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DEVELOPING A DATA SHARING PILOT ON CONDITION-BASED MAINTENANCE

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NDIA Logistics Division Software and Data Analytics Working Group

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INTRODUCTION

The Department of Defense (DoD) generates a huge volume of data, but often fails to effectively use that data to make decisions. In order to perform useful data analytics in support of specific missions, as well as general decision-making, planners benefit greatly from access to high-quality data and effective analytics capabilities. To address this challenge, the Department can leverage emerging technologies such as machine learning and predictive modeling to improve its ability to rapidly analyze large quantities of data than is possible with human operators. In the commercial sector, companies in high- and low-technology sectors are exploiting advanced data collection and analysis techniques to improve business processes, reduce costs, identify and capture markets, and develop innovative products and services. The Department would derive great benefit from incorporating similar processes.

Despite the benefits, the DoD is unable to take full advantage of emerging data technologies due to limited access at scale; much of the Department's data is divided and siloed within agencies, services, and contractors. There are few incentives for an organization to share their data with others, nor is there a set of standards or a framework in place to facilitate downstream analytics. Additionally, existing data is often unavailable to the groups where it could be useful due to a culture of data protection—sometimes for legitimate security reasons —but also for financial, organizational, or competitive advantage. By implementing the right guidelines and framework, access to previously siloed data could improve DoD decision-making.

To help the Department take full advantage of the data it collects and stores, NDIA's Logistics Division and Emerging Technologies Institute (ETI) convened experts from government, industry and academia to develop the outline for a pilot program. This program is intended to improve data sharing with an eye towards increased effectiveness and efficiency in one pilot area: Condition-Based Maintenance activities. Workshop participants came from traditional defense primes, nontraditional software and data analysis companies, maintenance service providers and customers of maintenance products and services. As such the group was able to access a variety of perspectives and experiences in shaping the pilot proposals. The workshop addressed a variety of technical and policy issues surrounding the use of data, including the importance of data sharing and data standards, but also relevant concerns associated with security and the handling of proprietary data.

This paper summarizes the workshop's general findings and describes a set of specific actions that should be taken by the government, including the Congress, and industry to establish a set of high value, high impact pilot programs in data sharing to improve CBM+ initiatives in DoD. These proposed data sharing pilot activities could be established as a partnership between the Department of Defense and appropriate private sector components.

BACKGROUND

The DoD is spending an increasing share of its budget on the maintenance of aging infrastructure, weapons systems, platforms and other equipment. DoD has attempted with mixed success to increase the use of Condition-Based Maintenance Plus (CBM+) methodologies over the years to reduce program total life cycle costs and improve the readiness of the force. It is also clear that the availability, analysis and effective use of that data would support a more effective implementation of traditional CBM methodologies. Condition-Based Maintenance Plus (CBM+) extends the concepts of CBM to include future and existing technologies and enhance reliability throughout the life of the weapons system.

A broad set of organizations and personnel, representing data owners and maintainers, data analysts, and practitioners with subject matter expertise and experience, will need to be involved to effectively collect and efficiently analyze data. Today, no single entity has all the data necessary to perform outstanding logistics data collection, analysis and application of learned insights. For example, Condition-Based Maintenance methodologies, where sensors measure the state of equipment in real-time, is most effective when coupled with actual failure and demand data or systems directly in the hands of system maintainers or supported by a Product Support Provider, Product Support Integrator or respective Depot Maintenance Activity. It is also better enabled by the repair data captured by organic and contract maintainers, readiness and operating data owned by the military services, engineering and supply chain information owned by government and industry as well as engineering knowledge of the systems and the missions of the organization that sustains the platforms in the first place.

During the workshop, mission owners joined experts and stakeholders with roles in collecting, holding and modeling the data, to unpack the ways in which information that already exists today can be used more effectively to reduce operational and sustainment costs and improve readiness. They also discussed what additional data elements, not already collected, would potentially add value if made available with the appropriate data standards, structure and security measures. The workshop participants also highlighted the outcomes of benefits from CBM+ use cases in a pilot.

At the highest level, workshop attendees generally agreed that a well-designed pilot program would have great benefits to the Department and industry, but that significant challenges exist to the activities that are envisioned. Some challenges identified in the discussion included:

- developing methods to provide data access to pilot program participants, including creating incentives for data owners and companies with data analytics capabilities to participate
- ensuring the subject matter experts are participating in the program so that it focuses on high priority problems in an informed manner
- engaging government and industry leaders to endorse and potentially support or fund activities within the pilot program

MOTIVATING THE PROBLEM

The workshop began with a keynote address by Dr. Vic Ramdass (Deputy Assistant Secretary of Defense for Materiel Readiness) framing the issue and addressing a compelling need for better analytics around CBM+. Dr. Ramdass outlined the steps that the DoD has taken in the last 20 years in terms of introducing and improving CBM+ but noted the vital role it has on improving integrated deterrence and providing a tactical and decisive edge to the military services. In the general discussion that followed, it was noted that leaders within the military services need to enact changes within their own organizations to improve data sharing for predictive maintenance. Industry-based and government representatives also recognized the importance of identifying and overcoming obstacles for a successful data sharing pilot program.

OBSTACLES TO DATA SHARING

Following the opening session, the first panel of the workshop included participants from government and industry who were asked to identify the largest barriers to data sharing between government (most especially the military Services) and industry. Discussion was premised on the fact that while CBM+ and other prognostic logistics have been practiced for years, advanced analytics and algorithms work best with more data.

Ultimately, the panel discussion emphasized that data sharing is more a cultural problem rather than a technical one, particularly due to an inability to change behaviors to allow for the introduction and implementation of new ways of analyzing problems. Having access to data that others do not can provide a competitive advantage to data owners who might be fighting for resources or control. In some cases, programs may prefer to perform their own analysis or assessments with the intention of steering outcomes to better support their vision or intended strategies.

In addition, data protection is often legitimately necessary for reasons of security or protection of intellectual property. Another obstacle is that necessary data sets may not even exist, possibly because they have not been compiled into a database or the equipment does not have sensors on it to track the useful data needed for predictive maintenance. The inconsistency of data sets, including format and organization, also makes automation and deployment difficult.

An obstacle identified by government representatives was the variation in governance across different parts of departments. Participants identified multiple methods of implementing predictive maintenance across different services, each relying on different offices or resources in ways that reduce cooperation. This inconsistency makes coordination difficult, as the Department of Defense lacks a single focal point to ease data sharing. Additionally, it was observed that a variety of pilot programs and approaches to predictive maintenance implementation have already been introduced since the early 2000s, but these have been self-contained within Services rather than any type of Department-wide comprehensive implementation. Each Service also is responsible for its own databases and uses a different data system.

The participants noted that addressing these obstacles requires a data environment that allows public-private partnership to facilitate collaboration. To build at the speed of relevance, collaboration is necessary. Because of these challenges and the cultural issues surrounding data sharing, incentives are required to encourage participation.

IDENTIFYING DATA SETS

In a successful pilot program, it is important to identify data sets, address constraints and obstacles to access, and work through those roadblocks to demonstrate successful results. To help inform decision-making and determine necessary, useful data sets, it is essential to consider data availability and ease of access. In the second panel, participants discussed whether known data sets should be identified when developing a pilot and how government and industry data owners could be incentivized to share those data sets. Panelists said when choosing data sets, the value proposition should be taken into consideration. Having mission information makes a difference in analytics. Understanding the probability of mission success means thinking with a forward-looking perspective and collecting good maintenance or transaction history. Any predictive capability demonstrated based on contrived data needs to be followed up on with operational data to fully understand what failed.

CBM+ is the next opportunity in which using data analytics can be a key enabler to ensuring weapons systems are fully functional and operationally ready to respond to conflict, whether kinetic and non-kinetic. Acquiring the necessary data to build applications in CBM+ will in turn allow the defense industry to respond more effectively to threats with speed and efficiency. Data includes the condition and performance of equipment, which is typically derived from sensors and collects information on temperature, vibration, and pressure. Necessary data elements include full, accurate system health data, which includes failure and corrective maintenance reports, demand history, and software diagnosis and prognosis. From the supply perspective, substantive data on the restoration of individual parts or systems is often lacking. Having information on what the faults were and what was fixed will be beneficial to improving predictive maintenance for that part. Maintenance history might include what types of maintenance tasks have been performed on the equipment, when they were performed and any issues that arose during maintenance. Often this data is not provided or lost in a complex supply chain.

Analysis of these data sets can identify patterns that are useful for predicting when equipment is likely to fail. Data sharing and data access are crucial to the speed of information. Data is an important government asset and industry access is instrumental to improve analytics. Particularly in the sustainment world, it is important to define success, then to work backwards and build data structures in a way that will inform outcomes.

SUCCESS STORIES

The third panel discussion centered around success stories of data sharing between DoD and industry that led to improved readiness or reduced costs and availability issues.

One example involved sharing data to improve machine learning algorithms on Project Maven - a partnership project between the Pentagon and the private sector which sought to improve the military's ability to identify and track targets. The key to overcoming data sharing obstacles using this example was allowing industry access to data without disadvantaging the data owners, which involved moving data into a government environment to enable vendors to use relevant data sets.

In a project with the Naval Sea Systems Command (NAVSEA), SparkCognition used historical sensor-based data related to performance and wrote a normative behavior model to predict downtime or failure of twelve San Antonio class ships and anomalies of diesel engines. However, only about two-thirds of the sensors on the propulsion system could be accessed, a barrier that caused inconsistency in data sets and interfered with automation.

Lockheed Martin also reported that maintenance decreased eight percent in the first 10 months when a CBM+ monitor system was employed. To overcome the obstacles previously mentioned, they first made sure the information was understood and actionable by looking at the entire system, not just at the component level. Establishing a rigorous system engineering approach allowed specific targets to be selected which provided value to engineers in achieving a desired outcome, rather than undertaking an unnecessarily difficult task.

The working group has also looked at other examples of successful use of data to improve maintenance outcomes. For example, Naval Air Systems Command (NAVAIR) used data trends to increase performance capability and decrease cost for the H-53 Heavy Lift Helicopter[1]. The initial data was provided by maintainers, the fleet, Defense Logistics Agency, suppliers and the aircraft's Health and Usage Management System (HUMS), fed into different DoD data repositories and analyzed and translated by engineers and stakeholders to support technical and business decision making. Program managers reported that sharing maintenance and engineering data for analysis and forecasting failure modes reduced operating costs and improved readiness. This program worked through contractual negotiations in order to share such data, and this process ultimately resulted in increased aircraft reliability and reduced total operational costs.

NAVAIR implemented a Performance-Based Logistics (PBL) contract to support the sustainment of the CH-53K helicopter and has established a Fleet Common Operating Environment (FCOE) database[2]. The FCOE capability created a business model and supported the establishment of a contracting agreements between the government and the Sikorsky facilities which enables the partners to share data in a central location on maintenance and sustainability issues. The data included in the logistics contract includes information related to repairs, overhauls, and asset management services.

These examples demonstrate how well-planned data sharing developed in partnership between industry and government enables improved predictive maintenance algorithms and provides cost-saving incentives to both vendor and customer.

RECOMMENDATIONS

Building on the discussion of this workshop, the Working Group and ETI recommend that at least two pilot activities be established to demonstrate how enhanced data sharing can positively impact Condition-Based Maintenance activities.

1. Ground Systems Pilot: Analytics on commonly used parts

DoD, working with NDIA, should establish a pilot program which connects government and industry developers, manufacturers, and users of specific spare parts and items and create a consortium to enable sharing of data related to repair history, cost, availability, and suppliers and other critical data related to such items to reduce redundancy, improve availability and reduce total life cycle costs for both government and industry. These items can be identified through analysis of National Stock Numbers (NSNs) with the assumption that commonly used items lend themselves to more open data sharing. Workshop participants believe that ground systems represent an opportunity to identify items and government and industry participants for an effective pilot. The proposal for this pilot was developed in part by participants from companies such as Rheinmetall and General Dynamics Land Systems, who expressed a willingness to participate in data sharing given these conditions.

Selected NDIA members, working with OSD, CDAO, DLA and appropriate service sustainment activities, should select appropriate items and create a process to solicit industry and government participants in the pilot. NDIA, working with the CDAO, should establish a data repository or provide access to existing repositories to support access and analysis of shared data, to include access to mission environment data and operational context. NDIA and OSD should work to identify interested government and industry participants in this pilot by Summer 2023.

2. Aviation Systems Pilot: Optimizing software-based anonymization and analytics

DoD, working with NDIA, should establish a pilot program to demonstrate how proprietary data can be appropriately anonymized for use by appropriate organizations involved in the analysis of survivability and availability trends. For example, these data could be used to improve readiness of major air platforms by reducing maintenance downtimes. The pilot would explore which types and sources of data are most useful for such analysis and how to optimize anonymization processes to balance the need to protect proprietary information while sharing useful data. Companies such as Lockheed Martin and Raytheon expressed

1 "H-53 Heavy Lift Helicopter program uses data trends to increase reliability, reduce cost," NAVAIR, 7 Nov 2012, https://www.navair.navy.mil/node/19381.

2 "CH53K: The Sustainment Approach," Defense Info, 10 March 2020, https://defense.info/defense-systems/ch53k-the-sustainment-approach/.

a willingness to participate in such a pilot with the appropriate conditions.

NDIA members, working with OSD, CDAO, DLA, and appropriate service sustainment activities, should identify appropriate data owners to share anonymized data for the purpose of improving algorithms and proving successful outcomes as a result of data sharing. The pilot should be structured so that maintenance data and operational data can be used to validate analysis and models leading to development of better predictive analytics. NDIA and OSD should work together to identify interested government and industry participants in this pilot by Summer 2023.

Additional Recommendations

In parallel with these pilots, the following policy actions should be undertaken to support CBM+ analytics.

- NDIA should work with CDAO and appropriate organizations to demonstrate how industry partners can get access to government-owned data sets related to Condition-Based Maintenance.
- DoD should leverage the SBIR program to fund activities in support of the development and demonstration of analytics capabilities in the CBM+ mission area including by establishing appropriate partnerships with sustainment organizations and prime contractors.
- DoD, in partnership with industry, should work to develop resources to establish a data repository for industry partners to share relevant data sets related to CBM+.
- Congress should direct DoD to establish training policies and procedures so that future acquisition programs provide mandates or incentives for the sharing of data in support of the use of CBM+ methodologies and reduce life-cycle costs.
- Congress should direct DoD to identify CBM+ related data sets and establish activities to make such data sets available in appropriate repositories and with appropriate anonymization to support development and use of analytic tools and activities to enable CBM+ services.
- OUSD (A&S) should identify senior officials to oversee CBM+ data sharing in each appropriate service or agency with the responsibility to identify and appropriately share relevant data sets, provide advice on data analytics tools tailored for CBM+ missions, and support acquisition officials in developing data strategies to enable data sharing of program information between government and industry over the life-cycle of programs.

Taken together, these recommendations will lessen barriers and facilitate data sharing between industry and government to improve DoD's decision-making capabilities.

EVENT AGENDA

Keynote: Motivating the Problem

Dr. Vic Ramdass, SES
Deputy Assistant Secretary of Defense for Material Readiness

Panel 1: Obstacles to Data Sharing

Bruce Kaplan
Fellow, Logistics Strategy and Integration, Logistics Management Institute (LMI)
Moderator

Robert Stukes
Chief Logistician, Program Executive Office Integrated Warfare Systems, Naval Sea Systems Command (NAVSEA)

Mike Isbill
Fellow, Lockheed Martin Corporation

Steve Martinez
Chief, Logistics Strategy, Concepts & Programs Division, U.S. Air Force

Representatives from the services and industry sustainment organizations will identify obstacles to data sharing and whether they serve a necessary purpose. This panel will discuss how a pilot program could be structured to address those issues.

- What incentive can be created for government or industry data owners to share their data as part of a pilot?
- Do any policies need to be waived or changed to execute the pilot program?
- What constraints should be put on the data sharing activities under the pilot program?

Panel 2: Identifying Data Sets

Dr. Marilyn Gaska
Senior Fellow, Lockheed Martin Corporation
Moderator

Justin Woulfe
Chief Technology Officer, Systecon North America

Greg Little
Deputy Comptroller for Enterprise Data and Business Performance (EDBP), OUSD(C), Chief Digital and Artificial Intelligence Office (CDAO)

Eric Herzberg
Fellow Emeritus, Logistics Management Institute (LMI)

Panelists from both government and industry will identify specific data sets that would be useful for a pilot and nominate data owners to participate in the pilot.

- Should known named data sets be identified in developing the pilot?
- What benefit can we create to encourage data owners to participate?

Panel 3: Success Stories

Dr. Mark Lewis
Executive Director, Emerging Technologies Institute (ETI)
Moderator

Logan Jones
President & General Manager, SparkCognition Government Systems

Colin Carroll
Head of Government and Business Services, Applied Intuition

Dr. Camille Lewis
Fellow, Lockheed Martin Corporation

This panel will center around previous examples of data sets being used to improve defense capabilities or reduce costs and lessons learned in overcoming data sharing and availability issues.

- Summarize a success story where DoD or industry data sharing has led to readiness improvement.
- What obstacles did you have to overcome?
- What recommendations do you have for shaping a pilot based on this experience?

The event was developed, planned, and executed by members of the NDIA Logistics Division Software and Data Analytics working group and staff of the NDIA, including the Emerging Technologies Institute.

The event was held on December 6, 2022 at the NDIA HQ. The event was attended by nearly 60 experts from DoD and NDIA member companies and universities representing manufacturing, operational, logistics, and data analytics subject matter expertise.

ABOUT ETI

ADVANCING THE TECHNOLOGIES OF TOMORROW TO ADVANCE OUR ECONOMY AND SECURE OUR NATIONAL DEFENSE

The Emerging Technologies Institute of NDIA is a new organization that provides leadership, bolsters public awareness, and creates independent, reliable research about the technologies critical to our nation's economy and national defense.

Led by Dr. Mark Lewis, former Acting Deputy Under Secretary of Defense for Research & Engineering, and supported by a preeminent advisory board, the research staff and leadership at ETI are among our nation's top experts on technological innovations.

ETI provides the leadership outside the government to bring together government, industry innovators, academia, investors, and the American public in pursuit of economic integration, defense modernization, and technological primacy. As part of a nonpartisan 501(c)(3) organization, ETI supports the modernization of the national industrial base and our military through the development, acquisition, and integration of emerging technologies—specifically those essential to our national defense strategy and our economic future. For more information, visit **EmergingTechnologiesInstitute.org**

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