much direct capability Oracle provides in the digital twin and modeling space in order to simulate and analyze these disruptions but after examining the market of supply chain management tools, we've concluded that Oracle offers a robust solution for what would be required to achieve true supply chain visibility and control that would allow for the analysis and reaction to supply chain disruptions.

[6] (Oracle, 2021)

2. SAP Supply Chain Management

The other massively popular enterprise software company, SAP, made the final cut with their supply chain management platform. Like Oracle, SAP's platform consists of multiple modules geared towards the different phases of supply chain management which allow for easy integration of different modules as well as allowing for the integration with external, non-SAP, software. Again, SAP's capabilities truly span the whole breadth of the supply chain process which puts them in the short list of vendors that could satisfy the described needs.

Where most vendors excel at offering high-end tools for one, or a handful, of the supply chain management processes, SAP and Oracle's size allows them to offer highly capable products for each of these supply chain phases[7]. SAP receives special recognition for not only it's planning technologies, but also the process discipline and success that comes along with their "Integrated Business Planning (IBP)[8]" platform. Similarly to Oracle, SAP has offerings for advanced analytics and other technologies, such as IoT, through additional SAP modules that can integrate with a custom configured supply chain management platform. Once again, it is not clear what type of direct capabilities SAP provides in the way of monitoring and responding to supply chain disruptions but it is likely one of the most complete solutions available on the market.

Lastly, it should be noted that since this use case is one of primarily US defense operations, SAP is a product of the allied nation, Germany, as opposed to being headquartered in the United States like all of the other products that made this shortlist. The authors have no reason to believe this would impact SAP's ability to be a vendor to US defense forces as SAP has been selected for platform implementation and management for separate US defense forces in past contract opportunities.

3. E2Open Platform

A less well-known name in the world of enterprise supply chain management, E2Open proved to offer the end-to-end supply chain management capabilities required for this use case and an explicit focus on visibility and leveraging technology make it a serious contender for application to the problems examined herein.

E2Open's "Harmony" framework brings all of the platform's capabilities and offerings together in a centralized location so that collaboration between different operators and leaders can take place seamlessly with a single source of truth. Also offered is the "E2Net", a network of connected supply chain vendors for operations like warehousing, transportation, procurement, and more that are easily available to users of the platform. The developers of the platform emphasize the ability to connect E2Open to other services and systems which would be pivotal in implementing a system for defense operation use.

[7] (Enfroy, 2021)
[8] (SAP, 2021)

E2Open's "control tower[9]" capabilities offer what appears to be a solution to the problem of analyzing and reacting to supply chain disruptions that more directly solves the problem than what is offered by Oracle or SAP. It isn't quite clear whether a full E2Open implementation is required to realize the value of this "control tower" capability, or if it could be realized with any number of systems in the place of E2Open.

4. <u>BlueYonder Luminate Platform</u>

BlueYonder's "Luminate[10]" platform takes the idea of modular capabilities to an extreme. The Luminate platform offers tool for each granular piece of the supply chain process and allows customers to decide which of the "domain-enriched apps" are desired for their specific system implementation. With this architecture, the system is naturally required to work easily with many different data feeds as well as external systems, making it a good fit for use in a defense organization.

The Luminate platform is the product of many years of consolidation in the supply chain software industry with companies such as JDA, Luminate, and BlueYonder coming together to form the current enterprise and it's extensive offerings. While Luminate's many modular components could likely provide the supply chain network visibility desired for operations in austere environments, it's not clear that they have a demonstrated history of working with systems at the scale of US defense forces. For that reason, they are listed lower in our assessment ranking. Additional research would be needed to determine their actual capability in serving an organization with the size of the US Marine Corps or the US Navy.

5. <u>Interos</u>

The last two platforms examined here do not fit the category of "end to end supply chain management system" and therefore would be wholly insufficient to solve the problem of monitoring and analyzing supply chain system disruptions in military operations and austere environments. They are included as "honorable mentions" as they excel at the task of identifying supply chain risk and simulating disruptions, which is a gap present in many of the end to end systems examined above. While we did not find any silver-bullet solutions that we thought perfectly could be applied in our use case, we believe that the closest solution available in the market today would be a combination of one of these major end to end systems and then one or both of these niche risk and simulation tools. Whether or not that type of combination is an efficient solution, or even possible, is beyond the scope of this paper and would need to be studied further in-depth.

[9] (E2Open, 2021)
[10] (Blue Yonder, 2021)

Interos is an intelligent supply chain risk management platform that aims to examine potential existing risk in supply chains and make the decision makers aware of those risk and potential solutions. Interos scans cybersecurity, vendor relationships, financial transactions[11], and other risk areas to help organizations build resilience in their supply chain. Already utilized by US government organizations, we feel that a tool like Interos, used in combination with one of the major end to end systems described above, could bring significant visibility and value to decision makers overseeing supply chain networks. The capability to constantly monitor, alert, and offer alternative solutions to supply chain risks and disruptions directly addresses some of the major challenges faced during military operations. As noted above, further research would need to be conducted to better understand how Interos could be integrated with foundational supply chain management tools to fully realize it's value.

6. **Coupa Supply Chain Design & Planning**

   Formerly known as "Llamasoft", Coupa's Supply Chain Design and Planning tool[12] is purpose built for examining the geographic layout of a supply chain network to examine opportunities for improvement in distribution, inventory management, and sourcing. Due to this focus, the tool is especially adept at modeling existing supply chains and simulating how changes in the supply chain might impact current operations. This is exactly the capability desired for our use case but the use of Coupa's tool pre-supposes that organized data is available regarding an entity's entire supply chain so that the network could be modeled in an organized fashion and then analyzed for risks and optimization opportunities. A tool like this would bring significant value to leaders and decision makers responsible for the smooth operation and risk management of a supply chain network, but could only be realized after that supply chain network operated in a disciplined and organized fashion with the support of one of the earlier identified systems.

5. CONCLUSION

Complex supply chains silently impact every aspect of modern day life. When interrupted, or unable to function correctly, all manner of goods and services are negatively affected and the pain is felt across the economy. For a large company or defense organization, it's incredibly important to have visibility into the entire breadth of your supply chain network and understand how the different pieces work together and rely on one another for the whole system to work correctly. In addition, it's important to understand how a disruption in one part of the supply chain might impact the other operations up and down-stream of that disruption. Being able to analyze these disruptions and then react quickly is an incredibly valuable capability which helps a supply chain become more resilient over time. To extend this capability even further so that alternative supply chain operations are prepared ahead of any disruption and then working to forecast or predict future disruptions could help minimize any damage that could come from one of these events.

In the search for a commercially available tool that could be used for supply chain disruption

[11] (Interos, 2021)
[12] (Coupa, 2021)

analysis and response, we came up short in finding a perfect solution that exists in the market today. Although there does not appear to exist a singular system that could meet this need currently, we identified the pre-cursor systems that would be required to get an organization close to this capability and also discussed potential combinations of systems that would get an entity even closer to having the full capability required. As these systems grow in size and complexity, additional commercial solutions will likely be developed that address these identified gaps and allow the global networks to become more organized and resilient than even the most cutting edge organizations can manage today.

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Appendix D – Nexus JEDI-X Data Interoperability

USAREUR JEDI MAPPING FINAL REPORT

Focus on SV 2020 Task 7e: Conduct data mapping in targeted systems to produce a software solution to prototype in data interoperability.

In February of 2022, the United States Army Europe/Africa (USAREURAF) was tasked with supporting the movement and sustainment of forces in response to actions in Ukraine. To complete this requirement USAREURAF was forced to quickly embrace logistics functions in a multi-national environment at a level and tempo not seen in Europe in decades.

Critical to this was the ability to share logistics data into NATO systems, such that efforts could be seamlessly coordinated and executed across multiple national boundaries, using dissimilar systems and processes to transport, support and sustain. The most pressing need was to exchange data with NATO's Logistics Functional Area Services (LOGFAS) system which is the common logistic tool used by NATO in multinational operations.

To accomplish this USAREURAF identified the JEDI tool(s) as a means to quickly support this requirement. Working with industry a concept demonstrator was developed based upon the JEDI-X solution that allowed for the inclusion of necessary data from a variety of disparate systems to be input to LOGFAS Additionally JEDI was able to reutilize this fused data into a User Defined Operational Picture that facilitated visualization and analytics while minimizing impact to sources systems data or business process.

Critical to this effort was mapping US DoD items into the NATO standard so that they could be easily translated by the JEDI tool for upload to LOGFAS. To address this the industry team developed a methodology and set of routines that reduced significantly the time needed to accomplish this task from days/weeks to hours. Once the data was mapped it was then able to quickly produce Force, Profile and Holdings reports which could then be developed into the required LOGFAS Detailed Deployment Plan file, critical for movement and transportation in LOGFAS.

Once the data was in LOGFAS the JEDI Multi National Logistics Common Operating Picture (MNLOGCOP) was modified to provide the visualization and analytics capability that USAREURAF desperately required to support the surge in activity in the European Theatre.

<u>Deliverables:</u>

- Assist in the mapping of up to 500 US DoD items into the NATO standard.
- Assist in the Validation Report that ensures compliance of the mapping effort.
- Participate in the demonstration after action report that details effect of utilization of the software solution during a US Multi National exercise.

NEXUS LIFE CYCLE MANAGEMENT

SV2020 US Army After Action Report
31 May 2022

Contract Number: MRICTMA009A

Contractor:
Nexus Life Cycle Management LLC (Nexus)

Contracted Task: Operational Support for LOGFAS
21st Theater Support Command (TSC) resourced incremental tasking under the SV2020 project to demonstrate a prototype end to end capability for adoption of NATO LOGFAS application using Commercial Off-The Shelf (COTS) application for Logistics Command and Control. This tasking supported SV2020 Task 7e: Conduct data mapping in targeted systems to produce a software solution to prototype in data interoperability.

The interoperability intended was between US logistics information systems and NATO's Logistics Functional Area Services (LOGFAS), a Government Off-The Shelf (GOTS) suite of applications supporting planning and execution of logistics functions within operations and exercises.

After Action Review – What was Planned:
Nexus proposed up to 60 days LOGFAS SME support available to 21st TSC over the following months, as well as 2 licenses for the JEDI Multinational Logistics Common Operating Picture (MN LOG COP) application, which were installed on the 21st TSC networks during a Nexus visit in February 2022. License keys were emailed to 21st TSC once the project was on contract. The on-site support was to be provided as 9 weeks of travel and labor for Subject Matter Expert personnel for a total of 62 days. Additionally, Nexus was to provide RIC/NIC mapping for US Army forces enabling the operations and delivery of Force Profile and Holdings within LOGFAS from US Army equipment data, based upon Unit Density Lists (UDLs). Preparation of FPH was to be performed remotely and concluded by 15 April 2022. The team coordinated provision of on-site technical support at in Ulm and Kaiserslautern, Germany:
Ulm: (47 Days on site)

- Ron Huizer: 28 February – 18 March
- Alfonso Crescenzo: 21-25 March
- Ron Huizer: 28 March – 15 April

Kaiserslautern: (15 Days on-site)

- Darrell Black – 6-14 April
- Dr. Andrew Love – 31 May – 4 June

Through this provision of support, 21st TSC would provide 3 types of support to the Concept Demonstrator:

- Basic Data Creation in the LOGFAS format
- Data Review (after US Army planners built missions in LOGFAS)
- Demonstration of the LOGFAS data as presented in a Logistics Common Operating Picture

The concept demonstrator was designed to show how the US Army data could be re-used through use of manual and automated means within the NATO LOGFAS application for effect during an exercise or operation. Additionally, a secondary goal was to demonstrate how the investment of time and effort to provide US Army data into LOGFAS could be re-used by populating the COTS JEDI MN LOG COP for logistics command and control of a multinational force.

After Action Review – What was Delivered:

Task 1 – Basic Data Creation: 21st TSC sent UDL to Nexus starting on 8 March, who in turn provided FPH for these forces in the LOGFAS format, with a complete set of RIC and NIC included. Included in the US unit data were also US Air Force units, in formats and with equipment Nexus had not previously seen. Nexus researched the DCAPES system which provided the data, specifically the MEFPAK module, and developed a means to produce RIC, NIC and FPH for these as well as for the US Army units. This task was completed by 14 March 2022

Task 2 – Data Review: This task was performed through on-site support of LOGFAS Subject Matter Experts (SME) in the NATO facility in Ulm, Germany. Our SME provided review of both the FPH created by Nexus remotely, as well as the Detailed Deployment Plans (DDP) created by 21st TSC planners using the FPH generated by Nexus. Due to COVID restrictions, the complete period of support between 28 February and 15 April was covered by a single SME.

Task 3- Demonstration of the LOGFAS data as presented in a Logistics Common Operating Picture: The JEDI MN LOG COP application was installed local at 21st TSC in February 2022 in anticipation of this project. Once the project was incrementally funded, Nexus provided license keys by email to unlock the application on the 21st TSC network. Through initial guidance during installation and remote support, 21st TSC was able to link the JEDI MN LOG COP to the appropriate LOGFAS application database. As FPH, DDP and additional details were populated in LOGFAS, they were immediately visible in the JEDI MN LOG COP for decision support/Logistics Command and Control. These licenses are valid through the completion of the exercise and are useable with the data in that exercise database in the future for After Action Review and demonstration purposes. Prior to start of the exercise, Nexus provided access to an on-site JEDI MN LOG COP SME in order to provide familiarization training to exercise personnel, as well as troubleshoot any last minute issues with the network, database or applications. This and a coordination visit were utilized to ensure project quality and performance.

After Action Review – What was Learned:

After completion of delivery of the tasked support and licenses, a review was performed at the Nexus offices with 21st TSC personnel. Lessons learned were captured and were planned to be applied in a future contract and plans for use of LOGFAS and JEDI MN LOG COP.

<u>Lesson Learned: Logistic Command and Control</u>

21st TSC identified significant value in use of the JEDI MN LOG COP in conjunction with LOGFAS as a means of performing Logistics Command and Control of a multinational force. 21st TSC provided feedback on specific functional enhancements that would improve its suitability for use in their command and planned to incorporate and demonstrate them in a future effort.

Lesson Learned: FPH Creation Algorithm

Through the Data Review task, many data quality problems were identified and corrected. One such improvement was in the means that the algorithm within the Nexus creation of FPH. Through feedback from data review, a revised algorithm was created to incorporate this improvement.

Lesson Learned: Process Improvement

Upon review of the entire process used in the Concept Demonstrator, an improved process was developed which formalized roles and responsibilities, and incorporated training and Over-the shoulder support (OTSS) at specific intervals to support a steady state capability. This process is captured in Figure 1 below.

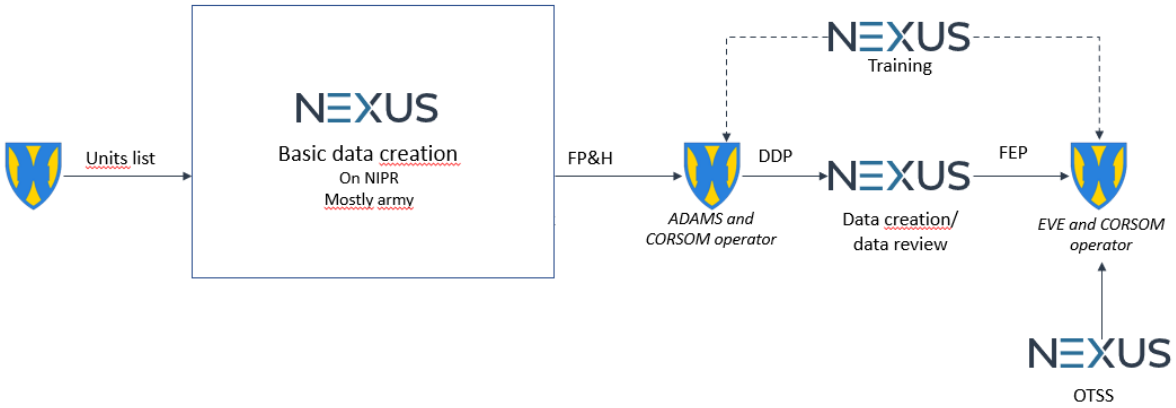

Figure 1: Process to support steady-state interoperability of US Army Data in LOGFAS

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALINC59125-09	KA71A	5985016160072	COMM TAC TERM CNTRL SYS: AN/TSQ-198B	COMM TAC TERM CNTRL SYS: AN/TSQ-198B	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.64 m	2.49 m	4862.5 kg	4862.5 kg	No		UNKNOWN	
USALINC61597-05	KA71	5895015746811	COMMAND SYS TACT: AN/TSQ-221	COMMAND SYS TACT: AN/TSQ-221	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.57 m	2.59 m	4535.9 kg	4535.9 kg	No		UNKNOWN	
USALINE21985-01	HD	1560012056274	EXT STORES SUBSYSTEM	EXT STORES SUBSYSTEM	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.54 m	1.27 m	0.94 m	378.3 kg	378.3 kg	No		UNKNOWN	
USALINM78551-01	HE8	1095012532030	MOUNTING KIT AIR DEF: M139	MOUNTING KIT AIR DEF: M139	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.03 m	1.68 m	1.75 m	689.9 kg	689.9 kg	No		UNKNOWN	
USALINN05006-01	QB68	6515016295051	NOISE-IMMUNE STETHOSCO: NIS	NOISE-IMMUNE STETHOSCO: NIS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.15 m	0.28 m	2.7 kg	2.7 kg	No		UNKNOWN	
USALINR17126-01	KA71A	5840014508126	RADAR SET: AN/TPN-31	RADAR SET: AN/TPN-31	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	12.80 m	3.15 m	2.59 m	16930.8 kg	16930.8 kg	No		UNKNOWN	
USALINR22436-01	TB2	5821014134233	RADIO SET HI FREQ: AN/ARC220V1	RADIO SET HI FREQ: AN/ARC220V1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.43 m	0.18 m	0.53 m	16.8 kg	16.8 kg	No		UNKNOWN	
USALINT05773-01	LE65	1095012593211	TESTER MINE DISPENSER: MST F/VOLCAN	TESTER MINE DISPENSER: MST F/VOLCAN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.51 m	0.43 m	1.09 m	8.6 kg	8.6 kg	No		UNKNOWN	
USALINT93517-06	LE65	6625015293346	T/S STABILATOR LINE: TS-3920C/ASM	T/S STABILATOR LINE: TS-3920C/ASM	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.81 m	0.61 m	0.76 m	44.5 kg	44.5 kg	No		UNKNOWN	
USALINW62187-01	RA71C	5865014929700	WARNG RECVR SYS: AN/AAR-57(V)4	WARNG RECVR SYS: AN/AAR-57(V)4	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.34 m	0.97 m	1.83 m	32.7 kg	32.7 kg	No		UNKNOWN	
USALINA24017-04	LQ2	4120015234131	AIR CONDITNR FL/WALL	AIR CONDITNR FL/WALL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.84 m	0.81 m	0.66 m	140.6 kg	140.6 kg	No		UNKNOWN	
USALINB05016-XX	LE1		B05016	B05016	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINC05069-02	TD	7010014933541	COMPUTER SET DIG: AN/UYK-128(V)1	COMPUTER SET DIG: AN/UYK-128(V)1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.38 m	0.81 m	0.56 m	10.0 kg	10.0 kg	No		UNKNOWN	
USALINC05095-01	AD26	2350015750951	CARRIER: AMMO TRACKED: M992A3 CAT	CARRIER: AMMO TRACKED: M992A3 CAT	Army	USA: United States of America	Equipment	Tracked Not SelfDeployable	No					Each	6.86 m	3.86 m	3.76 m	33774.5 kg	33774.5 kg	No		UNKNOWN	
USALINC43399-11	LA65F	5895014955980	CENTRAL COMM TROJAN: M1102	CENTRAL COMM TROJAN: M1102	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	3.43 m	2.24 m	2.54 m	616.9 kg	616.9 kg	No		UNKNOWN	
USALINH05013-01	CA14E	2350015770830	HOWITZER MED SELF PROPEL: M109A7 SPH	HOWITZER MED SELF PROPEL: M109A7 SPH	Army	USA: United States of America	Equipment	Tracked Not SelfDeployable	No					Each	9.73 m	3.35 m	3.76 m	35915.4 kg	35915.4 kg	No		UNKNOWN	
USALINM12418-06	NB51	4240013703823	MASK CHEM BIOLOGICAL: M40A1 LG	MASK CHEM BIOLOGICAL: M40A1 LG	Army	USA: United States of America	Equipment	Box	No					Each	0.38 m	0.28 m	0.15 m	3.2 kg	3.2 kg	Yes		UNKNOWN	
USALINZ05699-01	LE6	0000000000000	MK-3496: TK FIREFNDR ORG: FIREFNDR ORG	MK-3496: TK FIREFNDR ORG: FIREFNDR ORG	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.48 m	0.30 m	0.10 m	2.3 kg	2.3 kg	No		UNKNOWN	
USALINC59313-02	TB1ZZZ	5895013482344	COMMUNICATION CENTRAL: AN/ASC-15CV1	COMMUNICATION CENTRAL: AN/ASC-15CV1	Army	USA: United States of America	Equipment	Box	No					Each	1.02 m	0.64 m	1.09 m	45.4 kg	45.4 kg	Yes		UNKNOWN	
USALINC05086-01	QC3	6520013730782	CURING UNIT DENTAL	CURING UNIT DENTAL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.28 m	0.18 m	0.33 m	4.5 kg	4.5 kg	No		UNKNOWN	
USALINC05093-01	NA1	5410015929464	CHMICL BIO PROT SHLTR: CBPS ELECTRIC	CHMICL BIO PROT SHLTR: CBPS ELECTRIC	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	10.21 m	2.44 m	2.82 m	16802.0 kg	16802.0 kg	No		UNKNOWN	
USALIND08483-01	LBE	3990003685272	CGO SET GENERAL HATCH	CGO SET GENERAL HATCH	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.83 m	1.27 m	3.66 m	1982.2 kg	1982.2 kg	No		UNKNOWN	
USALIND95617-03	QA32	6545015294440	DES PROSTHETICS: 2005	DES PROSTHETICS: 2005	Army	USA: United States of America	Package	Container	No					Each	0.79 m	0.48 m	0.18 m	27.2 kg	27.2 kg	Yes		UNKNOWN	
USALINE05021-01	QU	6540015856821	EDGER,HAND,OPHTHALMIC: OPHTHALMIC	EDGER,HAND,OPHTHALMIC: OPHTHALMIC	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.28 m	0.41 m	0.28 m	8.2 kg	8.2 kg	No		UNKNOWN	
USALINF05005-01	LH13	4210015991725	FIRE FIGHTING SET,IND: FIRES	FIRE FIGHTING SET,IND: FIRES	Army	USA: United States of America	Package	Container	No					Each	1.37 m	0.76 m	0.71 m	68.0 kg	68.0 kg	Yes		UNKNOWN	
USALINF05034-01	LF63A	4930015456669	FUEL SYS SUPPLY POINT-800K: 800K	FUEL SYS SUPPLY POINT-800K: 800K	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	435448.7 kg	435448.7 kg	No		UNKNOWN	
USALING12034-04	LE63AB	6115014620291	GEN SET DED SKID MTD: MEP-806B	GEN SET DED SKID MTD: MEP-806B	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.21 m	0.91 m	1.50 m	1810.7 kg	1810.7 kg	No		UNKNOWN	
USALINL05013-01	QU	6540016200727	LENS MEASURING INSTRU	LENS MEASURING INSTRU	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.18 m	0.23 m	6.4 kg	6.4 kg	No		UNKNOWN	
USALINM23423-19	QA31	6545015182964	MES BLOOD BANK LAB: DET-2003	MES BLOOD BANK LAB: DET-2003	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.39 m	1.17 m	14.27 m	5669.9 kg	5669.9 kg	No		UNKNOWN	
USALINM57970-01	LD26	4110015347675	MOB INTG RMN COL SYS: MIRCS	MOB INTG RMN COL SYS: MIRCS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	7461.6 kg	7461.6 kg	No		UNKNOWN	
USALINP47705-04	QU	6545016126750	OPTICAL EQUIP SET: OPTICAL EQUIPMENT SET (OES	OPTICAL EQUIP SET: OPTICAL EQUIPMENT SET (OES	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.91 m	1.07 m	1.07 m	526.6 kg	526.6 kg	No		UNKNOWN	
USALINS29227-01	LH5	4240005100204	SAFETY EQUIPMENT SET	SAFETY EQUIPMENT SET	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.91 m	0.71 m	0.81 m	82.1 kg	82.1 kg	No		UNKNOWN	
USALINT05108-XX	TD43		T05108	TEST SET TELECOMM: SYS TS-4544/U	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	3.4 kg	3.4 kg	No		UNKNOWN	
USALINW48759-01	LE6	5180005961509	TOOL KIT PIPEFITTERS: 2-1/2 - 4-IN	TOOL KIT PIPEFITTERS: 2-1/2 - 4-IN	Army	USA: United States of America	Equipment	Box	No					Each	1.68 m	0.41 m	0.48 m	136.1 kg	136.1 kg	Yes		UNKNOWN	
USALINW65884-01	LE6A	5180002898930	T/K SUP PL PMP STA: 4, 6, 8-INCH	T/K SUP PL PMP STA: 4, 6, 8-INCH	Army	USA: United States of America	Package	Container	No					Each	0.56 m	0.23 m	0.20 m	30.8 kg	30.8 kg	Yes		UNKNOWN	
USALINW89557-32	LA27	3930013822567	TRACTOR WHL WHS GED: M487	TRACTOR WHL WHS GED: M487	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	No					Each	2.72 m	1.24 m	2.13 m	2721.6 kg	2721.6 kg	No		UNKNOWN	
USALINB05004-01	LH2	4220015995367	BREAKAWAY DIVERS AIR SYS: BDASS	BREAKAWAY DIVERS AIR SYS: BDASS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.12 m	2.62 m	2.03 m	2051.6 kg	2051.6 kg	No		UNKNOWN	
USALINC05038-01	TD13	7022016310621	COMPUTER GROUP: TACTICAL: OL-761B(V)6/T	COMPUTER GROUP: TACTICAL: OL-761B(V)6/T	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.51 m	0.20 m	4.5 kg	4.5 kg	No		UNKNOWN	
USALINC05050-01	TD	7022016062426	CPU GRP: TAC OL-761B(V)2/T: OL-761B(V)2/T	CPU GRP: TAC OL-761B(V)2/T: OL-761B(V)2/T	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.43 m	1.14 m	0.89 m	1176.6 kg	1176.6 kg	No		UNKNOWN	
USALINC05102-01	EH14A	1940016180272	COMBAT ASSAULT CRAFT: 15 PAX BOAT	COMBAT ASSAULT CRAFT: 15 PAX BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	7.01 m	1.83 m	0.61 m	204.1 kg	204.1 kg	No		UNKNOWN	
USALINC05103-01	EH14A	1940016180276	COMBAT RAIDING CRAFT: INFLATABLE BOAT	COMBAT RAIDING CRAFT: INFLATABLE BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.88 m	1.83 m	0.61 m	145.1 kg	145.1 kg	No		UNKNOWN	
USALINC05115-01	TB1	5985016456998	COMMO SYS-AN/TYQ-167(V)2: AN/TYQ-167(V)2	COMMO SYS-AN/TYQ-167(V)2: AN/TYQ-167(V)2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.53 m	3.51 m	379.7 kg	379.7 kg	No		UNKNOWN	
USALINC05139-XX	TB		C05139	C05139	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALIND05024-01	LH2	4220016190577	DEEP SEA (DSS): DSS 300FT SET	DEEP SEA (DSS): DSS 300FT SET	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.24 m	2.74 m	2.34 m	2426.7 kg	2426.7 kg	No		UNKNOWN	
USALIND20400-01	BA44	1040014630157	DISP RIOT CNTL AGENT: M37	DISP RIOT CNTL AGENT: M37	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.51 m	0.30 m	0.51 m	5.9 kg	5.9 kg	No		UNKNOWN	
USALIND32723-01	LH2	4220005413885	DIVING EQUIP SET: OPEN CIRCUIT	DIVING EQUIP SET: OPEN CIRCUIT	Army	USA: United States of America	Equipment	Box	No					Each	0.91 m	0.61 m	0.30 m	43.1 kg	43.1 kg	Yes		UNKNOWN	
USALIND32791-02	LH2	4220015702857	DIVING EQUIP SET: PHOTO SPT	DIVING EQUIP SET: PHOTO SPT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.61 m	0.61 m	0.30 m	9.1 kg	9.1 kg	No		UNKNOWN	
USALIND32859-01	LH2	4220010230246	DIVING EQUIP SET: TYPE A	DIVING EQUIP SET: TYPE A	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.22 m	0.91 m	1.52 m	272.2 kg	272.2 kg	No		UNKNOWN	
USALIND32927-02	LH2	4220010231701	DIVING EQUIP SET: TYPE B	DIVING EQUIP SET: TYPE B	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.22 m	1.22 m	1.22 m	553.4 kg	553.4 kg	No		UNKNOWN	
USALIND49154-01	LH2	4220005698809	DIVING EQUIPMENT SET: INDIV SCUBA	DIVING EQUIPMENT SET: INDIV SCUBA	Army	USA: United States of America	Equipment	Box	No					Each	0.61 m	0.91 m	0.30 m	22.7 kg	22.7 kg	Yes		UNKNOWN	
USALIND89675-06	QC1BB	4220015489065	CHAMBER RECOMPRESSION: RC-100 PSI	CHAMBER RECOMPRESSION: RC-100 PSI	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.05 m	2.44 m	2.13 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINJ05026-01	AC1	2320016536495	JLTV A1 HEAVY GUNS: M1278A1	JLTV A1 HEAVY GUNS: M1278A1	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.56 m	2.44 m	2.39 m	6259.6 kg	6259.6 kg	No		UNKNOWN	
USALINL05001-01	BE5	1095015432189	LAUNCHED ELECTRODE STUN DEVICE: LESD	LAUNCHED ELECTRODE STUN DEVICE: LESD	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.15 m	0.05 m	0.10 m	3.6 kg	3.6 kg	No		UNKNOWN	
USALINL05019-01	BE5	5180016592703	LDR PNT OF CAPTURE KIT: LPOCK	LDR PNT OF CAPTURE KIT: LPOCK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.25 m	0.13 m	0.28 m	1.8 kg	1.8 kg	No		UNKNOWN	
USALINL05021-01	BE24A	1240016639605	LASR TARGT LOC MOD: AN/PED-7	LASR TARGT LOC MOD: AN/PED-7	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.15 m	0.15 m	0.10 m	0.5 kg	0.5 kg	No		UNKNOWN	
USALINM05074-01	LE6	5895016584004	MAINT KIT ELEC EQT: MK-3431/U	MAINT KIT ELEC EQT: MK-3431/U	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.30 m	0.30 m	0.20 m	7.7 kg	7.7 kg	No		UNKNOWN	
USALINM05075-XX	LE		M05075	M05075	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05076-XX	LE65		M05076	M05076	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05084-XX	NB2		M05084	M05084	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05087-XX	ZZZZZZ		M05087 (item not in JECD)	M05087	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINP05051-01	LE6	5180016592694	PLT EVIDENCE KIT (PECK): PECK	PLT EVIDENCE KIT (PECK): PECK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.25 m	0.56 m	7.7 kg	7.7 kg	No		UNKNOWN	
USALINR05029-01	TB1C	5820200104352	RADIO TERMINAL,LINEOF: AN/TRC-238(V)1	RADIO TERMINAL,LINEOF: AN/TRC-238(V)1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.84 m	1.96 m	224.1 kg	224.1 kg	No		UNKNOWN	
USALINR05031-01	TB1C	5820200104455	RADIO TERMINAL,LINEOF: AN/TRC-238(V)2	RADIO TERMINAL,LINEOF: AN/TRC-238(V)2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.84 m	1.96 m	224.1 kg	224.1 kg	No		UNKNOWN	
USALINR05036-01	EH14A	1940016467565	RIGID INFLAT BOAT (RIB): RIGID INFLATABLE BOAT RIB	RIGID INFLAT BOAT (RIB): RIGID INFLATABLE BOAT RIB	Army	USA: United States of America	Equipment	Floating Craft SelfDeployable	No					Each	9.60 m	3.05 m	3.78 m	5233.1 kg	5233.1 kg	No		UNKNOWN	
USALINS05063-01	QC	6515015194251	STIMULATOR, ULTRASOUND: PORTABLE	STIMULATOR, ULTRASOUND: PORTABLE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.30 m	0.13 m	2.7 kg	2.7 kg	No		UNKNOWN	
USALINS41465-01	LE6	6625011375369	SIGNAL GEN PULSE: SG-1205()/U	SIGNAL GEN PULSE: SG-1205()/U	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.46 m	0.30 m	10.4 kg	10.4 kg	No		UNKNOWN	
USALINT05053-01	LH2	4220016179405	TPE 1 HI PRES AIR COMP: TYPE I (HPBAC-I)	TPE 1 HI PRES AIR COMP: TYPE I (HPBAC-I)	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	1.22 m	1.40 m	544.3 kg	544.3 kg	No		UNKNOWN	
USALINT05055-01	LH2	4220016179406	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.17 m	0.48 m	0.74 m	118.8 kg	118.8 kg	No		UNKNOWN	
USALINT05073-01	TB12	5895016541702	TRANS TAC CMD COM T2C2: AN/TSC 233 V2	TRANS TAC CMD COM T2C2: AN/TSC 233 V2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.81 m	0.53 m	1.91 m	196.0 kg	196.0 kg	No		UNKNOWN	
USALINT05087-01	LE6	5180016592696	TM EVIDENCE KIT (TECK): TECK	TM EVIDENCE KIT (TECK): TECK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.25 m	0.13 m	0.28 m	1.8 kg	1.8 kg	No		UNKNOWN	
USALINT05093-01	ND1	4240016651803	TEST KIT MASK PROTECTIVE: PATS M41A1	TEST KIT MASK PROTECTIVE: PATS M41A1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.38 m	0.41 m	0.25 m	10.0 kg	10.0 kg	No		UNKNOWN	
USALINT05098-01	TD1	6625016827085	TEST: SET ELECTRONIC SYS: AN/PSM-95 R	TEST: SET ELECTRONIC SYS: AN/PSM-95 R	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.56 m	0.15 m	13.6 kg	13.6 kg	No		UNKNOWN	
USALINT05099-01	TD1	6625016832824	TEST SET ELECTRONIC SYSTEM: AN/PSM-95 LIGHT	TEST SET ELECTRONIC SYSTEM: AN/PSM-95 LIGHT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.41 m	0.23 m	10.9 kg	10.9 kg	No		UNKNOWN	
USALINT45817-01	LE6	5180015218102	TOOL KIT GUID MIS LNCH: DS/GS HMARS	TOOL KIT GUID MIS LNCH: DS/GS HMARS	Army	USA: United States of America	Package	Container	No					Each	0.64 m	0.08 m	0.33 m	43.1 kg	43.1 kg	Yes		UNKNOWN	
USALINU05015-01	LE2A	4220016186266	UNDERWATER CONSTRUC ST: BOX 1 ISU-90	UNDERWATER CONSTRUC ST: BOX 1 ISU-90	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.74 m	2.24 m	2.29 m	5329.7 kg	5329.7 kg	No		UNKNOWN	
USALINW05009-01	LE6	6625016808563	WIRELESS PLATFORM TEST ST: WATS	WIRELESS PLATFORM TEST ST: WATS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.41 m	0.23 m	11.3 kg	11.3 kg	No		UNKNOWN	
USALINZ05549-01	TD43B	0000000000000	ENCRYPT-DECRYPT EQUIP: KG-250XS	ENCRYPT-DECRYPT EQUIP: KG-250XS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.10 m	0.10 m	0.05 m	1.4 kg	1.4 kg	No		UNKNOWN	
USALINZ05740-01	TD15	0000000000000	CROSS DOMAIN SERVER: AN/GYK-79 MOBILE-MOUNTED	CROSS DOMAIN SERVER: AN/GYK-79 MOBILE-MOUNTED	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.76 m	0.43 m	0.08 m	29.9 kg	29.9 kg	No		UNKNOWN	
USALINZ05807-XX	LE6		Z05807	Z05807	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINZ05833-XX	ZZZZZZ		Z05833 (remote armor/combat vehicle weapon system - not a RIC option!)	Z05833	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINZ05867-01	LA6	2330016539745	JNT LT TAC VEH TRL JLTV-T: M1289	JNT LT TAC VEH TRL JLTV-T: M1289	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	4.52 m	2.44 m	1.52 m	1867.0 kg	1867.0 kg	No		UNKNOWN	
USALINB14729-U1	LDA	8465011178699	DUFFLE BAG NYLON W/STRAPS: DUFFLE BAG	DUFFLE BAG NYLON W/STRAPS: DUFFLE BAG	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.46 m	0.91 m	34.0 kg	34.0 kg	No		UNKNOWN	
USALINC05102-01	EH14A	1940016180272	COMBAT ASSAULT CRAFT: 15 PAX BOAT	COMBAT ASSAULT CRAFT: 15 PAX BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	7.01 m	1.83 m	0.61 m	204.1 kg	204.1 kg	No		UNKNOWN	
USALINL05024-01	LB13A	3930016598135	LITE RGH TERRN FORKLIFT: LCRTF 5K	LITE RGH TERRN FORKLIFT: LCRTF 5K	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	No					Each	5.84 m	2.03 m	2.01 m	8674.0 kg	8674.0 kg	No		UNKNOWN	
USALINR12379-XX	ZZZZZZ		R12379	R12379	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINT05055-01	LH2	4220016179406	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.17 m	0.48 m	0.74 m	118.8 kg	118.8 kg	No		UNKNOWN	
USALINT61562-19	AD22RA	2320013719578	TRK UTIL CGO/TRP CARR: M1038A1 WWN	TRK UTIL CGO/TRP CARR: M1038A1 WWN	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	4.72 m	2.74 m	1.83 m	2497.9 kg	2497.9 kg	No		UNKNOWN	
USALINYA0083-01	LD21DA	8115007534690	CONEX INSERT: TRI-WALL	CONEX INSERT: TRI-WALL	Army	USA: United States of America	Equipment	Pallet	No					Each	1.14 m	0.81 m	0.71 m	45.4 kg	45.4 kg	Yes		UNKNOWN	
USALINYA0084-01	LD21DA	8115007534691	CONEX INSERT: TRI-WALL	CONEX INSERT: TRI-WALL	Army	USA: United States of America	Equipment	Pallet	No					Each	1.47 m	0.84 m	0.69 m	45.4 kg	45.4 kg	Yes		UNKNOWN	
USALINYA0144-01	HJ83	0000000000000	AIRDROP PLATFORM: 20-FOOT	AIRDROP PLATFORM: 20-FOOT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.74 m	0.64 m	884.5 kg	884.5 kg	No		UNKNOWN	
USALINYA0400-01	LD21D	8115014440198	UNI-PAK CNTNR (CMCL): TRI-WALL	UNI-PAK CNTNR (CMCL): TRI-WALL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.12 m	1.22 m	1.14 m	22.7 kg	22.7 kg	No		UNKNOWN	
USALINYA0484-01	LD21D	8745014670448	CNTNR SPECIAL (SHOP)	CNTNR SPECIAL (SHOP)	Army	USA: United States of America	Package	Container	No					Each	4.19 m	2.21 m	2.13 m	1796.2 kg	1796.2 kg	Yes		UNKNOWN	
USALINYA0574-01	LG71	0000000000000	WATER DIST SYS (WDS)	WATER DIST SYS (WDS)	Army	USA: United States of America	Package	Container	No					Each	1.98 m	2.44 m	2.44 m	3388.3 kg	3388.3 kg	Yes		UNKNOWN	
USALINYA0609-01	LD21D	8145014731212	BOH ENVIROMENTAL CNTR: FPU-8-1	BOH ENVIROMENTAL CNTR: FPU-8-1	Army	USA: United States of America	Package	Container	No					Each	2.13 m	2.44 m	2.29 m	1995.8 kg	1995.8 kg	Yes		UNKNOWN	
USALINYA0610-01	LD21D	8145015020581	BULK STG/SHPG CNTR: BOH-12	BULK STG/SHPG CNTR: BOH-12	Army	USA: United States of America	Package	Container	No					Each	3.89 m	2.44 m	2.34 m	2358.7 kg	2358.7 kg	Yes		UNKNOWN	
USALINYA0616-01	LD21D	8145014670448	CONTAINER, SPECIAL	CONTAINER, SPECIAL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.22 m	2.21 m	2.13 m	1315.4 kg	1315.4 kg	No		UNKNOWN	
USALINYA0645-01	LD21AA	5419013996391	20 FT ISO CONTAINER: FORCE PROVIDER MODULE	20 FT ISO CONTAINER: FORCE PROVIDER MODULE	Army	USA: United States of America	Package	Container	No					Each	6.10 m	2.44 m	2.44 m	4930.5 kg	4930.5 kg	Yes		UNKNOWN	
USALINYA0682-01	LD15J	8145014670445	SHELTER, SHOP VAN	SHELTER, SHOP VAN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.19 m	2.21 m	2.13 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINYA0697-01	LD21A	8145014839123	TRICON CONTAINER: GREEN	TRICON CONTAINER: GREEN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.07 m	2.44 m	2.44 m	3538.0 kg	3538.0 kg	No		UNKNOWN	
USALINYA0705-01	LA65	8340014594366	DRASH UTIL TRL: HP-2C/188	DRASH UTIL TRL: HP-2C/188	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	4.19 m	2.18 m	1.83 m	1542.2 kg	1542.2 kg	No		UNKNOWN	
USALINYA0857-01	LD21A	0000000000000	SHIPPING CNTR: ISO AERO 2	SHIPPING CNTR: ISO AERO 2	Army	USA: United States of America	Package	Container	No					Each	6.10 m	2.44 m	2.59 m	3855.5 kg	3855.5 kg	Yes		UNKNOWN	
USALINYA0869-01	LD21D	8145014670444	EXP MOB SHP CNTNR	EXP MOB SHP CNTNR	Army	USA: United States of America	Package	Container	No					Each	3.71 m	2.21 m	2.13 m	1950.4 kg	1950.4 kg	Yes		UNKNOWN	
USALINYA0981-01	LD21D	8145015188749	CONTAINER, FRT, SP: FPU-8-2	CONTAINER, FRT, SP: FPU-8-2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.24 m	2.44 m	2.34 m	1610.3 kg	1610.3 kg	No		UNKNOWN	
USALINYA1043-01	LD21AA	8150015983223	BOH CONTAINER FPU-20-3: FPU-20-3	BOH CONTAINER FPU-20-3: FPU-20-3	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	3900.9 kg	3900.9 kg	No		UNKNOWN	
USALINYA1078-01	LD21AA	0000000000000	BRADLEY VEH SPL TOOL CTNR: TOOLS CTNR	BRADLEY VEH SPL TOOL CTNR: TOOLS CTNR	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	2798.7 kg	2798.7 kg	No		UNKNOWN	
USALINYA1109-01	AD9	2355016275147	GRND MOB VEH 1.1 (GMV 1.1): M1288	GRND MOB VEH 1.1 (GMV 1.1): M1288	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.03 m	1.83 m	5080.2 kg	5080.2 kg	No		UNKNOWN	
USALINZ00514-XX	ZZZZZZ		Z00514	Z00514	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINA53199-09	LA16BR	7010015826366	ALL SRC ANALYSIS SYS: FCA M1152A1 W/B2	ALL SRC ANALYSIS SYS: FCA M1152A1 W/B2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.13 m	2.29 m	2.59 m	5488.5 kg	5488.5 kg	No		UNKNOWN	
USALINC05051-01	ND	6665016217138	CBRN DISMNTED RECON (SKO): MODULE A QUADCON	CBRN DISMNTED RECON (SKO): MODULE A QUADCON	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.44 m	1.45 m	2.44 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINC43331-01	LA16BR	5895014955981	CNT COM TROJAN SPIRIT LT: AN/TSQ226 (V)2	CNT COM TROJAN SPIRIT LT: AN/TSQ226 (V)2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.36 m	2.24 m	2.57 m	4824.0 kg	4824.0 kg	No		UNKNOWN	
USALINC90599-01	AD22RA	5895013875792	COMM CONTROL SET: AN/TSQ-183A	COMM CONTROL SET: AN/TSQ-183A	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	4.57 m	2.16 m	2.44 m	3211.4 kg	3211.4 kg	No		UNKNOWN	
USALINM05027-02	AF22	2355016215506	M-ATV UI CROWS WIN-T S: M1274 M-ATV	M-ATV UI CROWS WIN-T S: M1274 M-ATV	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.94 m	2.51 m	2.59 m	16782.9 kg	16782.9 kg	No		UNKNOWN	
USALINM05028-02	AF22	2355016207041	M-ATV UI (CROWS) WIN-T: M1276 M-ATV	M-ATV UI (CROWS) WIN-T: M1276 M-ATV	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.94 m	2.51 m	2.59 m	16782.9 kg	16782.9 kg	No		UNKNOWN	
USALINT01691-01	LA2	2320015527793	TRK CHASSIS MTV: M1092A1P2	TRK CHASSIS MTV: M1092A1P2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	7.21 m	2.44 m	2.84 m	11612.0 kg	11612.0 kg	No		UNKNOWN	
USALINW76336-40	LA27	2410014120930	TRACTOR FTRAC LS DED: JD450G	TRACTOR FTRAC LS DED: JD450G	Army	USA: United States of America	Equipment	Tracked Not SelfDeployable	Yes					Each	4.57 m	2.46 m	2.77 m	8300.7 kg	8300.7 kg	No		UNKNOWN	
USALINYA0771-01	LD21D	8145015305456	CNTNR TOOL RM/EQP STG: 6610	CNTNR TOOL RM/EQP STG: 6610	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.15 m	2.03 m	1.91 m	725.7 kg	725.7 kg	No		UNKNOWN	
USALINYA0819-01	LA1	2340014202816	UTILITY VEH 4WD: GATOR	UTILITY VEH 4WD: GATOR	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	Yes					Each	3.20 m	2.03 m	1.65 m	645.0 kg	645.0 kg	No		UNKNOWN	
USALINYA0821-01	AD91E	2320014990015	TRK UTILITY UP-ARMOR: M1145	TRK UTILITY UP-ARMOR: M1145	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.00 m	2.18 m	1.83 m	4445.2 kg	4445.2 kg	No		UNKNOWN	
USALINYA0951-01	AD11R	0000000000000	TACTICAL COMMAND SYS: AN/TSQ 252V5	TACTICAL COMMAND SYS: AN/TSQ 252V5	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.00 m	2.13 m	2.74 m	4862.5 kg	4862.5 kg	No		UNKNOWN	
USALINYA1037-01	LD21D	8145015917441	CONT DEPLOY STORAGE	CONT DEPLOY STORAGE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.66 m	2.08 m	2.18 m	1587.6 kg	1587.6 kg	No		UNKNOWN	
USALINYA1066-01	LA1	0000000000000	POLARIS TAC VEH 4X4: MRZR 2	POLARIS TAC VEH 4X4: MRZR 2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	2.97 m	1.52 m	1.88 m	730.3 kg	730.3 kg	No		UNKNOWN	
USALINYA1070-01	LA65T	8340015662649	35K HDT GEN/ECU SET/SST: ECU, 505 ULME	35K HDT GEN/ECU SET/SST: ECU, 505 ULME	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	6.25 m	2.44 m	2.59 m	5533.8 kg	5533.8 kg	No		UNKNOWN	
USALINYA1102-01	LA1	0000000000000	POLARIS DEFENSE DAGOR: POLARIS DAGOR	POLARIS DEFENSE DAGOR: POLARIS DAGOR	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	4.52 m	1.88 m	1.85 m	3515.3 kg	3515.3 kg	No		UNKNOWN	
USALINYA1115-01	LD21AA	8150016190838	ISO 20FT CARGO CONT WS: TYPE III WORKSHOP	ISO 20FT CARGO CONT WS: TYPE III WORKSHOP	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	3778.4 kg	3778.4 kg	No		UNKNOWN	

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALINC59125-09	KA71A	5985016160072	COMM TAC TERM CNTRL SYS: AN/TSQ-198B	COMM TAC TERM CNTRL SYS: AN/TSQ-198B	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.64 m	2.49 m	4862.5 kg	4862.5 kg	No		UNKNOWN	
USALINC61597-05	KA71	5895015746811	COMMAND SYS TACT: AN/TSQ-221	COMMAND SYS TACT: AN/TSQ-221	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.57 m	2.59 m	4535.9 kg	4535.9 kg	No		UNKNOWN	
USALINE21985-01	HD	1560012056274	EXT STORES SUBSYSTEM	EXT STORES SUBSYSTEM	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.54 m	1.27 m	0.94 m	378.3 kg	378.3 kg	No		UNKNOWN	
USALINM78551-01	HE8	1095012532030	MOUNTING KIT AIR DEF: M139	MOUNTING KIT AIR DEF: M139	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.03 m	1.68 m	1.75 m	689.9 kg	689.9 kg	No		UNKNOWN	
USALINN05006-01	QB68	6515016295051	NOISE-IMMUNE STETHOSCO: NIS	NOISE-IMMUNE STETHOSCO: NIS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.15 m	0.28 m	2.7 kg	2.7 kg	No		UNKNOWN	
USALINR17126-01	KA71A	5840014508126	RADAR SET: AN/TPN-31	RADAR SET: AN/TPN-31	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	12.80 m	3.15 m	2.59 m	16930.8 kg	16930.8 kg	No		UNKNOWN	
USALINR22436-01	TB2	5821014134233	RADIO SET HI FREQ: AN/ARC220V1	RADIO SET HI FREQ: AN/ARC220V1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.43 m	0.18 m	0.53 m	16.8 kg	16.8 kg	No		UNKNOWN	
USALINT05773-01	LE6S	1095012593211	TESTER MINE DISPENSER: MST F/VOLCAN	TESTER MINE DISPENSER: MST F/VOLCAN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.51 m	0.43 m	1.09 m	8.6 kg	8.6 kg	No		UNKNOWN	
USALINT93517-06	LE6S	5625015293346	T/S STABILATOR LINE: TS-3920C/ASM	T/S STABILATOR LINE: TS-3920C/ASM	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.81 m	0.61 m	0.76 m	44.5 kg	44.5 kg	No		UNKNOWN	
USALINW92187-01	KA71C	5865014929700	WARNG RECVR SYS: AN/AAR-57(V)4	WARNG RECVR SYS: AN/AAR-57(V)4	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.34 m	0.97 m	1.83 m	32.7 kg	32.7 kg	No		UNKNOWN	
USALINZZZZZ-XX	ZZZZZZ		ZZZZZZ	ZZZZZZ	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Nam	Unit Of Issue	Shipping Lengt	Shipping Width	Shipping Height	Gross Weigh	Tare Weigh	Stackable	Remarks	Long RIC Description	Financial Value
USALINA24017-04	LQ2	4120015234131	AIR CONDITNR FL/WALL	AIR CONDITNR FL/WALL	Army	USA: United States of Americ	Equipmen	Bulk Equipment	No					Each	0.84 m	0.81 m	0.66 m	140.6 kg	140.6 kg	No		UNKNOWN	
USALINB05016-XX	LE1		B05016	B05016	Army	USA: United States of Americ	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINC05069-02	TD	7010014933541	COMPUTER SET DIG: AN/UYK-128(V)1	COMPUTER SET DIG: AN/UYK-128(V)1	Army	USA: United States of Americ	Equipmen	Bulk Equipment	No					Each	0.38 m	0.81 m	0.56 m	10.0 kg	10.0 kg	No		UNKNOWN	
USALINC05095-01	AD26	2350015750951	CARRIER: AMMO TRACKED: M992A3 CAT	CARRIER: AMMO TRACKED: M992A3 CAT	Army	USA: United States of Americ	Equipmen	Tracked Not SelfDeployabl	No					Each	6.86 m	3.86 m	3.76 m	33774.5 kg	33774.5 kg	No		UNKNOWN	
USALINC43399-11	LA65F	5895014955980	CENTRAL COMM TROJAN: M1102	CENTRAL COMM TROJAN: M1102	Army	USA: United States of Americ	Equipmen	Towed Vehicle	No					Each	3.43 m	2.24 m	2.54 m	616.9 kg	616.9 kg	No		UNKNOWN	
USALINH05013-01	CA14E	2350015770830	HOWITZER MED SELF PROPEL: M109A7 SP	HOWITZER MED SELF PROPEL: M109A7 SP	Army	USA: United States of Americ	Equipmen	Tracked Not SelfDeployabl	No					Each	9.73 m	3.35 m	3.76 m	35915.4 kg	35915.4 kg	No		UNKNOWN	
USALINM12418-06	NB51	4240013703823	MASK CHEM BIOLOGICAL: M40A1 LG	MASK CHEM BIOLOGICAL: M40A1 LG	Army	USA: United States of Americ	Equipmen	Box	No					Each	0.38 m	0.28 m	0.15 m	3.2 kg	3.2 kg	Yes		UNKNOWN	
USALINZ05699-01	LE6	0000000000000	MK-3496: TK FIREFNDR ORG: FIREFNDR OR	MK-3496: TK FIREFNDR ORG: FIREFNDR OR	Army	USA: United States of Americ	Equipmen	Bulk Equipment	No					Each	0.48 m	0.30 m	0.10 m	2.3 kg	2.3 kg	No		UNKNOWN	

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALINC59313-02	TB1ZZZ	5895013482344	COMMUNICATION CENTRAL: AN/ASC-15CV1	COMMUNICATION CENTRAL: AN/ASC-15CV1	Army	USA: United States of America	Equipment	Box	No					Each	1.02 m	0.64 m	1.09 m	45.4 kg	45.4 kg	Yes		UNKNOWN	

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALINC05086-01	QC3	6520013730782	CURING UNIT DENTAL	CURING UNIT DENTAL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.28 m	0.18 m	0.33 m	4.5 kg	4.5 kg	No		UNKNOWN	
USALINC05093-01	NA1	5410015929464	CHMICL BIO PROT SHLTR: CBPS ELECTRIC	CHMICL BIO PROT SHLTR: CBPS ELECTRIC	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	10.21 m	2.44 m	2.82 m	16802.0 kg	16802.0 kg	No		UNKNOWN	
USALIND08483-01	LBE	3990003685272	CGO SET GENERAL HATCH	CGO SET GENERAL HATCH	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.83 m	1.27 m	3.66 m	1982.2 kg	1982.2 kg	No		UNKNOWN	
USALIND95617-03	QA32	6545015294440	DES PROSTHETICS: 2005	DES PROSTHETICS: 2005	Army	USA: United States of America	Package	Container	No					Each	0.79 m	0.48 m	0.18 m	27.2 kg	27.2 kg	Yes		UNKNOWN	
USALINE05021-01	QU	6540015856821	EDGER,HAND,OPHTHALMIC: OPHTHALMIC	EDGER,HAND,OPHTHALMIC: OPHTHALMIC	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.28 m	0.41 m	0.28 m	8.2 kg	8.2 kg	No		UNKNOWN	
USALINF05005-01	LH13	4210015991725	FIRE FIGHTING SET,IND: FIRES	FIRE FIGHTING SET,IND: FIRES	Army	USA: United States of America	Package	Container	No					Each	1.37 m	0.76 m	0.71 m	68.0 kg	68.0 kg	Yes		UNKNOWN	
USALINF05034-01	LF63A	4930015456669	FUEL SYS SUPPLY POINT-800K: 800K	FUEL SYS SUPPLY POINT-800K: 800K	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	435448.7 kg	435448.7 kg	No		UNKNOWN	
USALING12034-04	LE63AE	6115014620291	GEN SET DED SKID MTD: MEP-806B	GEN SET DED SKID MTD: MEP-806B	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.21 m	0.91 m	1.50 m	1810.7 kg	1810.7 kg	No		UNKNOWN	
USALINL05013-01	QU	6540016200727	LENS MEASURING INSTRU	LENS MEASURING INSTRU	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.18 m	0.23 m	6.4 kg	6.4 kg	No		UNKNOWN	
USALINM23423-19	QA31	6545015182964	MES BLOOD BANK LAB: DET-2003	MES BLOOD BANK LAB: DET-2003	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.39 m	1.17 m	14.27 m	5669.9 kg	5669.9 kg	No		UNKNOWN	
USALINM5797D-01	LD26	4110015347675	MOB INTG RMN COL SYS: MIRCS	MOB INTG RMN COL SYS: MIRCS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	7461.6 kg	7461.6 kg	No		UNKNOWN	
USALINP47705-04	QU	6545016126750	OPTICAL EQUIP SET: OPTICAL EQUIPMENT SET (OES	OPTICAL EQUIP SET: OPTICAL EQUIPMENT SET (OES	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.91 m	1.07 m	1.07 m	526.6 kg	526.6 kg	No		UNKNOWN	
USALINS29227-01	LH5	4240005100204	SAFETY EQUIPMENT SET	SAFETY EQUIPMENT SET	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.91 m	0.71 m	0.81 m	82.1 kg	82.1 kg	No		UNKNOWN	
USALINT05108-XX	TD43		T05108	TEST SET TELECOMM: SYS TS-4544/U	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	3.4 kg	3.4 kg	No		UNKNOWN	
USALINW48759-01	LE6	5180005961509	TOOL KIT PIPEFITTERS: 2-1/2 - 4-IN	TOOL KIT PIPEFITTERS: 2-1/2 - 4-IN	Army	USA: United States of America	Equipment	Box	No					Each	1.68 m	0.41 m	0.48 m	136.1 kg	136.1 kg	Yes		UNKNOWN	
USALINW65884-01	LE6A	5180002898930	T/K SUP PL PMP STA: 4, 6, 8-INCH	T/K SUP PL PMP STA: 4, 6, 8-INCH	Army	USA: United States of America	Package	Container	No					Each	0.56 m	0.23 m	0.20 m	30.8 kg	30.8 kg	Yes		UNKNOWN	
USALINW89557-32	LA27	3930013822567	TRACTOR WHL WHS GED: M487	TRACTOR WHL WHS GED: M487	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	No					Each	2.72 m	1.24 m	2.13 m	2721.6 kg	2721.6 kg	No		UNKNOWN	

NIC	RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALIN805004-01	LH2	4220015995367	BREAKAWAY DIVERS AIR SYS: BDASS	BREAKAWAY DIVERS AIR SYS: BDASS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.12 m	2.62 m	2.03 m	2051.6 kg	2051.6 kg	No		UNKNOWN	
USALINC05038-01	TD13	7022016310621	COMPUTER GROUP: TACTICAL: OL-761B(V)6/T	COMPUTER GROUP: TACTICAL: OL-761B(V)6/T	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.51 m	0.20 m	4.5 kg	4.5 kg	No		UNKNOWN	
USALINC05050-01	TD	7022016062426	CPU GRP: TAC OL-761B(V)2/T: OL-761B(V)2/T	CPU GRP: TAC OL-761B(V)2/T: OL-761B(V)2/T	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.43 m	1.14 m	0.89 m	1176.6 kg	1176.6 kg	No		UNKNOWN	
USALINC05102-01	EH14A	1940016180272	COMBAT ASSAULT CRAFT: 15 PAX BOAT	COMBAT ASSAULT CRAFT: 15 PAX BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	7.01 m	1.83 m	0.61 m	204.1 kg	204.1 kg	No		UNKNOWN	
USALINC05103-01	EH14A	1940016180276	COMBAT RAIDING CRAFT: INFLATABLE BOAT	COMBAT RAIDING CRAFT: INFLATABLE BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.88 m	1.83 m	0.61 m	145.1 kg	145.1 kg	No		UNKNOWN	
USALINC05115-01	TB1	5985016456998	COMMO SYS-AN/TYQ-167(V)2: AN/TYQ-167(V)2	COMMO SYS-AN/TYQ-167(V)2: AN/TYQ-167(V)2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.53 m	3.51 m	379.7 kg	379.7 kg	No		UNKNOWN	
USALINC05139-XX	TB		C05139	C05139	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALIND05024-01	LH2	4220016190577	DEEP SEA (DSS): DSS 300FT SET	DEEP SEA (DSS): DSS 300FT SET	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.24 m	2.74 m	2.34 m	2426.7 kg	2426.7 kg	No		UNKNOWN	
USALIND20400-01	BA44	1040014630157	DISP RIOT CNTL AGENT: M37	DISP RIOT CNTL AGENT: M37	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.51 m	0.30 m	0.51 m	5.9 kg	5.9 kg	No		UNKNOWN	
USALIND32723-01	LH2	4220005413885	DIVING EQUIP SET: OPEN CIRCUIT	DIVING EQUIP SET: OPEN CIRCUIT	Army	USA: United States of America	Equipment	Box	No					Each	0.91 m	0.61 m	0.30 m	43.1 kg	43.1 kg	Yes		UNKNOWN	
USALIND32791-02	LH2	4220015702857	DIVING EQUIP SET: PHOTO SPT	DIVING EQUIP SET: PHOTO SPT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.61 m	0.61 m	0.30 m	9.1 kg	9.1 kg	No		UNKNOWN	
USALIND32859-01	LH2	4220010230246	DIVING EQUIP SET: TYPE A	DIVING EQUIP SET: TYPE A	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.22 m	0.91 m	1.52 m	272.2 kg	272.2 kg	No		UNKNOWN	
USALIND32927-02	LH2	4220010231701	DIVING EQUIP SET: TYPE B	DIVING EQUIP SET: TYPE B	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.22 m	1.22 m	1.22 m	553.4 kg	553.4 kg	No		UNKNOWN	
USALIND49154-01	LH2	4220005698809	DIVING EQUIPMENT SET: INDIV SCUBA	DIVING EQUIPMENT SET: INDIV SCUBA	Army	USA: United States of America	Equipment	Box	No					Each	0.61 m	0.91 m	0.30 m	22.7 kg	22.7 kg	Yes		UNKNOWN	
USALIND89675-06	QC1BB	4220015489065	CHAMBER RECOMPRESSION: RC-100 PSI	CHAMBER RECOMPRESSION: RC-100 PSI	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.05 m	2.44 m	2.13 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINJ05026-01	AC1	2320016536495	JLTV A1 HEAVY GUNS: M1278A1	JLTV A1 HEAVY GUNS: M1278A1	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.56 m	2.44 m	2.39 m	6259.6 kg	6259.6 kg	No		UNKNOWN	
USALINL05001-01	BE5	1095015432189	LAUNCHED ELECTRODE STUN DEVICE: LESD	LAUNCHED ELECTRODE STUN DEVICE: LESD	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.15 m	0.05 m	0.10 m	3.6 kg	3.6 kg	No		UNKNOWN	
USALINL05019-01	BE5	5180016592703	LDR PNT OF CAPTURE KIT: LPOCK	LDR PNT OF CAPTURE KIT: LPOCK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.25 m	0.13 m	0.28 m	1.8 kg	1.8 kg	No		UNKNOWN	
USALINL05021-01	BE24A	1240016639605	LASR TARGT LOC MOD: AN/PED-7	LASR TARGT LOC MOD: AN/PED-7	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.15 m	0.15 m	0.10 m	0.5 kg	0.5 kg	No		UNKNOWN	
USALINM05074-01	LE6	5895016584004	MAINT KIT ELEC EQT: MK-3431/U	MAINT KIT ELEC EQT: MK-3431/U	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.30 m	0.30 m	0.20 m	7.7 kg	7.7 kg	No		UNKNOWN	
USALINM05075-XX	LE		M05075	M05075	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05076-XX	LE6S		M05076	M05076	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05084-XX	NB2		M05084	M05084	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINM05087-XX	ZZZZZZ		M05087 (item not in JECD)	M05087	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINP05051-01	LE6	5180016592694	PLT EVIDENCE KIT (PECK): PECK	PLT EVIDENCE KIT (PECK): PECK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.25 m	0.56 m	7.7 kg	7.7 kg	No		UNKNOWN	
USALINR05029-01	TB1C	5820200104352	RADIO TERMINAL,LINEOF: AN/TRC-238(V)1	RADIO TERMINAL,LINEOF: AN/TRC-238(V)1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.84 m	1.96 m	224.1 kg	224.1 kg	No		UNKNOWN	
USALINR05031-01	TB1C	5820200104455	RADIO TERMINAL,LINEOF: AN/TRC-238(V)2	RADIO TERMINAL,LINEOF: AN/TRC-238(V)2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	0.84 m	1.96 m	224.1 kg	224.1 kg	No		UNKNOWN	
USALINR05036-01	EH14A	1940016467565	RIGID INFLAT BOAT (RIB): RIGID INFLATABLE BOAT RIB	RIGID INFLAT BOAT (RIB): RIGID INFLATABLE BOAT RIB	Army	USA: United States of America	Equipment	Floating Craft SelfDeployable	No					Each	9.60 m	3.05 m	3.78 m	5233.1 kg	5233.1 kg	No		UNKNOWN	
USALINS05063-01	QC	6515015194251	STIMULATOR, ULTRASOUND: PORTABLE	STIMULATOR, ULTRASOUND: PORTABLE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.36 m	0.30 m	0.13 m	2.7 kg	2.7 kg	No		UNKNOWN	
USALINS41465-01	LE6	6625011375369	SIGNAL GEN PULSE: SG-1205(J)/U	SIGNAL GEN PULSE: SG-1205(J)/U	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.46 m	0.30 m	10.4 kg	10.4 kg	No		UNKNOWN	
USALINT05053-01	LH2	4220016179405	TPE 1 HI PRES AIR COMP: TYPE I (HPBAC-I)	TPE 1 HI PRES AIR COMP: TYPE I (HPBAC-I)	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.57 m	1.22 m	1.40 m	544.3 kg	544.3 kg	No		UNKNOWN	
USALINT05055-01	LH2	4220016179406	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.17 m	0.48 m	0.74 m	118.8 kg	118.8 kg	No		UNKNOWN	
USALINT05073-01	TB12	5895016541702	TRANS TAC CMD COM T2C2: AN/TSC 233 V2	TRANS TAC CMD COM T2C2: AN/TSC 233 V2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.81 m	0.53 m	1.91 m	196.0 kg	196.0 kg	No		UNKNOWN	
USALINT05087-01	LE6	5180016592696	TM EVIDENCE KIT (TECK): TECK	TM EVIDENCE KIT (TECK): TECK	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.25 m	0.13 m	0.28 m	1.8 kg	1.8 kg	No		UNKNOWN	
USALINT05093-01	ND1	4240016651803	TEST KIT MASK PROTECTIVE: PATS M41A1	TEST KIT MASK PROTECTIVE: PATS M41A1	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.38 m	0.41 m	0.25 m	10.0 kg	10.0 kg	No		UNKNOWN	
USALINT05098-01	TD1	6625016827085	TEST: SET ELECTRONIC SYS: AN/PSM-95 R	TEST: SET ELECTRONIC SYS: AN/PSM-95 R	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.56 m	0.15 m	13.6 kg	13.6 kg	No		UNKNOWN	
USALINT05099-01	TD1	6625016832824	TEST SET ELECTRONIC SYSTEM: AN/PSM-95 LIGHT	TEST SET ELECTRONIC SYSTEM: AN/PSM-95 LIGHT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.41 m	0.23 m	10.9 kg	10.9 kg	No		UNKNOWN	
USALINT45817-01	LE6	5180015218102	TOOL KIT GUID MIS LNCH: DS/GS HMARS	TOOL KIT GUID MIS LNCH: DS/GS HMARS	Army	USA: United States of America	Package	Container	No					Each	0.64 m	0.08 m	0.33 m	43.1 kg	43.1 kg	Yes		UNKNOWN	
USALINU05015-01	LE2A	4220016186266	UNDERWATER CONSTRUC ST: BOX 1 ISU-90	UNDERWATER CONSTRUC ST: BOX 1 ISU-90	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.74 m	2.24 m	2.29 m	5329.7 kg	5329.7 kg	No		UNKNOWN	
USALINW05009-01	LE6	6625016808563	WIRELESS PLATFORM TEST ST: WATS	WIRELESS PLATFORM TEST ST: WATS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.56 m	0.41 m	0.23 m	11.3 kg	11.3 kg	No		UNKNOWN	
USALINZ05549-01	TD43B	0000000000000	ENCRYPT-DECRYPT EQUIP: KG-250XS	ENCRYPT-DECRYPT EQUIP: KG-250XS	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.10 m	0.10 m	0.05 m	1.4 kg	1.4 kg	No		UNKNOWN	
USALINZ05740-01	TD15	0000000000000	CROSS DOMAIN SERVER: AN/GYK-79 MOBILE-MOUNTED	CROSS DOMAIN SERVER: AN/GYK-79 MOBILE-MOUNTED	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.76 m	0.43 m	0.08 m	29.9 kg	29.9 kg	No		UNKNOWN	
USALINZ05807-XX	LE6		Z05807	Z05807	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINZ05833-XX	ZZZZZZ		Z05833 (remote armor/combat vehicle weapon system - not	Z05833	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINZ05867-01	LA6	2330016539745	JNT LT TAC VEH TRL JLTV-T: M1289	JNT LT TAC VEH TRL JLTV-T: M1289	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	4.52 m	2.44 m	1.52 m	1867.0 kg	1867.0 kg	No		UNKNOWN	

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USALINB14729-U1	LDA	8465011178699	DUFFLE BAG NYLON W/STRAPS: DUFFLE BAG	DUFFLE BAG NYLON W/STRAPS: DUFFLE BAG	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	0.46 m	0.46 m	0.91 m	34.0 kg	34.0 kg	No		UNKNOWN	
USALINC05102-01	EH14A	1940016180272	COMBAT ASSAULT CRAFT: 15 PAX BOAT	COMBAT ASSAULT CRAFT: 15 PAX BOAT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	7.01 m	1.83 m	0.61 m	204.1 kg	204.1 kg	No		UNKNOWN	
USALINL05024-01	LB13A	3930016598135	LITE RGH TERRN FORKLIFT: LCRTF 5K	LITE RGH TERRN FORKLIFT: LCRTF 5K	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	No					Each	5.84 m	2.03 m	2.01 m	8674.0 kg	8674.0 kg	No		UNKNOWN	
USALINR12379-XX	ZZZZZZ		R12379	R12379	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	
USALINT05055-01	LH2	4220016179406	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	HIGH PRE BREATH AIR COMP: HPBAC-II DIVE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.17 m	0.48 m	0.74 m	118.8 kg	118.8 kg	No		UNKNOWN	
USALINT61562-19	AD22RA	2320013719578	TRK UTIL CGO/TRP CARR: M1038A1 WWN	TRK UTIL CGO/TRP CARR: M1038A1 WWN	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	4.72 m	2.74 m	1.83 m	2497.9 kg	2497.9 kg	No		UNKNOWN	
USALINYA0083-01	LD21DA	8115007534690	CONEX INSERT: TRI-WALL	CONEX INSERT: TRI-WALL	Army	USA: United States of America	Equipment	Pallet	No					Each	1.14 m	0.81 m	0.71 m	45.4 kg	45.4 kg	Yes		UNKNOWN	
USALINYA0084-01	LD21DA	8115007534691	CONEX INSERT: TRI-WALL	CONEX INSERT: TRI-WALL	Army	USA: United States of America	Equipment	Pallet	No					Each	1.47 m	0.84 m	0.69 m	45.4 kg	45.4 kg	Yes		UNKNOWN	
USALINYA0144-01	HJ83	0000000000000	AIRDROP PLATFORM: 20-FOOT	AIRDROP PLATFORM: 20-FOOT	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.74 m	0.64 m	884.5 kg	884.5 kg	No		UNKNOWN	
USALINYA0400-01	LD21D	8115014440198	UNI-PAK CNTNR (CMCL): TRI-WALL	UNI-PAK CNTNR (CMCL): TRI-WALL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	1.12 m	1.22 m	1.14 m	22.7 kg	22.7 kg	No		UNKNOWN	
USALINYA0484-01	LD21D	8745014670448	CNTNR SPECIAL (SHOP)	CNTNR SPECIAL (SHOP)	Army	USA: United States of America	Package	Container	No					Each	4.19 m	2.21 m	2.13 m	1796.2 kg	1796.2 kg	Yes		UNKNOWN	
USALINYA0574-01	LG71	0000000000000	WATER DIST SYS (WDS)	WATER DIST SYS (WDS)	Army	USA: United States of America	Package	Container	No					Each	1.98 m	2.44 m	2.44 m	3388.3 kg	3388.3 kg	Yes		UNKNOWN	
USALINYA0609-01	LD21D	8145014731212	BOH ENVIROMENTAL CNTR: FPU-8-1	BOH ENVIROMENTAL CNTR: FPU-8-1	Army	USA: United States of America	Package	Container	No					Each	2.13 m	2.44 m	2.29 m	1995.8 kg	1995.8 kg	Yes		UNKNOWN	
USALINYA0610-01	LD21D	8145015020581	BULK STG/SHPG CNTR: BOH-12	BULK STG/SHPG CNTR: BOH-12	Army	USA: United States of America	Package	Container	No					Each	3.89 m	2.44 m	2.34 m	2358.7 kg	2358.7 kg	Yes		UNKNOWN	
USALINYA0616-01	LD21D	8145014670448	CONTAINER, SPECIAL	CONTAINER, SPECIAL	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.22 m	2.21 m	2.13 m	1315.4 kg	1315.4 kg	No		UNKNOWN	
USALINYA0645-01	LD21AA	5419013996391	20 FT ISO CONTAINER: FORCE PROVIDER MODULE	20 FT ISO CONTAINER: FORCE PROVIDER MODULE	Army	USA: United States of America	Package	Container	No					Each	6.10 m	2.44 m	2.44 m	4930.5 kg	4930.5 kg	Yes		UNKNOWN	
USALINYA0682-01	LD15J	8145014670445	SHELTER, SHOP VAN	SHELTER, SHOP VAN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	4.19 m	2.21 m	2.13 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINYA0697-01	LD21A	8145014839123	TRICON CONTAINER: GREEN	TRICON CONTAINER: GREEN	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.07 m	2.44 m	2.44 m	3538.0 kg	3538.0 kg	No		UNKNOWN	
USALINYA0705-01	LA65	8340014594366	DRASH UTIL TRL: HP-2C/188	DRASH UTIL TRL: HP-2C/188	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	4.19 m	2.18 m	1.83 m	1542.2 kg	1542.2 kg	No		UNKNOWN	
USALINYA0857-01	LD21A	0000000000000	SHIPPING CNTR: ISO AERO 2	SHIPPING CNTR: ISO AERO 2	Army	USA: United States of America	Package	Container	No					Each	6.10 m	2.44 m	2.59 m	3855.5 kg	3855.5 kg	Yes		UNKNOWN	
USALINYA0869-01	LD21D	8145014670444	EXP MOB SHP CNTNR	EXP MOB SHP CNTNR	Army	USA: United States of America	Package	Container	No					Each	3.71 m	2.21 m	2.13 m	1950.4 kg	1950.4 kg	Yes		UNKNOWN	
USALINYA0981-01	LD21D	8145015188749	CONTAINER, FRT, SP: FPU-8-2	CONTAINER, FRT, SP: FPU-8-2	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.24 m	2.44 m	2.34 m	1610.3 kg	1610.3 kg	No		UNKNOWN	
USALINYA1043-01	LD21AA	8150015983223	BOH CONTAINER FPU-20-3: FPU-20-3	BOH CONTAINER FPU-20-3: FPU-20-3	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	3900.9 kg	3900.9 kg	No		UNKNOWN	
USALINYA1078-01	LD21AA	0000000000000	BRADLEY VEH SPL TOOL CTNR: TOOLS CTNR	BRADLEY VEH SPL TOOL CTNR: TOOLS CTNR	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	2798.7 kg	2798.7 kg	No		UNKNOWN	
USALINYA1109-01	AD9	2355016275147	GRND MOB VEH 1.1 (GMV 1.1): M1288	GRND MOB VEH 1.1 (GMV 1.1): M1288	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	No					Each	5.33 m	2.03 m	1.83 m	5080.2 kg	5080.2 kg	No		UNKNOWN	
USALINZ00514-XX	ZZZZZZ		Z00514	Z00514	Army	USA: United States of America	Equipment		No					Each	0.03 m	0.03 m	0.03 m	0.0 kg	0.0 kg	No		UNKNOWN	

NIC	RIC	LIN/RIC	NATO Stock Nr	Name	English Name	Service	Nation	Type	Mobility Category	Hazardous	UN Class	UN Number	NEQ	Proper Shipping Name	Unit Of Issue	Shipping Length	Shipping Width	Shipping Height	Gross Weight	Tare Weight	Stackable	Remarks	Long RIC Description	Financial Value
USALINA53199-09	LA16BR	A53199=LA16BR	7010015826366	ALL SRC ANALYSIS SYS: FCA M1152A1 W/B2	ALL SRC ANALYSIS SYS: FCA M1152A1 W/B2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.13 m	2.29 m	2.59 m	5488.5 kg	5488.5 kg	No		UNKNOWN	
USALINC05051-01	ND	C05051=ND2ZZZ	6665016217138	CBRN DISMNTED RECON (SKO): MODULE A QUADCON	CBRN DISMNTED RECON (SKO): MODULE A QUADCON	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	2.44 m	1.45 m	2.44 m	2268.0 kg	2268.0 kg	No		UNKNOWN	
USALINC43331-01	LA16BR	C43331=LA16BR	5895014955981	CNT COM TROJAN SPIRIT LT: AN/TSQ226 (V)2	CNT COM TROJAN SPIRIT LT: AN/TSQ226 (V)2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.36 m	2.24 m	2.57 m	4824.0 kg	4824.0 kg	No		UNKNOWN	
USALINC90599-01	AD22RA	C90599=AD22RA	5895013875792	COMM CONTROL SET: AN/TSQ-183A	COMM CONTROL SET: AN/TSQ-183A	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	4.57 m	2.16 m	2.44 m	3211.4 kg	3211.4 kg	No		UNKNOWN	
USALINM05027-02	AF22	M05027=AF22ZZ	2355016215506	M-ATV UI CROWS WIN-T S: M1274 M-ATV	M-ATV UI CROWS WIN-T S: M1274 M-ATV	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.94 m	2.51 m	2.59 m	16782.9 kg	16782.9 kg	No		UNKNOWN	
USALINM05028-02	AF22	M05028=AF22ZZ	2355016207041	M-ATV UI (CROWS) WIN-T: M1276 M-ATV	M-ATV UI (CROWS) WIN-T: M1276 M-ATV	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.94 m	2.51 m	2.59 m	16782.9 kg	16782.9 kg	No		UNKNOWN	
USALINT01691-01	LA2	T01691=LA2ZZZ	2320015527793	TRK CHASSIS MTV: M1092A1P2	TRK CHASSIS MTV: M1092A1P2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	7.21 m	2.44 m	2.84 m	11612.0 kg	11612.0 kg	No		UNKNOWN	
USALINW76336-40	LA27	W76336=LA27ZZ	2410014120930	TRACTOR FTRAC LS DED: JD450G	TRACTOR FTRAC LS DED: JD450G	Army	USA: United States of America	Equipment	Tracked Not SelfDeployable	Yes					Each	4.57 m	2.46 m	2.77 m	8300.7 kg	8300.7 kg	No		UNKNOWN	
USALINYA0771-01	LD21D	YA0771=LD21DZ	8145015305456	CNTNR TOOL RM/EQP STG: 6610	CNTNR TOOL RM/EQP STG: 6610	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.15 m	2.03 m	1.91 m	725.7 kg	725.7 kg	No		UNKNOWN	
USALINYA0819-01	LA1	YA0819=LA1ZZZ	2340014202816	UTILITY VEH 4WD: GATOR	UTILITY VEH 4WD: GATOR	Army	USA: United States of America	Equipment	Wheeled Not SelfDeployable	Yes					Each	3.20 m	2.03 m	1.65 m	645.0 kg	645.0 kg	No		UNKNOWN	
USALINYA0821-01	AD91E	YA0821=AD91EZ	2320014990015	TRK UTILITY UP-ARMOR: M1145	TRK UTILITY UP-ARMOR: M1145	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.00 m	2.18 m	1.83 m	4445.2 kg	4445.2 kg	No		UNKNOWN	
USALINYA0951-01	AD11R	YA0951=AD11RZ	0000000000000	TACTICAL COMMAND SYS: AN/TSQ 252V5	TACTICAL COMMAND SYS: AN/TSQ 252V5	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	5.00 m	2.13 m	2.74 m	4862.5 kg	4862.5 kg	No		UNKNOWN	
USALINYA1037-01	LD21D	YA1037=LD21DZ	8145015917441	CONT DEPLOY STORAGE	CONT DEPLOY STORAGE	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	3.66 m	2.08 m	2.18 m	1587.6 kg	1587.6 kg	No		UNKNOWN	
USALINYA1066-01	LA1	YA1066=LA1ZZZ	0000000000000	POLARIS TAC VEH 4X4: MRZR 2	POLARIS TAC VEH 4X4: MRZR 2	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	2.97 m	1.52 m	1.88 m	730.3 kg	730.3 kg	No		UNKNOWN	
USALINYA1070-01	LA65T	YA1070=LA65TZ	8340015662649	35K HDT GEN/ECU SET/SST: ECU, 505 ULME	35K HDT GEN/ECU SET/SST: ECU, 505 ULME	Army	USA: United States of America	Equipment	Towed Vehicle	No					Each	6.25 m	2.44 m	2.59 m	5533.8 kg	5533.8 kg	No		UNKNOWN	
USALINYA1102-01	LA1	YA1102=LA1ZZZ	0000000000000	POLARIS DEFENSE DAGOR: POLARIS DAGOR	POLARIS DEFENSE DAGOR: POLARIS DAGOR	Army	USA: United States of America	Equipment	Wheeled SelfDeployable	Yes					Each	4.52 m	1.88 m	1.85 m	3515.3 kg	3515.3 kg	No		UNKNOWN	
USALINYA1115-01	LD21AA	YA1115=LD21AA	8150016190838	ISO 20FT CARGO CONT WS: TYPE III WORKSHOP	ISO 20FT CARGO CONT WS: TYPE III WORKSHOP	Army	USA: United States of America	Equipment	Bulk Equipment	No					Each	6.10 m	2.44 m	2.44 m	3778.4 kg	3778.4 kg	No		UNKNOWN	

Appendix E – Tasks and Deliverables Summary

Tasks

Capability and Capacity Planning

Definition: Capability and Capacity Planning is an activity that determines the amount of Capability and Capacity required by maintenance and sustainment organizations to meet changing demands, and that is required to support operational requirements in the future. These actions can be performed at both granular and aggregate levels.

Requirement: Development of a software solution to address the improvement of global Capability and Capacity Planning Software tools, to include "what-if" analysis of the Enterprise workload across organic, non-Navy military and commercial sites. This solution includes tools for cataloging Enterprise Capability, Enterprise Capacity, Reliability Based Maintenance for Equipment, and Enterprise Infrastructure Investment prioritization. Additionally, draft technology and business roadmaps for Capacity Management tools and develop standardized templates for use by COMFRC personnel.

Task 1a: Develop data templates that identify data requirements, definitions and business rule refinement that align COMFRC's data solution with applicable commercial best practices.

Task 1b: Investigate and benchmark the existing portfolio of global asset visibility capabilities and tools from existing government program efforts, industry, and other services.

Task 1c: Design and conduct pilots where capabilities meet required business rules and expectations that provide for drill-down to explore these functions with a greater degree of granularity.

Task 1d: Coordinate with COMFRC leadership for the program and its dependent initiatives and recommend organizational changes, specific roles, decision-making processes, and a standardized escalation framework in support of program implementation.

Task 1e: Develop and execute a plan to validate the program's tools and procedures prior to full implementation.

Financial Management

Definition: Financial Management refers to the efficient and effective management of funds, such that the NAE SV2020 strategy objectives can be accomplished.

Requirement: Changes are necessary within Financial Management within NAE sustainment to ensure financial resources are better aligned with the specific gaps that are limiting optimal readiness. Critical is the development of integrated applications and software solutions, that in prototyping, can be used to understand and realize the impacts to re-align specific sustainment activities from Appropriated to Working Capital funding sources to improve the timing of available funds in a SV2020 environment available in response to evolving operational and sustainment conditions.

Task 2a: Development of transparent, auditable actions for Working Capital Fund (WCF) consolidation, Financial System of Record transition, FRC Western and Pacific (WESTPAC) migration to WCF operations, Enterprise Investment, and Aligned Financials.

Task 2b: Conduct in-depth research, analysis, and reporting for government review and approval, which achieve NAVAIR's stated financial transformation in SV2020.

Task 2c: Decompose high level objectives into actionable efforts that culminate in the prototypes to be evaluated.

Task 2d: Develop tools to synchronize, prioritize and schedule the actionable efforts, from inception to final prototype deployment.

Global Maintenance Management

Definition: Global Maintenance Management in the context of SV2020 refers to the Enterprise allocation, direction, and organization of maintenance resources worldwide that contribute to control of equipment availability.

Requirement: SV2020 requires a solution that will provide an overall, enterprise wide, actionable and accessible capability to Global Maintenance Management.

Task 3a: Develop and implement prototype-enabled solutions that support the stand-up of the Naval Aviation Sustainment Center (NASC).

Task 3b: Support the government in development of Total Asset Visibility solutions that enable the NASC to make critical decisions regarding scarce resources.

Task 3c: Develop a Global Maintenance Management Concept of Operations (CONOPS) that supports the use of the prototype capabilities for integration and interoperability of logistics resources across the NAE.

Task 3d: Investigate and recommend tools and techniques for development or integration of Knowledge Management Systems dashboards that connect planning with models and simulation for performance prediction.

Task 3e: Develop the logic and propose tools and techniques for implementation of Supportability Optimization that predicts the optimum intersection of infrastructure, performance and cost.

Supply Support

Definition: Supply Support is a critical element of integrated logistical support. Management of the flow of materiel, labor, and service resources from point of origin to point of consumption is a basic tenet of the supply chain support function.

Requirement: Develop a solution prototype that will facilitate the supply chain transformation into a more globally responsive, sustainable, accessible, affordable, interconnected, and auditable system with ample agility to provide material solutions that meet end user needs and expectations.

Task 4a: Develop capabilities to support processes that enable the supply chain to be more predictive and operationally focused through increased integration, interoperability, and collaboration, while improving asset visibility across multiple interconnected supply chains.

Task 4b: Demonstrate the technology to enable changes to seamlessly integrate supply chain management tools with maintenance management tools.

Task 4c: Investigate and benchmark tools and ideas for inventory alignment with dynamic forecasting and demand planning that will optimize time to reliably replenish via appropriately established Reorder Points (ROPs).

Task 4d: Through integration of maintenance and supply data, identify misalignments in planning data and/or execution related policy/authority decisions.

Task 4e: Develop improved forecasting software tools for consumable piece parts by bringing weapons system maintenance expertise into consumable demand forecasting (vice historical usage alone) to better calibrate inventory investment and reduce NMCS. The industry participant can also provide gap analyses in support of OEM or DLA planning forecasts.

Task 4f: Evaluate prior strategic sourcing activities and assess lessons learned to help facilitate future initiatives and employ them in a final software prototype solution. This includes analysis of failed PBLs and other long term, strategic efforts.

Task 4g: Develop supply chain maps to document the entirety of the supply chain for a given component or system. The information will inform value-added decisions and enable cost trade-offs to be made in developing a sourcing strategy for the requirement. This mapping process can also assist in improving BOM accuracy.

Workforce Proficiency

Definition: Workforce Proficiency represents a framework for demonstrating and documenting required skill sets, competencies, and proficiencies for workers.

Requirement: Development of a prototype software and non-software solution to aid in identifying the right mix of labor qualifications, certifications and training for military and depot sustainment personnel.

Task 5a: Identify solutions to increase workforce proficiency through the integration of the combined industrial and defense workforce.

Task 5b: Implementation and documentation of Advanced Skills Management (ASM) for Military & Depot, Depot Certification of Military, Enterprise Training Gap Closure, and other Workforce Proficiency functions to make the data therein made accessible.

Task 5c: Investigate, document, and make recommendations for integrated prototype tools to manage the alignment of qualifications, certifications, training, and skills, with performance requirements and mission essential tasks.

Services

Definition:
Requirement: It is widely understood that the commercial industry has many available technology platforms for identifying, hiring and managing its workforce. Not all platforms available commercially work within the statutory and regulatory requirements for Federal employees. A varying mix of contracted and government personnel comprise the workforce, which is a critical element of sustainment and readiness of the Naval Air Forces. The government requires enhanced prototype processes and tools to integrate its future government and contracted workforce into the other focus areas of SV2020.

Task 6.a: Develop enhanced prototype processes and tools to facilitate the contacting, hiring and management of a workforce that is efficient, capable, affordable, agile, and accessible to meet the changing demand for manpower across the NAE.

Task 6.b: Develop prototype processes for efficient & effective Enterprise Indirect Functions, Real-Time Manpower Availability, and a COMFRC Contracting Strategy to be responsive to the constantly changing workload demands that are anticipated within SV2020.

Logistics and Engineering

Definition: Logistics and Engineering focuses on the planning, acquisition and management of sustainment engineering and logistics functions, to include subject matter expertise, management, and operational support services. Included in this category are systems operations, automated tools, value chain management, inventory management, and distribution and transportation management. The NAE uses many custom, tailored, and commercial software tools to transact, store, manage and make decisions based upon logistics and engineering data. These systems and tools are poorly integrated, causing significant challenges in discovering and re-using data across the enterprise to identify and address issues.

Requirement: Develop a concept demonstrator that will allow for the inclusion of necessary data from a variety of disparate systems and fuse that into a User Defined Operational Picture that will facilitate visualization and analytics while minimizing impact to sources systems data or business process.

Task 7a: Develop solutions to modernize and evolve the NAE sustainment suite of systems to rapidly respond to warfighter needs through optimized engineering and logistics processes and integrated IT systems.

Task 7b: Develop prototype techniques for monitoring, documenting and auditing third party and OEM repairs in the supply chain to include prototype analysis tools for analyzing the impact of supply system disruptions caused by weather, workforce interruptions, and acts of nature.

Task 7c: Investigate and test for inclusion emerging analytic techniques in industry and academia for predicting work content, failure predictions, inventory smoothing, mission assignment, and mission success probabilities.

Task 7d: Identify any gaps in access to data or other documents available to the end user and devise a method of providing access to that information. This may include development of or modification to a dashboard to provide user document library access.

Task 7e: Conduct data mapping in targeted systems to produce a software solution to prototype in data interoperability.

Deliverables

Capability and Capacity Planning: A prototype capability (system or application) for the management of Global NAE Capability and Capacity. This prototype will be software and non-software prototypes that will establish business rules, collect data (from authoritative systems), validate data (through disruptive technology implementation), aggregate information (using data governance and management best practices) and display developed data-driven Capability and Capacity Management metrics for use by decision makers (using Industry 4.0 and User Defined Operational Picture concepts).

Currently in private industry there is a great deal of momentum and effort geared towards an Industry 4.0 approach to solving logistical challenges. Unfortunately, current work has not had an opportunity to be as expansive and inclusive as needed to fully exploit this promising capability. Bundled concepts such as standards-based interoperability, Blockchain and artificial intelligence in data mining, to name a few, need to be robustly exercised to prove out their applicability to logistical challenges. This is something that commercial entities do not have the resources to expend to this effort. This NAVAIR project, by virtue of the size and complexity of the challenges involved, will provide the first test bed and real-world environment to capture the necessary complexities to fully vet this concept. By performing this CTMA project, commercial enterprise will now have the chance to harvest the successes and lessons learned for incorporation into their own 4.0 initiatives. Leveraging this work commercially will speed technology enhancements and allow private industry to finally gain traction in 4.0 and increase new revenues.

Financial Management: A prototype solution that provides for an automated approach for the government to collect input for required documents including WSPD, PBA, Bed-down Plans and DSORs. This automation will discretely collect and compare the inputs, by customer, by category and by funding and will enable an efficient and timely approach to collecting and consolidating multiple user input. Through multi-year prototyping, it will include integrated, enterprise-level financial management software and non-software tools.

The transfer of knowledge learned, and success achieved have a direct correlation to similar challenges faced in private industry in developing a ‘holistic’ fiscal management approach. Unfortunately, industry has been moving to the adoption of ERPs that are ‘one size fits all’ and don’t consider the other non-fiscal core issues that can impact financial management. NAVAIR is facing this same challenge. This work will seek to consider these ‘out layers’ and their impact to the overall Financial Management plan. Clearly this is an area that has direct applicability to commercial parties and their overall bottom line.

Global Maintenance Management: A prototype that provides capabilities for Optimized Scheduled Maintenance, Global Maintenance Management, Dynamic Scheduling, and Automated Workflows. Additionally, it will include creation of modelling techniques and tools to aggregate enterprise maintenance and maintenance facility data. Additionally, development of a software tool with interactive dashboards for decision makers to develop scenarios regarding variations in the allocation of maintenance resources.

Visibility is the key to decision making. DOD entities are not alone in this challenge. Increasingly, private industry is harnessing itself with complex Global Sustainment initiatives. In the world's global market, forces that are unpredictable and caustic can occur at a movements notice. To ensure success, industry needs a similar capability that this project will work to develop. Due to the approach that the project's Industry Team desires to use, many of the components that commercial entities currently use will be tested. This will insure a rapid and seamless adaptability to industry challenges when they seek to embrace the results of this project and seek cost savings.

Supply Support: A Prototype capability for Integrated Maintenance and Supply Chain Dashboards/Databases that includes a data-driven decision –making tool approach to identify causal factors for readiness issues and assist in developing corrective action plans to supplement traditional scheduled-based maintenance (scheduled intervention and reliability improvement programs). This prototype will be a software tool capable of demonstrating an integrated and cross-functional Supply Chain and Maintenance Management merged operational picture. It will be able to provide detailed cost estimates to assess sustainment strategies and be used to support decision-making at the leadership level. These cost estimates will support CAPE cost collection requirements and can be developed into BCAs and/or be used to support budgetary planning and customer interface.

American Industry is faced with a complex and changing global supply chain that in many cases is more reactive than proactive. Commercial supply chains are lengthy, time consuming and not prone to flexibility. The necessary robust tools that can operate in this ever-changing landscape do not have the appropriate flexibility to pivot as business challenges arise. This project will develop tools, processes and integrate technologies that will address this private sector challenges and drive speed or product to market. Adoption of the positive impacts that this prototype work will produce should provide the industry with another tool that it requires to maintain dominance in the global market.

Workforce Proficiency: A Prototype capability for management of certification for repair technicians at Intermediate and Depot Level Repair facilities, and a Global Training Database are envisioned within this focus area.

The American workforce continues to be the envy of the world, however keeping it that way will be a challenge. For several years now, industry has been struggling with an employment market that is ever shrinking. Finding qualified and skilled employees is becoming ever more pressing as employees move up the skill ladder. Understanding what skills individuals possess, what skills can they quickly gain, what skills atrophy faster and how to know when to retrain are challenging. Increasing the speed and quality of individual training is extremely important for a commercial enterprise. This project will work to solves these same challenges in the NAVAIR support network and can be easily transferred to private industry. Proving the benefits of embracing a global training database will be of special importance to NAVAIR. The same holds true in the private sector, having a global database that can allow for the management of the skills in the workforce is paramount and can be the leg up for American Industry in the global market. Industry will have the opportunity to embrace this workforce enabler at the conclusion of this work.

Services: Prototype processes and tools to facilitate the contacting, hiring and management of a workforce that is efficient, capable, affordable, agile, and accessible to meet the changing demand for manpower across the NAE. These tools shall support efficient & effective Enterprise Indirect Functions, Real-Time Manpower Availability, and a COMFRC Contracting Strategy to be responsive to the constantly changing workload demands that are anticipated within SV2020.

Industry understands the multitude of services that need to be managed and coordinated that are paramount to a successfully organization. Too many times a scattered approach is taken in this area that consumes vital resources and impacts on time delivery of a product or service. This project will develop solutions at the enterprise level that will drive down to the lowest common factor and ensure continuity of the whole family of services. At the conclusion commercial entities will benefit from this work by embracing these same strategies in their operations and improving upon them as needed and saving industry money.

Logistics and Engineering: Prototype capability to demonstrate an Integrated Data Environment which includes Logistics Product Data, Reliability Centered Maintenance Feedback, Engineering/Technical Data, and Supply Data. This solution will include Digital Enablers, Dynamic Scheduling, CBM+, Logistics & Engineering for Sustainment,

Readiness Modeling & Parts Forecasting, Environmental and Mission profiling, and Integrated Manufacturing & Repair which will mitigate the challenges presented by current IT systems and tools.

Commercial industry is spending vast resources attempting to harness the benefits that the world of adaptive manufacturing (AM) is promising. Although a wide variety of approaches are available, what has been a constant source of frustration is how to deal with the Integrated Data Environment. Success in AM must consider the plethora of data that impacts its adoption. Due to the very challenges that NAVAIR is attempting to address in regard to the sustainment of aging weapons system platforms, this project will solve this issue. The transition of this success to the private sector will provide the template for AM insertion that all companies are searching for. An additional benefit to industry will be the realization of a robust and highly integrated data environment from ‘cradle to grave’ of an item and decreasing overall costs.

Appendix F – Troika Solutions, LLC Interim Report

This interim report was generated by Troika Solutions, LLC under the direction of MRI and represents the project status as of 30-Jun-2020. This report describes the activity and accomplishments of the Naval Aviation Enterprise Strategic Vision 2020 (SV2020) project team from February 2019 through January 2020. Some of the information in this Appendix report is also contained in the body of the main final report.

Purpose

To be successful, SV2020 integrates and aligns ongoing initiatives with new solutions to ensure the NAE approaches readiness recovery, sustainment modernization, and sustainment operations as a single unified Enterprise. The strategy creates an agile globally-managed sustainment environment, designed to supply the readiness warfighters need, and preemptively address sustainment constraints. The sustainment strategy is data-driven and predictive, capitalizing on data with veracity and velocity to optimize sustainment and empowering smarter, faster, data-driven decision-making. SV2020 provides powerful predictive capabilities to Combatant Commanders and acquisition authorities to plan for tomorrow's fight

To accomplish such a radical change in Naval Air Systems Command (NAVAIR) operations, the Enterprise requires the employment of a variety of software tools that cascade across multiple disciplines and traditional work centers. This effort will stretch the boundaries of current norms and incorporate modern and emerging technologies to enhance visibility and readiness. The nature of the effort requires the NAE to engage industry to assist in achieving this daunting task.

Scope/Approach

The project team, comprised of industry technical experts and DOD functional representatives, focused on integrating the NAE business activities that are critical to maintenance and sustainment. The team addressed six (6) functional areas for analysis, application of specific software tools, and implementation within an interoperable environment. The scope of the project included the functional areas of:

- Capability and Capacity Planning
- Global Maintenance Management
- Supply Support
- Workforce Proficiency
- Services
- Logistics and Engineering

The SV2020 approach included implementation of software prototypes to facilitate the Systems Effectiveness Analysis of Product Support for Naval Air Forces, with the ultimate intent of restoration and maintenance of flight-line readiness. The target solution was to transform Naval Aviation sustainment into an integrated, predictive, data-driven, globally-managed sustainment environment. The approach implemented process reviews, data analysis and software development that focused on the development of future focused capabilities used in the maintenance and sustainment of Fixed Wing, Rotary Wing, Vertical Lift and Unmanned weapon systems.

Project Narrative

The SV2020 participants formed action teams aligned to the functional areas. Periodic In Process Reviews (IPRs) were conducted to ensure cross-team coordination and inform the project management participant, Michigan Research Institute, of progress, status, and impediments.

The project collaboration events are listed in Table F-1.

Table F-1. Collaboration Event Timeline

Event	Date	Location
Project Kick Off – Start of Work	12 February 2019	Crystal City, VA
IPR #1	19 March 2019	Crystal City, VA
IPR #2	9 May 2019	San Diego, CA
IPR #3	25 June	Virtual via web conference
IPR #4	31 July	Virtual via web conference
IPR #5	11 December	Spokane, WA

During the Start of Work meeting, the initial tasks planned were identified as:

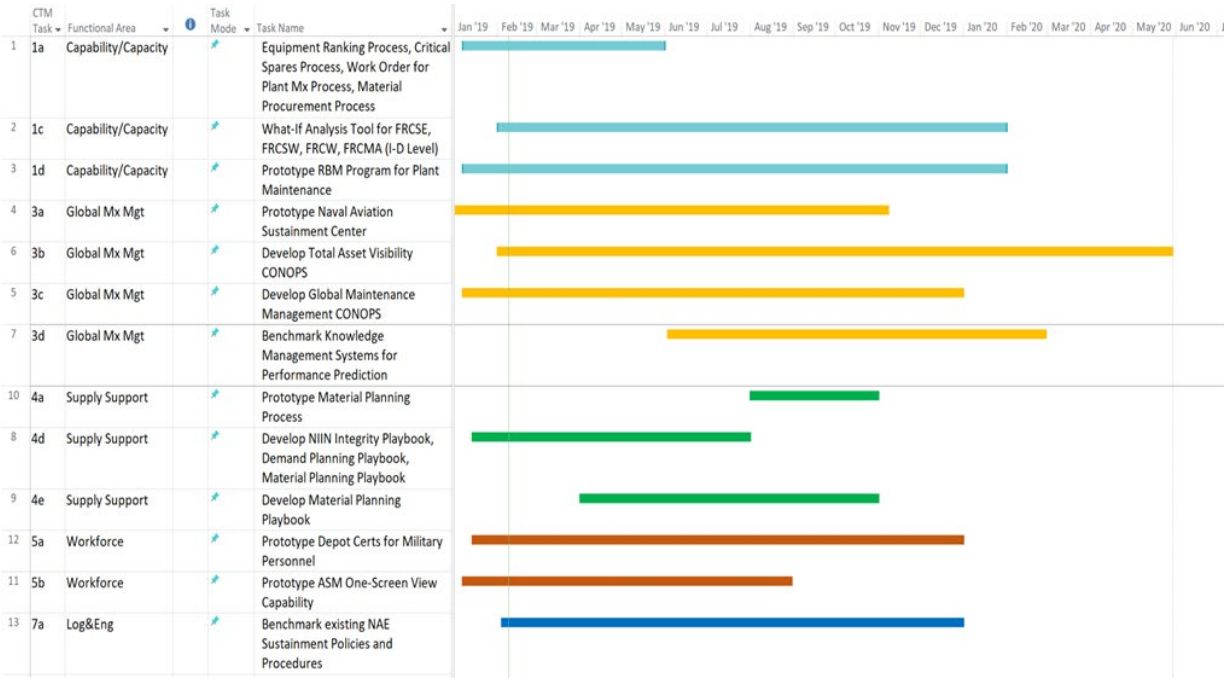

Figure F-1. Initial Task Planning Capability and Capacity Planning

Capability and Capacity Planning is an activity that determines the throughput required by maintenance and sustainment organizations to meet changing demands, and that is required to support operational requirements in the future. These actions can be performed at both granular and aggregate levels. The Capability and Capacity thread of SV2020 allows the Naval Aviation Enterprise to view both the capability and capacity of the entire naval aviation sustainment system and conduct "what-if" analysis of workload. The goal is to provide the capability to optimize repair solutions to increase readiness.

During the project, the objective was to develop a software solution to address the improvement of global Capability and Capacity Planning tools, to include "what-if" analysis of the Enterprise workload across organic, non-Navy military and commercial sites. This solution included tools for cataloging Enterprise Capability, Enterprise Capacity, Reliability Based Maintenance for Equipment, and Enterprise Infrastructure Investment prioritization. Additional areas of work included the development of draft technology and business roadmaps for Capacity Management tools and standardized templates for use by the Commander, Fleet Readiness Centers (COMFRC) personnel.

After site visits to collect capability and capacity data, a database was created to host the data and expose if via web browser. The Arena modeling tool provided the ability to conduct "what-if" analysis of all workloads across the enterprise to allow COMFRC to do rough cut capacity planning across the Future Years Defense Program (FYDP). The modelling tool also allows COMFRC to understand impacts from workload changes in the execution year.

Specific tasks undertaken included:

1. The development of data templates that identify data requirements, definitions and business rule refinement that align COMFRC's data solution with applicable commercial best practices.
2. Design and conduct pilots where capabilities meet required business rules and expectations that provide for drill-down to explore these functions with a greater degree of granularity.
3. Recommend organizational changes, specific roles, decision-making processes, and a standardized escalation framework in support of program implementation. Provide analytical support to pilot conduct.

In general, the objective of the Capability and Capacity Planning functional area was to capture, document, collate, and provide visibility to existing naval aviation maintenance and repair capability and capacity across concentric spheres of the enterprise starting with the Navy, extending to DOD organic sites, and finally to contract repair facilities.

Site visits were conducted at Navy sites to capture capability and capacity data. The data was captured and presented visually. This concept was briefed to Navy and Air Force leadership.

The Capacity model served as the key enabler of effective capacity management and provided the NAE with global visibility of capacity to include the ability to perform "what-if" analysis for organic, non-Navy and commercial repair sites. It also enabled COMFRC to perform Rough Cut Capacity Planning which will aid in the development of the COMFRC Strategic Plan, a Master Production Schedule across the FYDP, as well as assist in decisions concerning military construction, equipment purchases, and optimal capacity location.

The items surrounding the model illustrate the various data sources that provide relevant and supporting information. The Capability and Capacity team identified standardization requirements of the data within the routers, providing real time equipment status and using standardized industry methods to develop Master Production Schedules.

The Capability and Capacity team also developed a tool to provide the NAE with the ability to plan and schedule key modification events.

The Modification Scheduler and Planner capability which was developed to support increase of readiness by optimizing modifications and is represented in the figure below. Specifically, the tool was developed to:

- Provide enterprise visibility of Air Vehicle Modifications from initiation to implementation
- Enable improved visibility of modifications throughout the contract, scheduling, and installment process
- Enable the development and delivery of the Depot Forecast Flow schedule and Depot Flow Plan
- Enable improved modification turn-around time and lower cost

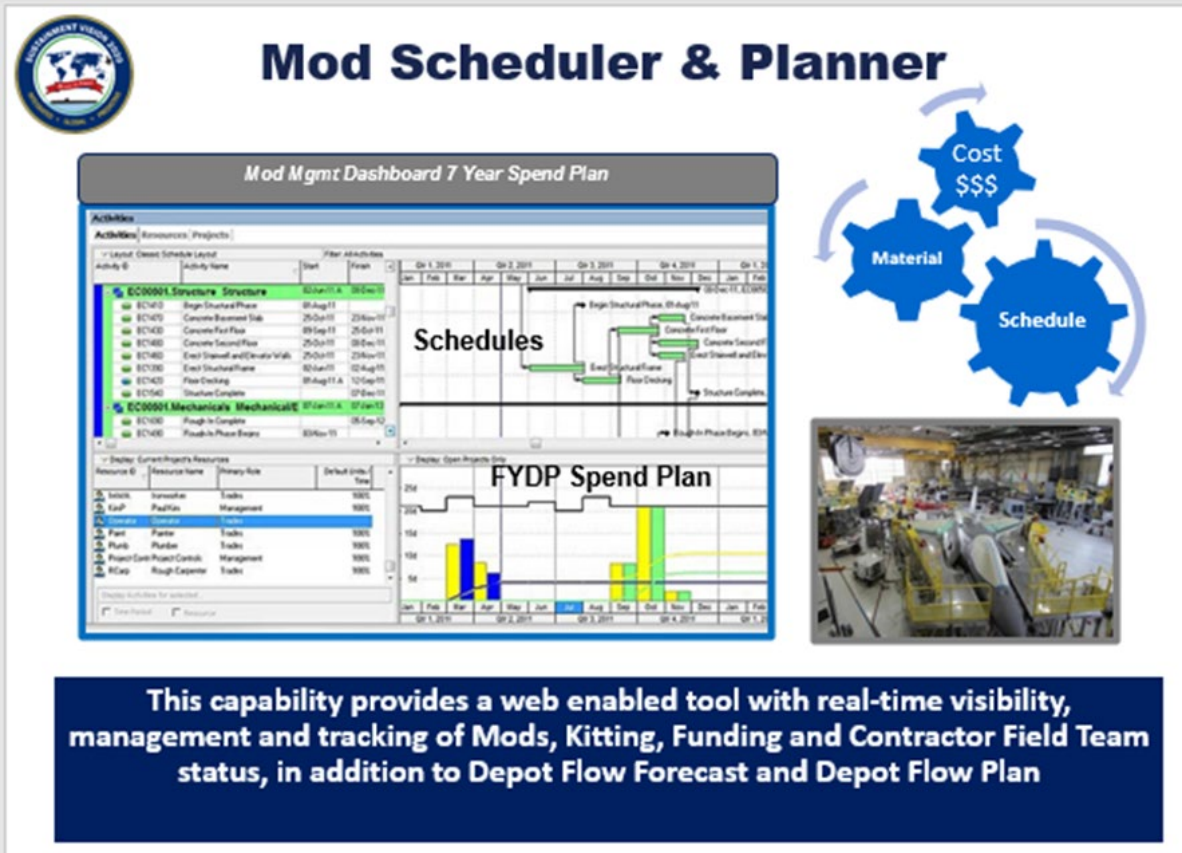

Figure F-2. Modification Scheduler and Planner Capability

To achieve the generic tasks, the specific actions were identified and tracked throughout the project. Table F-2 provides an overview of the achievements documented per task at each IPR.

Global Maintenance Management

Global Maintenance Management in the context of SV2020 refers to the Enterprise allocation, direction and organization of maintenance resources worldwide that contribute to control of equipment availability.

Table F-2. Capability and Capacity Accomplishments

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Develop Equipment Ranking Process, Critical Spares Process, Work Order for Plant Mx Process, Material Procurement Process	Documented each process in a Strategic Work Package (SWP)	Developed Standard Work Packages for each process/ working govt. approval process	Refined SWPs -Equipment Ranking Process -Critical Spares Process -Work Order Process	Refined SWPs -Equipment Ranking Process -Critical Spares Process -Work Order Process -Preliminary Draft Material Procurement Process	Completed Standard Work Packages for Equipment Ranking, Critical Spares Process, Work Order Process, Material Procurement Process
Task 2: Prototype What-If Analysis Tool for FRCSE, FRCSW, FRCW, FRCMA (I-D Level)	Selected analysis tool; completed models for Nose Landing Gear and 520 Work Center	Continued development of Depot Level Models at Jax/NI Began data collection for Intermediate Level Models at Oceana, Lemoore	Completed Jacksonville Component Model	Started the capacity model for FRCSE Components Started the capacity model for FRCSW Components	Completed the capacity model for FRCSE Components Completed the capacity model for FRCSW Components Completed the FRCMA Oceana I-Level Model Completed the FRCW Lemoore I-Level Model
Task 3: Prototype Reliability Based Maintenance Program for Plant Maintenance	Crafted SWP's for Equipment Ranking, Critical Spares, Work Order for Plant Mx, Material Procurement	Developed the RBM Process – Routing for approval	Completed SWPs for Equipment Ranking Process, Critical Spares Process, Work Order for Plant Mx Process	Completed SWPs for Equipment Ranking Process, Critical Spares Process, Work Order for Plant Maintenance Process	Task Discontinued

The objective of this part of the project was to develop a solution that provides an overall, enterprise wide, actionable and accessible capability to view, managed and direct maintenance assets and capability across the world in real time.

Specific tasks undertaken included:

1. Developed and implemented prototype-enabled solutions that support the stand-up of the Naval Aviation Sustainment Center (NASC)
2. Supported the development of Total Asset Visibility solutions that enable the NASC to make critical decisions regarding scarce resources
3. Developed a Global Maintenance Management Concept of Operations (CONOPS) that supports the use of the prototype capabilities for integration and interoperability of logistics resources across the NAE
4. Investigated and recommended tools and techniques for development or integration of Knowledge Management System dashboards that connect planning with models and simulation for performance prediction

The Global Maintenance Management (GMM) team creates and sustains a globally managed maintenance environment to optimize aviation readiness by advancing enterprise sustainment strategies. The GMM team focused on three key areas: the NASC facility and capability, Total Resource Visibility, and Maintenance End-to-End.

The NASC development provided a physical operations center facility to enable enterprise collaboration with advanced technology to ensure remote access and interaction. The NASC enabled improvements in business processes and collaboration.

Total resource visibility activities provided visualization and analytics using a new architecture to implement advanced applications. The visibility of the end to end maintenance process, from flight line to factory, ensures optimization of maintenance actions across the enterprise.

To achieve the generic tasks, the specific actions were identified and tracked throughout the project. Table F-3 provides an overview of the achievements documented per task at each IPR.

Supply Support

Supply Support is a critical element of integrated logistical support. Management of the flow of materiel, labor and service resources from point of origin to point of consumption is a basic tenet of the supply chain support function. During the project, a prototype solution was developed to facilitate the transformation of the supply chain into a more globally responsive, sustainable, accessible, affordable, interconnected and auditable system with ample agility to provide material solutions that meet end user needs and expectations. Specifically, misalignments in planning data and execution related policy were identified through integration of maintenance and supply data. The team developed improved forecasting software tools for consumable piece parts by bringing weapons system maintenance expertise into consumable demand forecasting (vice historical usage alone) to better calibrate inventory investment and reduce non mission capable statuses. Gaps were identified in original equipment manufacturer and Defense Logistics Agency planning forecasts and considered in the supply support improvement recommendations.

Table F-3. Global Maintenance Management Accomplishments

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Prototype the Naval Aviation Sustainment Center (NASC)	Defined NASC functions; documented current NASC functionality	Lessons learned from Boston Consulting Group Aircraft On Ground Prototype in Norfolk	Documented lessons learned from BCG AOG Prototype in Norfolk Initiated ground work necessary to obtain NASC Space at Pax	Documented lessons learned from BCG AOG Prototype in Norfolk Completed ground work necessary to obtain NASC Space at Pax	Mezzanine sharing system established at Pax Conducted discussions between SV2020 Director & GMM Director regarding standup of a NASC "Node" (i.e. managed from any location with emphasis on collaboration) vice a NASC in a specified geographical location. Currently testing by facilitating RCB Meetings utilizing the Mezzanine System Created Tableau Training Presentation and provided to V-22 Leads for familiarization Facilitated and participated in multiple V-22 Lead Meetings providing training to Avionics & Air Vehicle Leads on how to retrieve data from Tableau for analysis for presentation at V-22 RCB #8
Task 2: Develop Total Asset Visibility (TAV) Concept of Operations	Identified existing TAV systems	Readiness Problem Statements identified, written, and delivered	Initiated 29 Process Maps for first three problem Statements Identification of a streamlined/alternative approach	Completed 29 Process Maps for first three problem Statements Continued to explore a streamlined/ alternative approach	Developed and refined Total Resource Visibility (TRV) data pipelines to enable the Maintenance control screen Met with NAVAIR 6.8 data subject matter experts to identify best possible data sources for TRV effort.
Task 3: Develop Global Maintenance Management Concept of Operations	Gathered and collated existing GMM documentation	None	None	None	Attended and participated in V-22 LOGCELL Event to review Supply E2E Process. Participated in DAC Lead Training and facilitated V-22 RCB Meeting utilizing the Mezzanine System
Task 4: Benchmark Knowledge Management for Performance Prediction	None	None	Conducted discussions with O/I/D Level Personnel to capture data regarding V-22 Maintenance/Maintenance Support Completed Prototype I Maintenance E2E Process Map	Continued Discussions/ Observation with O/I/D Level Personnel to capture data regarding V-22 Maintenance/ Maintenance Support Travel to MCB Quantico IPAC to discuss capabilities of Marine Online (MOL Database) for inclusion O Level Maintenance Management Provided ASM Division Leadership/Fleet Administrator Courses	Continued Discussions/Observation with O/I/D Level Personnel to capture data regarding V-22 Maintenance/Maintenance Support Developed a prototype Maintenance Control screen to facilitate improved squadron readiness maintenance management via improved degrader visibility and higher percentage yield on discrepancy selection. Multiple meetings with NAE SMEs regarding current data sources and availability of Aviation Logistics Data

The goal of the Supply Support area of work is to establish an integrated maintenance and supply chain that links component, engines, and support equipment repair to the flight-line demand signal. As demonstration of feasibility, a software tool was developed to demonstrate an integrated and cross-functional merged operational picture between supply chain and maintenance management domains.

To achieve the merged operational picture, supply data was consolidated into one location with drilldown capability to allow operational status to facilitate supply chain decisions. This insight into supply and maintenance information allows for preemptive action to be taken to avoid shortages and delays.

A set of tools was developed to enable Readiness Modeling/Parts Forecasting and establish processes that enable visibility into aircraft/system availability and supply provisioning. The tools are:

- Data Analytics – the harvesting of pertinent data and subsequent robust analysis to show gap areas in readiness/availability. An experienced group of Type/Model/Series (TMS) Subject Matter Experts (SMEs)/Data Scientists participated in identifying the key data attributes
- iSAM – Integrated and automated Supportability Analysis Methodology. This tool:
  - Combines RCM + MTA + LORA + Dynamic Scheduling results into one model for decision assistance
  - Provides insight at both the aircraft and system levels
  - Illustrates the effect of specific actions and decisions on aircraft or system availability and lifecycle costs
- AIPS – Artificial Intelligence Prognostic Steering. This tool:
  - Provides a comprehensive tool to view Maintenance, Engineering, and Prognostic attributes
  - Enables the user to forecast probably failures, predict degraded life limited parts, and anticipate false alarms to optimize maintenance solutions
  - Results in increased aircraft readiness, improved maintenance efficiency, and decreased inventory levels
- EPAM/Vector/ASD
  - Enables visualization of T/M/S readiness status, availability and associated component reliability

Readiness modelling demonstrates the interaction of the tools developed under SV2020 and the outcomes provided to the fleet including improved supply support.

To achieve the generic tasks, the specific actions were identified and tracked throughout the project. The following table provides an overview of the achievements documented per task at each IPR.

Table F-4. Supply Support Accomplishments

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Prototype demand planning process	None	Completed three Provisioning Data Assessments (PDA) Scorecards Completed Demand Planning Pre-summit Completed draft BMF file structure and submitted to H-53 Program Office for feedback Automated BMF Process Prototyped Retail Demand Planning Tool	Started integration of Retail Demand Planning into NAVAIR End to End Process Developed Spiral 1 Retail Demand Planning Forecast (RDPF) Tool prototype -Utilizing Programs written in Tableau software to crunch massive data pulls into NAVAIR, NAVSUP and DLA databases	Continued integration of Retail Demand Planning into NAVAIR End to End Process Refined Spiral 1 RDPF Tool prototype. -Utilizing Programs written in Tableau software to crunch massive data pulls into NAVAIR, NAVSUP and DLA databases.	Developed and refined Spiral 2 RDPF Tool prototype Utilizing Programs written in Tableau software to crunch massive data pulls into NAVAIR, NAVSUP and DLA databases.
Task 2: Develop NIIN Integrity Playbook, Demand Planning Playbook	Created Baseline Master File for DLA Managed NIINs Updated NAVSUP-WSS policy change for Logistic Reassignment of DLA managed NIINs	Completed draft BMF file structure and submitted to H-53 Program Office for feedback Automated BMF Process Conducted Retail demand Planning Pre-conference	Conducted Retail Demand Planning Summit in Pax River. -Demonstrated RDPF tool to PMAs using live data Completed Playbook Sprint 1 -Created outline of Playbooks	Conducted Retail Demand Planning Sprint and NIIN Integrity Sprint in Richmond VA. Completed Playbook Sprint 1 for Spiral 1 Playbooks. Created Outline of Playbooks	Submitted NIIN Integrity Playbook/Demand Planning Playbook DRAFTS to DLA Developed prototype of RDPF in NAVSUP LOGCELL E2E Cycle
Task 3: Develop Material Planning Playbook	None	None	Conducted Demand Planning Summit on 5 June 2019 Conducted Sprint 1 on RDPF Tool 19-20 June -Framework developed for Playbooks	Conducted Sprint 2 on RDPF Tool and NIIN integrity Playbook Conducted review of Refined Framework	Task Decommissioned

Workforce Proficiency

Workforce Proficiency represents a framework for demonstrating and documenting required skill sets, competencies and proficiencies for workers. The workforce proficiency area of work developed prototype software and non-software solutions to aid in identifying the right mix of labor qualifications, certifications and training for military and depot sustainment personnel.

From an enterprise level, the NAE needed a process to select the best military candidates, train them to perform depot level maintenance and ensure the NAE utilizes their certification to the maximum extent possible. The goal was for maintenance activity to become a level of certification vice a specific location.

The concept is that Depot Level Certified Military Technicians will increase unit capability both ashore and afloat when forward deployed. When technicians are trained and certified to perform depot maintenance actions to fully repair a component on site (rather than transporting the component to the depot location) the NAE saves both time and money.

To achieve this vision, a system was developed to identify the correct person with the required skills and ensure that the person was available to meet aviation maintenance requirements. To achieve this goal, the team was focused on:

- Implementation of the Advanced Skills Management (ASM) system at depot maintenance sites
- Standardization of ASM at the intermediate repair sites (I-level)
- Depot certification of military personnel

ASM is a web-based training management tool that provides real-time assessment of skills and identifies deficiencies. ASM can be used to track technical training related to an individual's career. The team applied standardization and rigor to ASM to ensure common naming, processes, licenses, qualifications and training across all I-level sites at Navy and Marine Corps. A pro-active and non-traditional achievement was to certify I-level personnel in depot level repairs. This innovative approach enabled repairs to be performed by qualified artisans without being moved to depot saving time, money, and reducing non mission capable aircraft.

The initial implementation of this approach was AM1 Hammer from Lemoore who achieved Depot Level II certification for advanced composite repair. He has repaired several priority panels and doors, performing 80 hours of work on 18 different parts over a 7-month timeframe resulting in a savings of more than $4 million. Further, NAE lacked a comprehensive and coherent view of workforce proficiency. The SV 2020 team improved NAE insight into the workforce by:

- Deploying ASM into the Depot sites matching the "O" level and "I" Level sailors and marines across COMFRC
- Implementing ASM at the depots to standardize processes, qualifications, certifications, licenses and documentation while enhancing opportunities for personnel mobility
- Implementing ASM to achieve a single proactive training system for supervisors and managers to use to assess training progression, and identify current and future skill and certification gaps

- Providing immediate visibility for workforce member and first level supervisors into training requirements
- Replacing antiquated training recordation processes

Note that to achieve the benefits of ASM, the SV2020 team implemented a rigorous standardization of the elements withing ASM. Historically there have been significant differences in usage and terms across the commands including differences across the shore AIMDs, FRC's and Afloat command configuration groups.

The SV2020 team standardized the titles of the Qualifications, Certifications and Licenses and the JQRs for all Quality type qualifications, i.e. CDI, CDQAR or QAR. For example, the team replaced over 2600 CDI qualifications, 1575 CDQAR qualifications, and 734 QAR qualifications as well as inactivated nearly 5000 non-standard local CDI/QAR qualifications. be inactivated.

The figure below illustrates the reduction of non-standard qualifications, certifications, and licenses leading to better workforce proficiency, control, and forecasting.

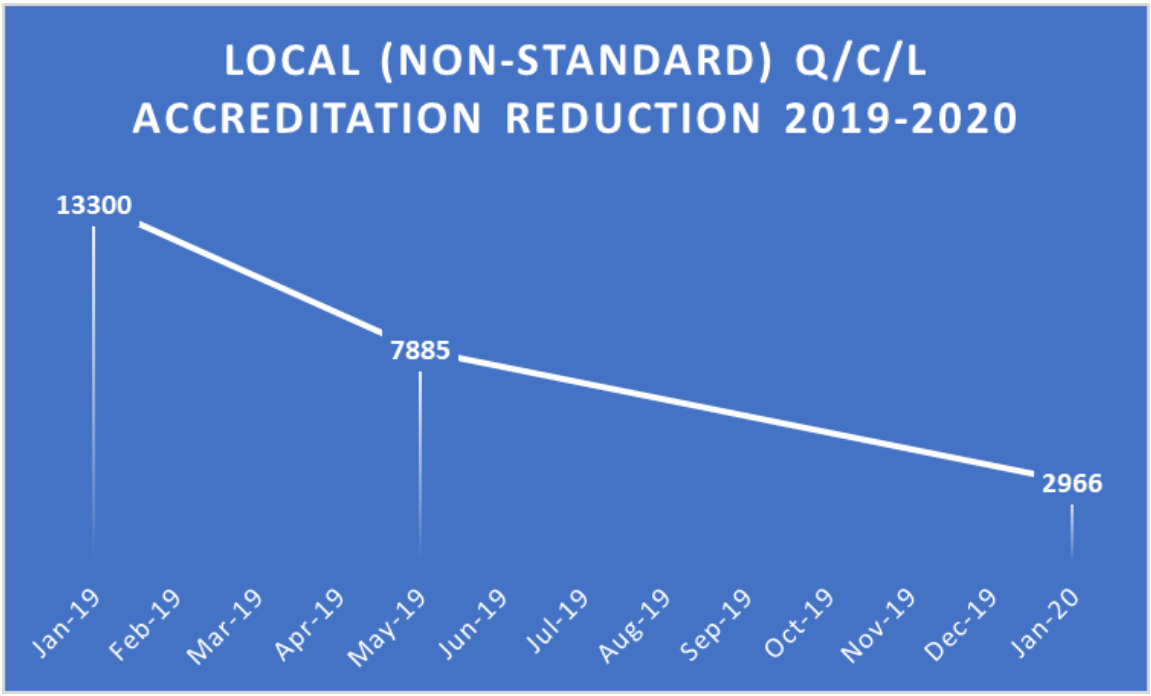

Figure F-3. Reduction in Non-Standard Certifications

To achieve the generic tasks, the specific actions were identified and tracked throughout the project. The following table provides an overview of the achievements documented per task at each IPR.

Table F-5. Workforce Proficiency Accomplishments

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Prototype Depot Level Certification for Military Personnel	Created draft Depot Level Certification for Military Personnel Instruction Created draft NAMP change request Advanced Composite Repair Sailor received Military Depot Artisan Level One Certification	Completed Depot-Level certification of military personnel instruction to establish a process for Sailors and Marines to be certified to perform Depot-Level repairs, being reviewed by COMFRC Department Heads Continuing development of NAMP 4790 change request for Depot-Level certification of military personnel Continuing development of the component degraders list to identify which components the Military Depot Artisan will work on Advanced Composite Repair Sailor attending Depot school, will be Military Depot Artisan Level Two Certified upon completion Two Marines selected to be certified on the Maus Unit to perform NDI depot maintenance	Completed the component degraders list to identify which components the Military Depot Artisan will work on Worked on the development of NAMP 4790 change request for Depot-Level certification of military personnel Worked on establishing NEC/MOS designation for Depot-Level certification of military personnel Advanced Composite Repair Sailor attended Depot school, now is Military Depot Artisan Level Two Certified	Developed metrics to measure Military Depot Artisan effectiveness Began NAMP 4790 change request for Depot-Level certification of military personnel, draft NAMPSOP has submitted for review Began establishing NEC/MOS designation for Depot-Level certification of military personnel	Refined metrics to measure Military Depot Artisan effectiveness Submitted NAMP change request/ Rejected pending more data to establish benefits Submitted COMFRC Instruction to be signed by Commander, COMFRC Determined component repair requirements by FRC (Norfolk & Oceana)

Task 2: Standardize ASM for USN and USMC I-Level Maintainers	Created NAE naming convention for Navy accreditation, qualifications, licenses, duty billets and titles Removed inactive qualifications Standardized QA PQS's Created PQS for Production Control Built AirSpeed accreditations in ASM FRCMA Pax will be test site	Developed Advanced Skills Management Standard Operations Procedures (SOP), submitted to ASM Model Manager -Define roles for ASM maintenance -Establish levels of ASM access -Develop change control procedures in ASM -Standardize signature authority -Draft ASM SOP Met with TECOM and agreed on NAE/TECOM configuration titles to be standardized between the Navy and Marine Corps ROM submitted to Keyport for funding requirements to implement future script changes	Completed standardization of ASM NAE naming convention and submitted to ASM Model Manager Worked on standardization of ASM Local naming convention Worked on standardization of common CDI/CDQAR/QAR titles in ASM	Standardized common CDI/CDQAR/QAR title format in ASM 4790/12 Standardized ASM PQS/JQR for CDI/CDQAR/QAR Worked on ASM Change Control Board Worked on standardized supplemental CDI/CDQAR/QAR titles in ASM	Standardized common CDI/CDQAR/QAR title format in ASM 4790/12 Standardized ASM PQS/JQR for CDI/CDQAR/QAR Worked on ASM Change Control Board Worked on standardize supplemental CDI/CDQAR/QAR titles in ASM Standardized 600 division CDI/CDQAR/QAR titles in ASM Standardized 500 division CDI/CDQAR/QAR titles in ASM Standardized 600 division CDI/CDQAR/QAR qualifications in ASM Implemented ASM at FRCSE, FRCMA, FRCSW, FRCE

Services

It is widely understood that the commercial industry has many available technology platforms for identifying, hiring and managing its workforce. Not all platforms available commercially work within the statutory and regulatory requirements for Federal employees. A varying mix of contracted and government personnel comprise the workforce, which is a critical element of sustainment and readiness of the Naval Air Forces. The government requires enhanced prototype processes and tools to integrate its future government and contracted workforce into the other focus areas of SV2020.

The Services team focused on efficient enterprise indirect functions, real-time manpower availability, and the Fleet Readiness Center contracting strategy. To address effective and efficient enterprise functions, the team developed a predictive model to answer the question "How do you know if you need more/or less" of an indirect capability. Additionally, various contracting strategies were evaluated and the team worked to develop and institutionalize a contracting strategy across

Fleet Readiness Centers that could establish and exploit common, national, contracts for equipment purchase, repair, installation, and rental.

To achieve the generic tasks, the specific actions were identified and tracked throughout the project. The following table provides an overview of the achievements documented per task at each IPR. Note that work on the services task was postponed to focus the team on higher priority tasks.

Table F-6. Services Accomplishments

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Prototype Depot Level Certification for Military Personnel	Created draft Depot Level Certification for Military Personnel Instruction Created draft NAMP change request Advanced Composite Repair Sailor received Military Depot Artisan Level One Certification				
Task 2: Standardize ASM for USN and USMC I-Level Maintainers	Created NAE naming convention for Navy accreditation, qualifications, licenses, duty billets and titles Removed inactive qualifications Standardized QA PQS's Created PQS for Production Control Built AirSpeed accreditations in ASM FRCMA Pax will be test site				

Logistics and Engineering

The Logistics and Engineering team focused on the planning, acquisition, and management of sustainment engineering and logistics functions, to include subject matter expertise, management and operational support services. Included in this category are systems operations, automated tools, value chain management, inventory management, and distribution and transportation management. The NAE uses many custom, tailored, and commercial software tools to transact, store, manage and make decisions based upon logistics and engineering data. These systems and tools are poorly integrated, causing significant challenges in discovering and re-using data across the enterprise to identify and address issues.

The team developed a concept demonstrator that allows for the inclusion of necessary data from a variety of disparate systems and fuse that into a User Defined Operational Picture that will facilitate visualization and analytics while minimizing impact to source systems data or business process.

The team developed solutions to modernize and evolve the NAE sustainment suite of systems to rapidly respond to warfighter needs through optimized engineering and logistics processes and integrated IT systems.

The engineering component of the team focused on driving solutions to improve readiness through optimized sustainment. The Integrated Support Service Center (ISSC) ensures that work performed by in-service support organizations positively impacts readiness.

The team performed a functional sustainment logistics assessment identifying systemic issues across platform Program Management organizations (PMAs). The assessments identified gaps and provided recommendations including:

- Increase the use of data analytics
- Incorporate technical data for readiness improvements
- Exploit tools to identify readiness trends and opportunities

The team conducted process mapping to document and illustrate the efficiencies and gaps in integration between maintenance and supply chain operations.

The ISSC provided visibility to how maintenance planning could improve readiness trends by implementing readiness analysis and trending tools, providing corrosion visualization, and incorporating the Integrated Data Repair Network onto the Enterprise Service Bus for broader dissemination of information.

The Logistics and Engineering team implemented the Integrated Support Service Center to conceptually aggregate and provide visibility of sustainment activities that traditionally occur inside of COMFRC local organizations including:

- RCM – reliability centered maintenance
- CBM+ – condition based maintenance plus
- Dynamic Scheduling – when combined with Optimized Scheduled Maintenance leads to schedule maintenance reductions with opportunistic maintenance – reduces maintenance burden at O-level
- MxE2E – Maintenance End-to-End – process of reviewing maintenance practices within a T/M/S to reveal gaps and propose solutions to PMs
- LORA – Level of Repair Analysis
- Predictive Analytics – robust analysis by SME/Data Scientists to identify patterns and opportunities for reliability and maintenance improvements

Core Logistics and Engineering for Sustainment capabilities were aggregated and provided by the ISSC to achieve the goal of increased readiness. The Logistics and Engineering team exploited digital enablers to implement the ISSC. The digital enablers established as the foundation of the ISSC. They include IT system solutions that enable Maintenance, Supply, and Readiness activities.

- IDRN – Integrated Data Repair Network
  - Product Lifecycle Management (PLM) that houses engineering and logistics data and processes for aircraft, systems and components
  - Enterprise Service Bus – a pipeline bridge that shares, remediates, and translates data from disparate databases into/out of PLM. Updates, additions and data manipulation results are fed back into source databases
- Integrated Manufacturing & Repair
  - Using additive manufacturing techniques, 3-D printing of parts

One of the key benefits of the ISSC is the ability to identify and execute Dynamic Scheduling. Dynamic Scheduling is the scheduling and execution of planned maintenance (PM) based on RCM derived interval rather than current packaged maintenance intervals. Dynamic Scheduling is flexible and allows accomplishment of tasks during unscheduled maintenance events. This opportunistic maintenance decreases future unavailability by allowing maintenance to be performed when the aircraft is accessible for other maintenance actions.

Dynamic Scheduling relies on Optimized Scheduled Maintenance, precise 5 Digit Failure Mode Digital Code (FMDC) and accurate Logistics Product Databases to achieve the benefits of Dynamic Scheduling. To achieve the generic tasks, the specific actions were identified and tracked throughout the project. The following table provides an overview of the achievements documented per task at each.

Table F-7. Logistics and Engineering Accomplishments.

	IPR #1	IPR #2	IPR #3	IPR #4	IPR #5
Task 1: Benchmark NAE Sustainment Policies and Tools	Established Ground Rules & Assumptions (GR&A) with PMA/AIR 4.0/6.0 Directors/FST's and TA to establish Internal/External Communications with Govt customers to evaluate Engineering and Logistics Processes	Reviewed artifacts from the Sustainment Team Assessment Report for the following programs (V-22/P-8A/H-1/H-60/ KC130J/E-2D/ and MQ-8 to evaluate overall impact to the Engineering and Logistics support elements. Reviewed RCM data elements requirements assessment report. Captured data element gaps between O/I Mx levels/FE component and PMI Line (ADCS) for use in developing a solution set for corrective action for analysis software tools and policy guidance revisions. Reviewed DeckPlate/ Depot/ADCS and Policy guidance artifacts report to determine a pattern of data collections inefficiencies across NAVAIR programs	Developed assessment criteria for Sustaining Engineering Began Codification criteria into a 4.0/6.0 process Began assessment of 8 platforms to ascertain common gaps across programs	Refined Assessment criteria for Sustaining Engineering Continued to codify into a 4.0/6.0 process Continued assessment of 8 platforms to ascertain common gaps across programs	Refined assessment criteria for Sustaining Engineering Collaborated with GMM Leadership (MX End 2 End Assessment) Conducted Depot Repair Data Initiative (ADCS/Master Discrepancy List direction, ADCS Back Shop Repair Data Collection, Policy Revision)