**Common Condition Based Maintenance**

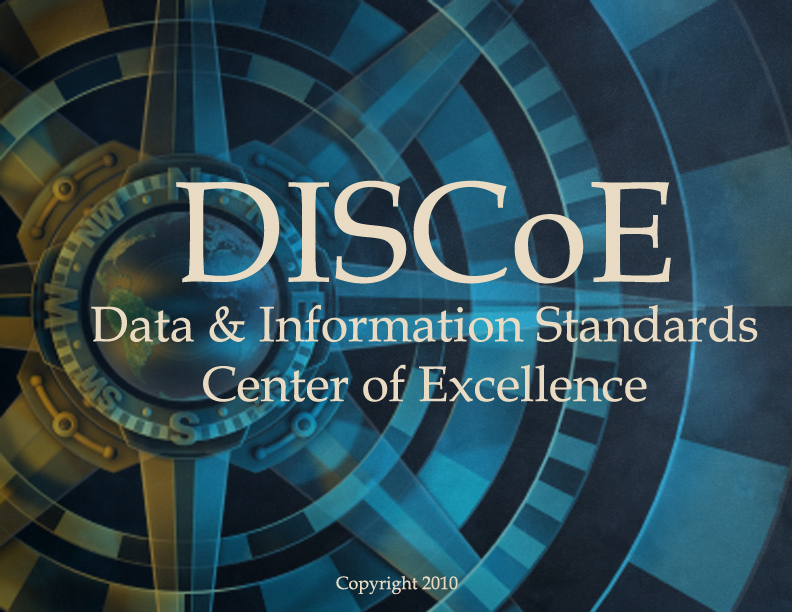
**Data Warehouse (CCBMDW)**

**Program Manager’s**

**CBM+ Files and Messages Primer**

**September 08, 2011**

**Internal Version 0.21b**



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| in process | LOGSA CBM+ File Identifiers Request |
| 2008.DEC | DoD MIL-STD-3008 (IETM Requirements to Support the GCSS-A) |
| 2010.APR | Common CBM+ Enterprise Repository |
| 2006.AUG | MIMOSA OSA-CBM Primer |
| 2003.MAR | ISO 13374 Condition monitoring and diagnostics of machines – Data processing, communication and presentation |
| 2011 | Army Posture Statement: CBM+ |

CBM+ PM Primer Topics and Objectives

* It is estimated that the *Program Manager CBM+ Primer* will be 60 pages (± 5%).
* The Primer will not provide in depth information on any one subject.
* The Primer will provide a cursory discussion of several subjects.
* The proposed subjects to be covered in the Primer are outlined in the tables below.

CBM+ is not a process by itself. It is a comprehensive strategy that includes a variety of interrelated and independent capabilities and initiatives. As such, CBM+ involves a wide spectrum of data producers and consumers from across all of the Department of Defense. The purpose of this CBM+ Files and Messages Primer is to provide a high level view of the considerations that should be taken into account to successfully implement CBM+ from sensor to enterprise. Put another way, this guidebook will present PM level decision makers with an overall view of CBM+ that will help them understand how to implement CBM+ within their program.

**Questions this guide will address:**

|  |  |
| --- | --- |
| * Who/What is a producer of CBM+ data? | * Who/What is a consumer of CBM+ data? |
| * CBM+ Identifier Synchronization (MIMOSA/NIIN/et al) |  |

**General topics visited throughout:**

|  |  |
| --- | --- |
| * Planning / As Designed | * CBM+ Producers and Consumers |
| * Implementation / As-Built | * Active CBM+ Programs |
| * Operations / As-Maintained |  |

**Topics discussed from a data producer point-of-view:**

|  |  |
| --- | --- |
| * Sensors | * Data Bus Standards |
| * Messaging Standards | * Data Acquisition Systems |
| * Adding an existing Platform to CCBMDW | * Adding a new Platform to CCBMDW |
| * MIMOSA | * MOA with LOGSA |
| * CCBMDW | * File Transfers |
| * CBM Enterprise Repository | * Data Ownership vs. Data Stewardship |
| * File Formats (CDF/ABCD, Excel, CSV, XML, HDF5) | * Business Rules |
| * Cataloging Data | * Data Manipulation |

**Topics discussed from a data consumer point-of-view:**

|  |  |
| --- | --- |
| * MOA with LOGSA | * CCBMDW |
| * File Formats (served as stored) | * RCM |
| * Data Analysis |  |

**Documentation to be referenced:**

|  |  |
| --- | --- |
| * DoD - CBM+ Roadmap (2007.DEC) | * DoD - CBM+ DoD Guidebook (2008.MAY) |
| * Army – File Naming Guidelines | * Army – CBM File Identifiers Request |
| * Army – DISCoE Interface Requirements Spec | * SAE – J1939 |
| * SAE – J1708 (physical) / J1587 (message content) |  |
| * DoD - MIL-STD-3008 (IETM Requirements to Support the GCSS-A – 2008.DEC) | |
| * Army – Common Condition Based Maintenance Enterprise Repository (CCBMER – 2010.APR) | |

Thinking Guide … Transactional Facts

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Figure ‑ Thinking Guide … Transactional Facts

Executive Summary

Paragraph 7-3e of AR 750-1 states “LOGSA, AMC will maintain the single Army database repository for RCM data (to include CBM data)”.

Written from a Logistics Support Activity (LOGSA) Perspective, this CBM+ Files and Messages Primer for Program Managers provides a discussion of the steps necessary to achieve initial Condition Based Maintenance-Plus (CBM+) capabilities in the Army. It addresses major actions and decision points necessary to achieve the sustainment capabilities inherent in CBM+, including new information infrastructure for information echelons above the platform. Its purpose is to provide a high level view of the considerations, steps, and processes that should be taken into account to successfully implement CBM+ and ensure that data generated on a platform can become usable information across the Army Enterprise.

This Primer is not comprehensive and is not intended to answer every question. It is, however, intended to be a reasonably thorough high-level Primer that will provide PM level decision makers with a better understanding of how to implement CBM+ within their program and to realize which, and of whom, questions need to be asked.

Specific focus is placed on the path of CBM files and messages from platform to the LOGSA Common CBM Data Warehouse (CCBMDW) with a more general focus placed on the concepts, tools, and processes that enable collected data to become actionable information.

The combination of necessary actions and the identification of supporting infrastructure needed to field CBM+ are defined as the Army initial capability. Systems and platforms will move towards an initial capability over time, as platform modifications and new platform production enables the force structure to apply the capability.

This document will evolve as the Army initial capability progresses towards maturity.

# 

# Introduction

*This Primer is written from the perspective of the LOGSA Common CBM Data Warehouse (CCBMDW). Every effort has been made to ensure accuracy and the information herein is correct as of the publish date. However, Army CBM efforts are dynamic and information is always changing.*

*LOGSA is ‘*Collaboration Ready*’ to work with you and your organization to ensure that your contributions help to make Army CBM+ as productive as possible as soon as possible.*

*A Point-Of-Contact (POC) block is provided, where applicable, at the end of each section to which it pertains. Also, a POC summary table is provided in the appendix. It is highly recommended that you make direct contact with the respective POCs to obtain guidance and that you do not base any decision solely on information contained in this primer.*

Condition Based Maintenance Plus (CBM+) is not a process by itself. It is a comprehensive strategy that includes a variety of interrelated and independent capabilities and initiatives. As such, CBM+ involves a wide spectrum of data producers and consumers from across all of the Department of Defense.

Of all the discussion about Condition Based Maintenance (CBM) and, more recently, Condition Based Maintenance “Plus” (CBM+) there seems to be a lack of understanding as to the differences between the two. The stated goal of CBM is to perform maintenance only when there is evidence of need. Established to expand upon CBM, the goal of CBM+ is to utilize sensor data to provide continuous assessment of platform condition and health.

CBM+ is the future of Army DoD Enterprise maintenance. Not only is CBM+ the process for determining the optimal timing of maintenance on a platform, it also provides the infrastructure and technologies that enable the maintainer to ascertain platform health and perform maintenance only on evidence of need.

A commonly held misconception is that CBM+ is accomplished by installing sensors on a platform. Platform / sensor integration is only one piece of the puzzle. A PM responsible for implementing a particular portion of CBM+ may be faced with sensor selection, integrating sensors with data buses, with data acquisition equipment interfaces, with analysis software integration, with enterprise system integration, and/or anything and everything that is in between.

Another misconception is that the algorithms for detecting failure and degradation are mature and accurate. With rare exception this is not the case. Effective implementation of CBM+ will result in platforms that are better maintained based on the scientific analysis of collected data. This means that CBM+ begins at the platform in the form of data collection, and ends at the platform by providing maintainers with accurate, timely, and actionable information. For this to occur data must be collected, normalized, transmitted to the national level (where it is stored and cataloged), retrieved, and analyzed.

Each system or platform, be it a helicopter, a tank, a truck, a generator, a jeep, or something else, is unique in terms of what needs to be monitored and the data that has to be produced. The path for developing a system or platform that can be fully integrated from sensor to enterprise is not simple. However, it can be made to be relatively straight forward by adhering to nationally recognized standards, recommended practices, and LOGSA guidelines.

Much has been written about CBM and CBM+ from a high level. However, Power-Point slides cannot be compiled and so it is left to technical people, bounded by reality, to find and implement technical solutions that work. In this case the colloquialism *the devil is in the details* has never been more true.

This Primer addresses data handling issues that arise between the platform and the analyst. A particular emphasis is placed on how to store data collected from sensors into a file, how to register a platform for data file association, and the events that must occur in order for LOGSA to associate platform generated messages received with the registered platform that generated them.

# 

# A Brief History

During World War II Conrad Waddington (1905-1975), a developmental biologist, paleontologist, geneticist, and embryologist, was asked to find ways to decrease the amount of time that RAF’s B-24 Liberator bombers spent in the maintenance shop. The idea, of course, was to increase the amount of time that they could spend hunting and killing German U-boats.

Conventional wisdom of the time held that fully mission capable aircraft and regularly scheduled preventive maintenance (PM) were directly proportional. However, Waddington discovered that unscheduled repairs increased sharply after each scheduled 50-hour PM event. He also observed that the need for unscheduled repairs declined steadily until after the next scheduled 50-hour PM event … when they would spike again.

Waddington concluded that scheduled maintenance “tends to *increase* breakdowns, and this can only be because it is doing positive harm by disturbing a relatively satisfactory state of affairs”. Among Waddington’s proposals was to increase the time between PM events and eliminate PM tasks that were not demonstrably beneficial.

Once his recommendations were implemented, the number of effective flying hours of the British Coastal Command bomber fleet increased by more than 60%.

Because the work of Waddington and his colleagues remained classified until 1973 it is very unlikely that Stanley Noland or Howard Heap had heard of it when their work at United Airlines became the origin of what is known today as Reliability Centered Maintenance (RCM).

Research by Noland and Heap noted that …

The vast majority of failures are not age related, and that a large number of them are either infant mortality or maintenance induced.

Efforts to predict life expectancies would be better spent managing failures.

There should be a shift from fixed-interval, time-directed maintenance to on-condition maintenance.

Time between overhauls (TBOs) and life limits should be eliminated in favor of condition monitoring and failure prediction. Many component and subsystem failures have acceptable consequences, and that “run-to-failure” is often the best maintenance strategy.

The work of Noland and Heap, *Reliability-Centered Maintenance*, was published by United Airlines for the (then) Office of the Assistant Secretary of Defense in 1978 and quickly became the de-facto source for how maintenance was done throughout the air transport industry.

Effects from the work of Waddington, Noland, and Heap are manifest today in the form of Condition Based Maintenance Plus (CBM+).

*Reference: Sport Aviation Magazine, March 2011, “The Waddington Effect”*

# CBM+ Concepts

|  |
| --- |
| DAU link: <https://learn.dau.mil/html/clc/Clc1.jsp?cl=>  A keyword search for 'CBM' returns "CLL029 Condition Based Maintenance (CBM+)"  Note: DAU is being revamped and this link will be “broke” until “Mid-September” |

## Reliability Centered Maintenance (RCM)

RCM is a structured logical approach to maintenance that uses system reliability characteristics to determine the optimal failure management strategy for a system in a given operating context. RCM does not provide a rigid formula for success. Flexible in nature, RCM recognizes that maintenance is not and cannot be a one-size-fits-all solution. The RCM approach applies a mixture of four key maintenance ingredients: Proactive, Predictive, Preventive, and Run-to-Failure. These ingredients, when intelligently selected and applied by subject matter experts, are used as the basis for identifying and defining the maintenance requirements for individual systems.

More than a failure predictor, RCM is a lifecycle process that is applied continuously and seeks to answer the question of failure probability for a given system at a given point in time.

RCM is based on the following precepts:

* RCM seeks to preserve a desired level of system or equipment functionality
* The RCM process should be applied from design through disposal
* RCM seeks to manage the consequences of failure - not to prevent all failures
* RCM identifies the most technically appropriate and effective maintenance task and/or default strategy
* RCM is driven first by safety. When safety (or a similarly critical consideration) is not an issue, maintenance must be justified on the ability to complete the mission and finally, on economic grounds.
* RCM acknowledges design limitations and the operational environment. At best, maintenance can sustain the inherent level of reliability within the operating context over the life of an item.

A DoD-approved RCM process includes sequentially identifying the items in .

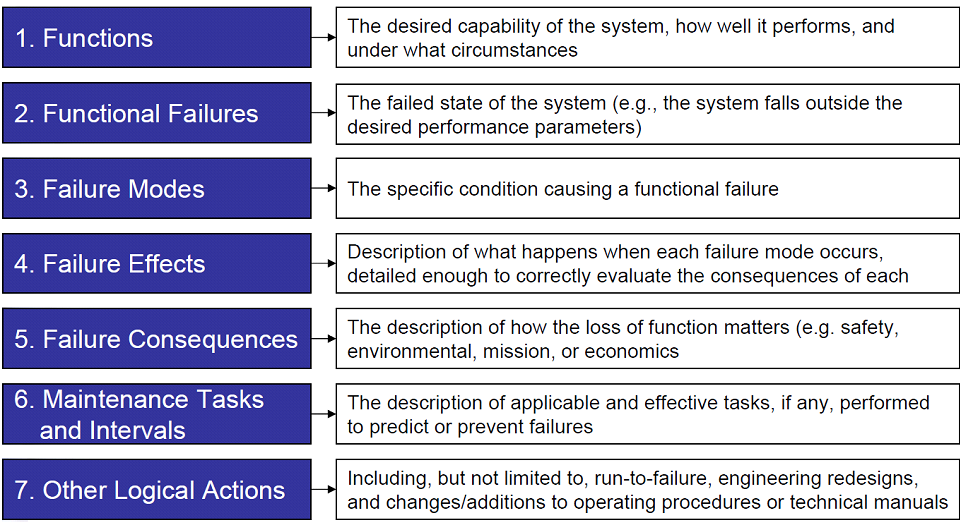


Figure ‑ The RCM Process

In summary, RCM combines professional intuition with collected data in a statistical approach to predict platform system health and provide feedback that can improve design. The overarching goal of RCM is to accomplish maintenance in a way that provides a measurable increase in mission capability and a simultaneous decrease in cost while achieving desired levels of safety, reliability, and environmental soundness.

## CBM+ As a Subset of RCM



Figure ‑ DoD CBM+

CBM+ is the application and integration of appropriate processes, technologies and knowledge-based capabilities to improve the reliability and maintenance effectiveness of DoD systems and components. At its core CBM+ is maintenance performed on evidence of need provided by Reliability-Centered Maintenance (RCM) analysis and other enabling processes and technologies.

### 2011 Army Posture Statement

*Excerpted from 2011 Army Posture Statement:*

<https://secureweb2.hqda.pentagon.mil/VDAS_ArmyPostureStatement/2011/information_papers/PostedDocument.asp?id=197>

CBM+ is a proactive equipment maintenance capability (i.e. RCM) that uses system sensor-based health indications to identify and predict functional failure prior to the event and provides the ability to take appropriate action. CBM+ is based on a set of rigorously defined maintenance tasks derived from reliability centered maintenance analysis. The building blocks in the development of CBM+ capabilities are a collection of data on the platform, movement of data off the platform, storing the data in a data warehouse, analyzing the data and acting on the data.

Program Managers (PM) are incrementally applying CBM+ technologies to existing platforms where feasible. Already, over 60 percent of the Army’s aircraft are equipped with digital source collectors. These systems are deploying to Operation Enduring Freedom and Operation New Dawn for use by Soldiers in the field to save lives and equipment. These technologies have been credited for averting Army Aircraft from critical failures. Resourcing is essential to continue the Army’s CBM+ efforts – a number of Army organizations have programmed for CBM capabilities in their FY 13-17 Program Objective Memorandum (POM).

The immediate focus is to continue to move forward with the application of CBM+ capabilities to our current force systems and to support/align future investments through the weapon system review for POM 13-17. The Army will also further refine a prognostic tool to monitor power production equipment for use in our Tactical Operations Centers and has implemented a CBM+ Initial Operating Capability (IOC) initiative targeted at high payoff Tactical Wheeled Vehicles that will apply sensors and collect on and at platform data. The Army is working to field a CBM capability that will enable interaction with platforms at the Digital LogBook level and further enhance the lifecycle management of Army systems.

Platforms coupled with CBM+ technologies typically experience a 5 percent increase in readiness. CBM+ will enable our Soldiers to be more productive, reduce maintenance services and provide leaders the visibility required to implement anticipatory logistics. The current maintenance paradigm can be changed from preventive to condition-based. Data indicates a potential 10-year savings of $307M(BY10 $) for Army Aviation alone. CBM equipped aircraft (UH-60, CH-47, and AH-64) generated additional flying hours per month, achieved a 5-8 percent readiness rate improvement, required 1-4 percent less maintenance test flight hours and experienced one less mission abort per 100 flight hours.

## Machine Condition Assessment

ISO 13374-1 (<http://webstore.ansi.org/RecordDetail.aspx?sku=BS+ISO+13374-1%3a2003>) states that condition assessment can be broken into the six distinct, layered processing blocks as shown in :



Figure ‑ Condition Assessment Processing Blocks

The DA, DM, and SD assessment blocks are technology-specific and require signal processing and data analysis functions.

* **(DA) Data Acquisition** – Converts output from a sensor/transducer to a digital parameter that represents a physical quantity and related metadata such as time, calibration, data quality, etc …
* **(DM) Data Manipulation** – Performs any kind of processing (e.g., signal processing) necessary for the sensor values to be meaningful with respect to state and health assessment.
* **(SD) State Detection** – Facilitates the creation and maintenance of normal baseline “profiles” that can be used to detect an abnormal condition whenever new data is acquired.

The HA, PA, and AG blocks normally attempt to combine monitoring technologies to assess current health, predict future failures, and provide recommended actions to operations and maintenance personnel.

* **(HA) Health Assessment** – Considers all state information to diagnose any faults and to rate current health.
* **(PA) Prognostics Assessment** – Predicts the remaining lifetime until the next significant state change.
* **(AG) Advisory Generation** – Provides actionable information regarding maintenance actions or changes of operational settings that will optimize platform service.

## From Sensor to Enterprise Overview

From sensor to analysis, most platform data originates from platform sensors. A discussion of what is or should be monitored is platform specific and beyond the scope of this document. However, it is important to understand that not all data generated by a platform is needed on that platform or in real-time.



Figure ‑ From Sensor to Enterprise Overview (Pre-CBM)

provides a high-level notional implementation of the “Pre-CBM” (as shown in Figure 3‑3) sensor to enterprise data path. It is intended to convey the idea that collected data is manually logged and later entered into an electronic system for eventual transmission to National. The time required for Pre-CBM data to become available at National for aggregation into actionable information is often measured in weeks/months and the data is often of limited use in the first place.



Figure ‑ From Sensor to Enterprise Overview (Post-CBM)

provides a high-level notional implementation of the “Post-CBM” (as shown in Figure 3‑3) sensor to enterprise data path. It is notional in many ways but a few are worth mentioning explicitly. A platform is not limited to the ones shown. A platform may be any piece of equipment, such as a generator, that could benefit from CBM. Also, Digital Logbook is used here in a generic sense. Any given platform may or may not have a Digital Logbook, or a Paper Logbook, or both. This diagram is intended to convey that data electronically collected from a platform sensor can be placed into a standardized file format and ultimately be collected at a central location where it can be catalogued and stored for analysis. The time required for Post-CBM data to become available at National for aggregation into actionable information can be measured in hours/days instead of weeks/months. The faster report time coupled with the advanced nature of the data makes Post-CBM data valuable to a much wider user base.

## Sensor Basics

According to the Merriam-Webster Dictionary (<http://www.merriam-webster.com/>) a *sensing device* is:

1. A device that responds to a physical stimulus (as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control)

Sensors produce a measurable response to a change in a physical condition and are an integral part of any CBM application. Responsible for converting a physical phenomenon into a quantity that is measurable, the data produced by sensors are the lifeblood of CBM.

Sensor data is a digitalized version of the output produced by a sensor. Sensor data may be a voltage value that varies with the speed of a rotating shaft, a 16-bit binary value that represents engine RPMs, or any number of other possibilities.

If it heats up, cools down, moves, changes, fluctuates or wobbles there is probably a sensor that can detect and measure it:

|  |  |
| --- | --- |
| * Acceleration | * Magnetic Fields |
| * Angular/Linear Position | * Pressure |
| * Chemical/Gas Concentration | * Proximity – Spatial Presence |
| * Humidity | * Sound |
| * Flow Rate | * Temperature |
| * Force | * Velocity |

There are many questions to ask and factors to consider when selecting a sensor. The importance of each factor is application specific. For example, you most likely do not need to use a sensor that is capable of measuring temperature more than once a second but you almost certainly do need an accelerometer that is capable of measuring vibrations in the sub-second range. And, of course, cost is almost always directly proportional to quality.

The following non-exhaustive factor list is intended to be food for thought when selecting a sensor:

|  |  |
| --- | --- |
| * **Accuracy** | What is the statistical variance over time? |
| * **Calibration** | Can it be calibrated? How is it calibrated? |
| * **Cost** | Always an issue |
| * **Sample Rate** | How many readings per unit of time? |
| * **Environmental** | Sensors typically have temperature and/or humidity limits |
| * **Range** | Measurement limits |
| * **Repeatability** | Reading variance when a single condition is repeatedly measured |
| * **Resolution** | The smallest measurement delta the sensor can detect and report |

The evolution of CBM has been made possible largely by the advancement of sensors. Electro-mechanical sensors, such as a fuel gauge that reports the level in a fuel tank, provide “paper logbook” data that is periodically captured. Paper logbook data is not easily shared among the personnel who need it. Electronic sensors, such as a fuel flow monitor, provide “digital logbook” data that can be continually captured and transmitted. Digital logbook data can be utilized by other platform systems and is easily shared among the personnel who need it.

## Pre-CBM vs. Post-CBM

Pre-CBM sensors and control panels are more basic while Post-CBM sensors and control panels are more capable. Imagine the tale of two sensors: an electro-mechanical fuel level sensor (Sensor-*A*), and an electronic fuel flow sensor (Sensor-B).

Sensor-*A* has been incorporated into Army items for decades and basically tells you how much fuel is left in the tank. The data Sensor-*A* provides is manually captured periodically and manually reported. While the data provided is of immediate use to the Platform Operator, it is useful to a Mission Planner or Provisioner only when reported. There has been very little (if any) change to the design of Sensor-*A* or its control panel through the years.

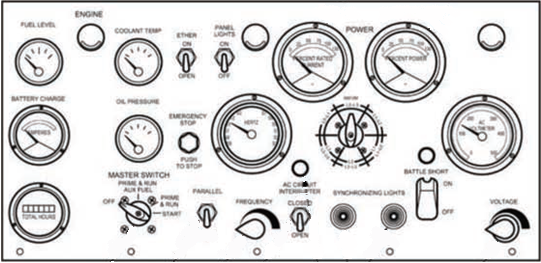


Figure ‑ Instrument / Control Panel (Pre-CBM)

Sensor-*B* is a recent recruit and is just beginning to find his way onto Army items. Sensor-B cannot tell you the amount of fuel that you have left but can tell you the rate at which you are using it and if it is contaminated. The arrival of Sensor-*B* and its associated control panel mark a major milestone in the advancement of army platforms and is a major contributor to CBM+ efforts.

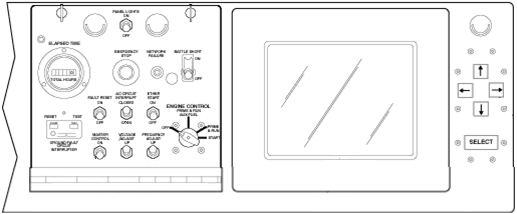


Figure ‑ Instrument / Control Panel (Post-CBM)

Data gleaned from the two individual sensors, when combined, provides information, such as an estimate of miles or hours until the tank is empty and if the platform is fulfilling the designer’s requirements, is much more valuable than the individual data that produces it. This information can be electronically reported into a system (CBM, G-ARMY, et al) where, in addition to the Platform Operator, it is of potential immediate use to the Mission Planner, Provisioner, Field Maintainer, Logistics Analysis, and Platform Designer.

|  |  |  |  |
| --- | --- | --- | --- |
| Real Time and Transactional Data | **Consumer** | **Knowledge from basic fuel sensor** | **Knowledge from advanced fuel sensor** |
| Platform Operator | knows to get more fuel | knows to get more fuel |
| Field Maintainer | gets nothing of value | alerted to required maintenance |
| Mission Planner | * can guesstimate fuel requirements * knows platform capability as of the last reported time | * knows fuel requirements * knows if platform is Fully Mission Capable * knows mission capability specifics |
| Provisioner | can guesstimate how much fuel is needed in the supply pipeline | * knows fuel requirements * knows spare parts requirements |
| Historical Data and Facts | Logistics Analyst | gets nothing of value | Failure Mode Effects Analysis (FMEA)  … |
| Platform Designer | gets nothing of value | * knows if design specifications are being met * knows where to focus attention for reliability improvement * knows what new CBM+ tools to add |

Figure ‑ Basic vs. Advanced Fuel Sensor

Sensors on a CBM platform are ultimately connected together and transmit their data readings to a centralized a data acquisition (DAQ) system. A discussion of DAQ systems is beyond the scope of this Primer. However, it is important to understand that the typical role of a DAQ system is to collect and store raw sensor readings which can then be collectively saved into a file on a computer.

## Data, Metadata, File, and Message Concepts

The stated the role of LOGSA is to maintain the single Army database repository for RCM data (to include CBM data). As such the CCBMDW will accept and archive files received from an authorized source and make them available for retrieval by authorized recipients.

The CBM data file is the primary product that the CCBMDW will provide. It is anticipated that the CCBMDW will also provide CBM+ support files that are needed to properly build CBM data files and with functional warning files that are needed to identify and correct issues with CBM+ system processes.

### Data

Before defining CBM or CBM+ data lets us start with the definition of data. According to the Merriam-Webster Dictionary *data* has 3 meanings:

1. Factual information (as measurements or statistics) used as a basis for reasoning, discussion, or calculation <the data is plentiful and easily available>
2. Information output by a sensing device or organ that includes both useful and irrelevant or redundant information and must be processed to be meaningful
3. Information in numerical form that can be digitally transmitted or processed

### CBM Data

The definition of *CBM Data* is a combination of *Data* definitions 1 and 3.

*Factual information used as a basis for reasoning, discussion, or calculation … that can be digitally transmitted and/or processed.*

This would be the raw data coming from the sensor, or the manual entries made in the digital log book. It is information that simply exists. A good example of this in the CBM world would be fuel pressure data streaming from the sensor to the Digital Source Collector (DSC). Just because the data comes from a sensor doesn’t make it CBM data. Consider a fuel bladder with a digital sensor, yes the data can be collected, but what engineer or CBM process or RCM analysis would use it? It is useful data logistically, and important to the Mission Planner, but it is of no use for purposes of RCM analysis and therefore should not be submitted in a file that otherwise requires long-term storage in the CCBMDW.

CBM data is categorized as that which should be committed to long term storage for purposes of RCM analysis. For example, while tire pressures and fuel levels may be of interest to the Logistics Integrated Warehouse (LIW) they do not provide useful environmental information nor are they indicators of long-term platform health. Typically such data points would not be categorized as CBM+ data. Are there cases where tire pressure or fuel level could be categorized as CBM+ data? Probably. As has been previously stated each system or platform is unique in terms of what needs to be monitored and the data that needs to be produced.

Possible examples of CBM data that could be important for purposes of RCM analysis:

Ambient Temperature – extreme cold, extreme hot, and/or fluctuations between the two could be important factors in building analysis algorithms. For example, RCM analysis could discover a failure that only occurs at temperatures below freezing.

Platform Location – Latitude, Longitude, and Elevation data could be important for numerous reasons. One example could be the discovery of a failure that occurs only while operating in high elevations.

Platform Attitude – Roll, Pitch, and Yaw data could be pivotal in the determination of real-world situations that cause a vehicle to rollover. Such findings, if discovered, could be the source of a training update that could save lives as well as platforms.

Fluid Levels/Pressures/Temperatures – High or low water, oil, transmission fluid, gear oil, et cetera, levels/pressures/temperatures could be used to explain component failures that might have otherwise been attributed to an incorrect root cause.

Vibrations – comparative analysis of vibration signatures collected over time has proven valuable in the identification of bearing wear patters. Vibration signature analysis can reduce lengthy and expensive inspection tear-downs.

Speed / RPM – Monitoring speed and RPM information is crucial to being able to definitively know if, when, and for how long a platform was operated outside of its design specifications. Such events are known as and commonly referred to as an *exceedance*.

### CBM+ Data

The definition of *CBM+ Data* is a combination of all 3 *Data* definitions:

Factual information used as a basis for reasoning, discussion, or calculation *… that is output by a sensing device and must be processed to be meaningful …* that can be digitally transmitted and/or processed*.*

CBM+ data is defined as CBM data that has been processed or acted upon by a CBM+ process, Operator, Maintainer, Mission Planner, Logistician, Analysis or Engineer. A simple on-platform example is tire pressure, which may be available on the automobile you drove to work. The CBM data is measured and recorded periodically, at the same time the platform monitors the CBM data to see if the tire pressure has fallen below a threshold and if it should issue a maintenance action (CBM event) to the platform operator.

Possible examples of CMB+ data that could be important for purposes of RCM analysis:

* Exceedances
* Histograms
* Analysis Results

### CBM+ Support Data (metadata)

Data that exists without context is usually of little or no value. For example, a file that contains 300,000+ “engine parameter” values is relatively useless without knowing the platform that it came from (tank/jeep/other?), the sensors that produced it (temperature/vibration/other?), and the engineering units (oC/inches/meters/pounds/other?). *Metadata* provides the context that makes CBM+ data useful.

Metadata is “data about data”. For example, not only does a digital photograph stored in the .jpg file format contain the information required to render the image (i.e. the data), it also contains optional sections identified by a *metadata tag* which contain information about the file (i.e. the metadata) such as the date and time that the picture was taken, the model of the camera used, exposure time, et cetera. In this example the metadata tags might be date, time, camera\_model, and exposure for the data set [2011-AUG-19, 14:50, Canon EOS, 0.125].

Continuing with the camera example it is easy to see the importance of having a standardized set of metadata tags. Imagine that all camera manufacturers agreed to use the .jpg data compression standard but defined their own set of metadata tags and engineering units. This would most likely mean that you would need to use a different computer program to view pictures taken with a camera that is from a different manufacturer. Or, you could do what they hope and keep buying cameras that only they manufacture. The latter is known as “vendor lock-in” and is all too familiar in the DoD world.

Metadata in a .jpg file adds value, but its presence is not crucial to the ability to view the image. Even though you might not know the date or time that a picture was taken you can still see the image of grandma blowing out a blur of candles.

Metadata in a CBM file not only adds value, but it is also crucial to the ability to, metaphorically speaking, view the image. In this case the image is a time-lapse motion picture of platform events that occurred during a CBM Session for which data was collected.

### CBM Events and Faults

One of the immediate benefits of having a platform sensor system is that it provides event information that is of immediate value to an operator and/or maintainer. An example of such an event is the occurrence of an overheat condition. Overheat conditions and other such similar occurrences are commonly called exceedances. An exceedance occurs when sensor data indicates that a value is above, e.g. an overheat condition, or below, e.g. low oil pressure, a predefined range. Receiving an immediate alert that platform oil pressure is outside of its normal operation range is much more valuable than finding it out from an analyst two or more weeks later.

While still important for purposes of RCM the immediate nature of an exceedance will cause the generation of an exceedance message. Exceedance messages will ultimately be received by the CCBMDW where an attempt will be made to reconcile them with the CBM data file that contains the raw data that generated the event. The reconciliation of exceedance messages and data files will provide a single coherent history.

Reconciliation success will depend on several factors. For example, if an exceedance message is to have any chance of being reconciled it will need to contain time-stamped platform specific information (metadata) that will make it individually identifiable. The form and content of exceedance messages is undefined as of the publication date of this Primer.

### CBM Files and Message Metrics

The nature of the relationship between an exceedance message and its corresponding CBM data file is largely one of timing and the task of reconciling them is not uncomplicated. Exceedance messages are smaller and have a higher priority which means that they will propagate through the system much faster and arrive at the CCBMDW much sooner than will the corresponding CBM data file.

Exceedance messages without a corresponding data file are relatively useless for purposes of RCM in much the same way that platform data without metadata is useless. The CCBMDW will store exceedance messages that it receives in anticipation that the corresponding data file will also be received. What if the data file *never* arrives? How long is *never*? What if someone along the pathway between the platform and the CCBMDW is forced to delete the CBM data file because of limited disk space or limited bandwidth? What if a system failure or other unforeseen problem causes one or more files to be deleted without anyone knowing?

There is no single answer to these and other questions that is suitable for all platforms or organizations. It is anticipated that the answers will be provided through the use of an implementable set of business rules that are agreed upon in advance by LOGSA and the CCBMDW user.

Recent discussions have illustrated the need to create a set *platform event* messages to provide low- level file logistics information. The idea is that messages such as “Platform X: Start CBM file build”, “Platform X: End CBM file build”, and “Platform X: Dropping CBM file *name*” would provide information that is critical to the ability of the CCBMDW to provide a complete data picture.

## CBM Data Producers, Consumers, and Stewards/Brokers

The role of personnel or organizations who work with CBM data can be logically categorized into one of three categories:

Producer – concerned with the supply-side of long term storage data

Consumer – concerned with the demand-side of long term storage data

Steward/Broker – concerned with the receipt and cataloging of long term storage data

You are a *Producer* if you or your organization influences or produces CBM+ data. A producer is typically concerned with one or more things such as sensors, data buses, data acquisition systems, data representation, metadata, file formats, file transfers, at- or near-platform real-time actions, etc ….

You are a *Consumer* if you or your organization utilizes CBM+ data. A consumer is typically concerned with data from a specific platform or system (or from a group of platforms or systems) that has been collected over a period of time. The typical goal of a consumer is to perform RCM analysis on a body of collected CBM+ data.

You are a *Steward/Broker* if you or your organization is responsible for providing the infrastructure necessary to facilitate the receipt and disbursement of files that contain CBM+ data. The typical goal of a Steward is to receive data files, parse and catalog the metadata, provide long-term storage, and provide the ability for RCM Analysts to access the long-term file storage and selectively query for file(s) that meet a certain criteria.

The roles of producer and consumer are logically divided but their missions are irrevocably coupled. Design decisions made by data producers have a direct impact on the mission of data consumers. Likewise, analysis decisions performed by data consumers will impact the mission of data producers.

In an ideal situation both producers and consumers are represented and work together from platform inception to fruition. In some cases the platform in question will be a new design. In other cases it will be a retrofit project for an existing platform. No matter the case it is important that both producer and consumer concerns are addressed.

depicts a high-level notional activity diagram for a PM tasked with a CBM+ Feasibility exercise.

The vast majority of CBM implementations that are currently being implemented or that will be implemented over the next five years are upgrades to existing platforms. CBM had no influence on the current platform which means that PMs must assess the situation, determine what needs to be accomplished, formulate an implementation plan, decide how best to use what is available, and move ‘smartly’ forward with the resources that they have.

The red star in the Bravo *Operations & Support* section of the Platform Life Cycle Framework (CBM) shown in is a visual indicator of the current life cycle location of most CBM projects.



Figure ‑ CBM Implementation Activity Flow (Post-CBM)



Figure ‑ Platform Life Cycle Framework (CBM)

## What CBM Data to Collect

The decision of what and how often to monitor often comes down to a platform specific list of tradeoffs.

A major consideration is that of *what* to monitor. Platform systems that are critical to platform operation or safety should be given priority over those that are not. Remember that many component and subsystem failures have acceptable consequences. Run-to-failure can be a viable maintenance strategy when you consider the cost of maintenance vs. the replacement cost. Secondary to platform safety and operation data collection priority should be given to platforms and platform subsystems that require expensive, lengthy, or difficult repairs when they fail.

Another consideration is *how often* to monitor. Monitor too much or too often and the amount of data produced could become unmanageable or too much for the DAQ system to store causing potentially valuable data to be lost. Monitor too little or too infrequently and the data produced may not provide sufficient information for effective RCM analysis. The correct balance lies somewhere in the middle and lends itself to being a “Top-Down” producer/consumer collaborative effort.

One of the initial steps in the implementation of CBM+ on any platform should be a collaborated effort between the producer and consumer to identify what data is required and the frequency needed to satisfy analysis requirements.

As of the publish date of this primer no central governing document exists that defines what has to be monitored for a given platform or what data has to be collected and transmitted to a central location for long term storage.

# 

# CBM Files and Messages

is a CBM specific version of and provides context for each of the condition assessment processing blocks.

Figure ‑ OSA-CBM Construct

Note that the output of the Data Acquisition (DA) and Data Manipulation (DM) blocks is Files and that the output of State Detection (SD) and Health Assessment (HA) is Messages. A discussion of the output of the Prognostics Assessment (PA) and Advisory Generation (AG) blocks is platform specific and beyond the scope of this document.

## Platform Start-Up

A CBM session is defined as starting when the platform powers-up the Digital Source Collector (DSC) and ending when the platform powers-down the DSC. The time-span of a CBM session will vary depending on the platform but can range anywhere from minutes to months.

When a platform is started the on-board DSC initializes a raw data file with information that uniquely identifies the platform and the sensors in its network.

## Platform Run-Time

The DSC collects, processes, and stores data in real-time during a CBM session.

Raw data collected from sensors is stored by the DSC. The DSC also processes and manipulates the data that it receives and performs real-time analysis in order to detect actionable events and faults. The result of this real-time analysis is platform dependent. For example, a low fuel pressure reading might cause a warning indicator to light on a manned vehicle, an audible warning alarm on an unmanned platform, and/or messages that are annotated with the name of the file that contains the sensor data responsible for generating the event to be sent through different channels of the Common Logistics Operating Environment (CLOE). It is anticipated that platform messages that utilize the CLOE will provide real-time logistics information that will be used to help ensure the on-time delivery of fuel, to place parts orders, to initiate maintenance work orders, et al.

## Platform Shut-Down

When the platform is shutdown the DSC file is closed and one last platform event message is created that captures all the usage data from the CBM session and any associated re-supply requests.

## Platform to Digital Logbook Data Transfer

The download to the digital logbook replaces the traditional method of manually writing information in a paper logbook. Manual entry would still be possible and could be used to document maintenance items that result from a visual inspection.

Collected data files and messages are transferred to a digital logbook as is notionally shown in . At this point both the content and format of the DSC data file(s) and messages is platform specific. Raw DSC data lacks context. A common requirement is that the raw data and messages must be translated into a standardized format that contains sufficient metadata for context. How and where the raw DSC data is processed into a CBM data file or message and what information is extracted from it is platform dependent.

The key requirement is that all files and messages be in a format that complies with established Army standards. Depending on the make, model, and version of the digital logbook the format may be text, XML, CDF, CIMS, or other. The main goal is to achieve functional interoperability across the enterprise. Remember … vendor lock-in BAD … data interoperability GOOD.

## At-Platform Analysis

Data files and messages that have been downloaded from a platform onto a digital logbook provide an operator / maintainer with the ability to perform at-platform CBM analysis (near real-time).

The at-platform CBM analysis (near real-time) could possibly handle historical trending, track work orders, provides IETM, and general support requiring more computing power and storage space. It is expected the DLB will produce additional CBM files and messages. For example suppose the historical trending shows a trend towards a component failure. That analysis could generate a predicted fault message, a time to fail message, a work order, a parts request, and an abbreviated CBM file with the historical sensor data for future analysis.

Exceedance

Exceedance Message

This situation illustrates the will require that data and messages priority

### CBM Files

CBM data files result from processing raw DSC data files into a workathat contains the appropriate metadata for context and that has been processed into a standarzied a Data that is collected during a CBM session is transferred to a digital logbook as notionally shown At this point both the content and format of the file is platform specific and must be processed into useful information. Speaking is general terms In order for useful of the The digital logbook will provide the ability to process the raw data to check for store the raw data file At some point this It is expected that the collected data will be downloaded from the DSC and stored into a computer file (.txt … .xml … .cdf (abcd) … CIMS) all All three Processing and manipulation may result in an exceedance or other

### CBM Messages

1) The message would be from the levels above the DA level of the OSA-CBM.

2) The message size, while an upper size limit has not been defined, messages should not be in the 100K range.

3) The message could contain a time series data stream, OSA-CBM DA level. The time series should be limited to only those pieces of data supporting the event/fault message.  (Example: Only 5 channels out of a 100, 5 minutes prior to the event/fault.)

4) The message can exist in the DBMS without serious 'BLOB' or 'XLM' overhead, where the file would only have a pointer and facts about the file stored in the DBMS.

5) The message can have many recipients, (Supply, Maintenance, Planner, Enterprise), where the file main recipient would be the LOGSA Common CBM Data Warehouse.

## Upload From Digital Logbook to Battalion Server

The upload to the next enterprise level would actually begin the transmission of CBM files and messages through the logistic domain. The priority message would be to the Mission Planners so that they know the mission status of the platform. The work order and parts requests would go next since they are the activities that will restore then platform back to ‘fully mission capable’ status. The fault messages should go next since they are small and fast to transmit. Finally the partial and complete CBM files would be transmitted providing that there is sufficient transmission capability. There is an implied warning that all messages and files may not make it off the platform, logbook or other staging points. If the transmission capability is limited and storage space becomes an issue something will have to give. It is imagined that would happen in inverse portion to the message or files priority.)

upload the CBM files and messages to the next level.

## Battalion Server Processing

Different parts of the Army enterprise, fuel, parts, performance monitoring (warranty), CBM warehouse, LCMC specific warehouse(s).

## Long Term Storage and Retrievel

When the CBM messages and files reach the CCBMDW they would start to be re-assembled into the complete CBM session profile. External data, (weather, location, etc) would be joined to the CBM session profile to provide the complete picture to the enterprise analyst or engineer. The CBM messages and files would be further merged to profile fleet operating and performance metrics to the interested LCMC, enterprise analyst or engineer. There job would be to determine platform improves, like the one at the beginning of the example,) and to prove better CBM+ tools for the operator/maintainer.

A producer is ultimately responsible for providing the data that is used by operators, maintainers, and analysts. The following narrative provides a re are many steps between the decision to upgrade a platform to produce CBM data and + and providing

Need to define how messages and files are re-connected at the CBM Data Warehouse to provide a complete picture of the platform during the CBM session.

Need to define how messages and files are re-connected at the CBM Data Warehouse to provide a complete picture of the platform during the CBM session.

## Implementation Example

Let’s take a possible CBM implementation and discuss the files and messages that the conversion from an analog control panel to a digital version. The new digital version will provide the operator/maintainer with the same basic information, but it will be able to provide CBM advisories, prognostic and health assessments.



Figure ‑ Implementation Overview

# CBM and CBM+ Tools

## Machinery Information Management Open Systems Alliance (MIMOSA)

The query functionality of the CCBMDW is facilitated through the use of a standardized set of metadata tags. ~~Metadata is “data about data”. For example, not only does a digital photograph stored in the .jpg format contain the information required to render the image (i.e. the data), it also contains optional sections that contain information such as the time and date that the picture was taken (i.e. the metadata).~~

The Machinery Information Management Open Systems Alliance Open System Alliance (MIMOSA-OSA) defines a standard set of identifiers and naming conventions that are used as metadata tags. Collectively the defined metadata tags form a controlled library of identifiers that standardize the vocabulary of platform data. The success of both producers and consumers requires that both conform to the controlled library of metadata tags.

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### Compliance

CCBMDW MIMOSA compliance is defined as the ability for the CCBMDW to open and parse any given CBM+ file without encountering an error caused by an unknown MIMOSA tag.

|  |
| --- |
| 2011.08.07 Chris: CLOE Compliance … i.e. This Section Needs to be Moved to ??? … talk to Bruce Murphy |

### Common Information Management Service (CIMS)

The Common Information Management Service (CIMS) is based on a Service Oriented Architecture (SOA) and is at core of the Army’s Threshold Capability Implementation (TCI) effort.

The purpose of the CIMS is to provide net-centric Local Data Base (LDB) data repository capabilities that support analytical methods for predictive maintenance and anticipatory logistics. The LDB supports a range of data types, from equipment sensor data to Item-Unique Identification along with many types of historical data and failure records. The data is used by different systems and diverse communities of users to improve equipment reliability, maintainability, and operational availability.

The CIMS empowers information sharing across the enterprise to collaborate on event resolution in support of the Army Integrated Logistics Architecture (AILA) and the Common Logistics Operating Environment (CLOE). Sustainment service interfaces, including Logistics interfaces, facilitate interoperability across the Army domain. The CIMS manages and governs the service interfaces and enables integration between the LDB and the rest of the war fighter services, logistics business services, and applications.

The functionality of CIMS is provided through its interface to the Global Combat Support System -Army (GCSS-Army)

*Source: Common Logistics Operating Environment (CLOE), Family of Systems (FoS) Component of the Army Integrated Logistics Architecture (AILA), CLOE SV-11, Common Information Management Service (CIMS), Interface Design Document (IDD), Version 1.4, Document Number: C1018-01-0005 , Document Date: 17-December-2010*

LOGSA and the Logistics Innovation Agency (LIA) are working together to define services to facilitate the transfer of CBM files and messages. A large part of the effort is focused on Information Assurance (IA) and audit trails (chain-of-custody).

|  |
| --- |
| CIMS uses MIMOSA codes |
| How do I talk to LIA G-Army? (define business processes) |

### Data Field Identification

#### Units of Measure

English/Metric (miles/km, degF/degC)

Inches / Feet

#### Consistent Representation

Naming conventions (sensors and data)

Data Types (Boolean, Integers, Floating Point, etc)

TF 10 tf YN yn, etc.

Time Series

## Common CBM Data Warehouse (CCBMDW)

The Common CBM Data Warehouse (CCBMDW) is the linchpin that connects producers and consumers. Data from producers is stored in the CCBMDW and consumers access the CCBMDW to retrieve data for analysis.

CBM+ files operate in much the same way. For example, not only does a properly formatted CBM+ file contain raw data from one or more sensors (i.e. the data), it also contains information such as the time, date, and platform (i.e. the metadata).

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### CBM Enterprise Metadata Layer

### Enterprise Asset Management Registry (EAMR)

The Enterprise Asset Management Registry is the authoritative source of all MIMOSA identifiers needed to catalog and store CBM results resulting with non-intrusive testing, visual inspection, embedded sensors and performance data for top end items and serialized components. It is maintained by LOGSA and is accessible by a user interface, short-term, and the LOGSA enterprise service bus, long-term.

The MIMOSA identifiers for top end items (tanks, trucks, generators, aircraft) that the EAMR will publish to the Army have already been incorporated into the PFSA warehouse and used by both TACOM and AMCOM in the research and development efforts.

In addition EAMR will provide tools to manage what top end items and major components are tracked in the CCBMDW. Borrowing from PFSA’s Prospective Based Analysis the tool set will allow Army commands to select what serialized components they want to focus on. This would be a feed to the MIMOSA table asset\_on\_segment which is key to the LIA TCI SV-11 patterns design.

LIA plans on using the MIMOSA asset\_on\_segment to join the top-level end item to the CBM serialized components. To do this the EAMR process will have to pull data from a variety of sources.

## LOGSA File Transfers (LOGFERS)

LOGSA's file transfer system is the Logistics Support Activity Transfer System (LOGFERS). It is a suite of programs designed to move data files to and from remote systems/locations and LOGSA systems. LOGFERS is the replacement for the Mainframe / Mid-tier Interlink Data Access System (MIDAS).

LOGFERS can connect to Army sites, other military sites, and commercial locations. Files will be transferred via Secure FTP (SFTP) by default unless there is a specific reason why FTP needs to be used. SSH keys are used for secure connections. File transfers are automated, scheduled, and constantly monitored. When required, LOGFERS can rename, compress, move or copy files. Transfers are made on the Non-Classified (But Sensitive) Internet Protocol Router Network (NIPRNET). LOGFERS is not available for transfer of classified data on the SIPRNET or between the NIRPNET and SIPRNET.

To establish a LOGFERS transfer a Memorandum of Agreement (MOA) must be in place between LOGSA and the appropriate Army command or agency. The LOGSA functional user then needs to submit a Engineering Change Proposal (ECP) to set up the LOGFERS account(s).

## Bulk File Handler (BFH)



Figure ‑ Bulk File Handler Process Flow

Bulk File Handler (BFH) is the name of the LOGSA software package that receives, stores, and serves CBM files. Figure 4-3 shows the high level processing flow of the Bulk File Handler. The AR-750 box on the left is what occurs to meet the AR-750 requirement. It will register a CBM file, good or bad, (for all purposes this is a transaction.) If the CBM file follows the file naming guides, then the registration facts are of greater detail. If the file is of a format LOGSA understands even more detail is collected in the transaction.

If the file format is readable by LOGSA then LOGSA will validate the MIMOSA tags, and report any issues with the tags to a CBM functional. A file that makes it past this point is said to be “workable”

|  |
| --- |
| We need to define the process of how to be designated a “CBM Functional” |

NEED PM PRODUCERS AND CONSUMERS INPUT!

If the file is workable then LOGSA will start cataloging the CBM session and the CBM events into fact tables.



Figure ‑ CBM Data Flow

This Figure illustrates the cyclic flow of data in the CBM process.

Explanation

## File Formats

Proprietary solutions are the enemy of interoperability. In what has become an unfortunate but time honored Army tradition vendors often create proprietary solutions that are interoperable only with their other proprietary solutions (if you are lucky) and that produce proprietary data. As more than one PM can attest what often starts out as a relatively inexpensive and quick solution turns into a lifecycle of expensive “vendor lock-in” misery.

Open standards are the foundation of interoperability.

The ultimate goal of collecting CBM+ data is to store it into a standard format and transmit it to a national repository where it will be catalogued and stored for later analysis. Non-standard data file formats are the enemy of efficiency. In some cases a non-standard data format could render the entire data collection useless. Data that cannot be read or comprehended is not beneficial. The Army has commissioned the creation of several best practices that provide CBM file identification and data field identification guidelines.

### Common Data Format (CDF)

Designed by NASA, Common Data Format[1] (CDF) is a conceptual data abstraction for storing, manipulating, and accessing multidimensional data sets. The contents of a CDF fall into two categories: data and metadata. Data in a CDF is a series of records comprising a collection of variables consisting of scalars, vectors, and n-dimensional arrays. Metadata in a CDF is a set of attribute entries that describe the data contained in the CDF. Originally designed to store and manipulate extremely large data sets, CDF lends itself well to storing and manipulating CBM data.

A set of utility programs is provided with the CDF distribution that provides the capability to perform a variety of operations on CDFs without having to write an application program. CDF is provided free-of-charge and can be found at <http://cdf.gsfc.nasa.gov/>.

### Army Bulk CBM Data (ABCD)

The Army Bulk CBM Data (ABCD) file specification was developed to address the interoperability needs of the CBM community for parametric/sensor data.

An ABCD file is a CDF File that uses standardized MIMOSA tags to describe the CBM data as well as the CBM Data File that contains it. ABCD is the standardized fusion of CBM data and its corresponding metadata into a CDF file. ABCD is the preferred CBM data packaging mechanism of the United States Army.

ABCD files are the result of CBM data being packaged into a CDF file in accordance with the ABCD File Specification. The ABCD File Specification is maintained by the Data and Information Standards Center of Excellence (DISCoE).

The contents of a CDF file fall into two categories:

* A series of records that comprise a collection of variables that consist of scalars, vectors, and n-dimensional arrays
* A set of attribute entries (metadata) that describes the CDF in global terms or for a specific single variable.

The dual functionality of CDF provides "data set independence." Both metadata (attributes) and data (variables) are combined into a single integrated data set.

The ABCD file specification requires specific global and variable level MIMOSA metadata be written into a CDF file. The figure below shows the overall conceptual file structure of an ABCD file.

|  |
| --- |
| Gene: Where is Time-Series??? |

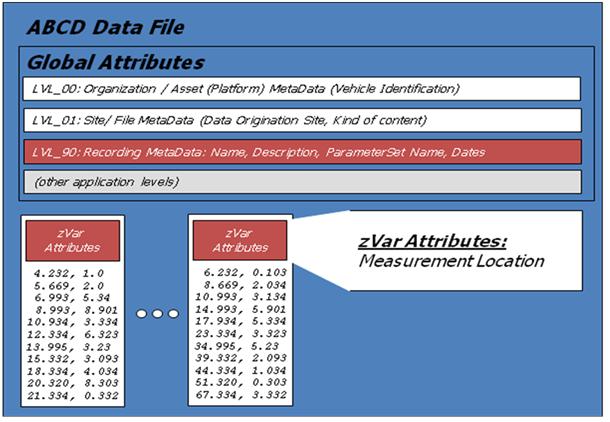


Figure 5-4 ABCD File Conceptual Structure

#### User Data

|  |
| --- |
| Gene: “User Data” |

CDF's "variable" is a generic name for an object that represents data, and it does not have any scientific context associated with it. For example, a variable can be data representing an independent variable, a dependent variable, time and date value, or whatever data might be (e.g. image, XML file, etc.). In other words, the variable doesn't contain any hidden meanings other than the data itself.

A variable or one variable's relationship with other variable(s) can be described through "attributes". The dimensionality of a variable depends upon how the data is specified by the user. For scalar data, as an example, the array of values would be 0-dimensional (i.e., a single value), whereas for image data the array would be 2-dimensional. Similarly, the array for volume data would be 3-dimensional. CDF allows users to specify arrays of up to ten dimensions. The array for a particular variable is called a "variable record." A collection of arrays, one for each variable, is referred to as a "CDF record." A CDF can, and usually does, contain multiple CDF records.

Two types of variables may exist in a CDF: rVariables and zVariables. ABCD compliance requires the use of zVariables as they are more efficient in terms of storage and offer more functionality than an rVariable. An ABCD file will normally contain many zVariables, each of which can contain scalar values or multi-dimensional arrays.

It is important to note that there is no single "correct" way to store data in a CDF. The user has complete control over how the data values are stored in the CDF depending on how the user views the data. This is the advantage of CDF. Data values can be organized in whatever way makes sense to the user.

#### Metadata

While CDF’s variable is a mechanism for storing/representing data, CDF’s “attribute” is a mechanism for describing the CDF file and the individual CDF variables in the file. There are two types of attributes in CDF: global attributes and variable attributes. Global attributes are used for describing the CDF file and variable attributes are used for describing individual variables. Examples of global attributes would include such things as file creation date, file author, source of data, and data set documentation. Examples of variable attributes would include such things as a field name for the variable, the valid minimum and maximum, the units in which the variable data values are stored, the format in which the data values are to be displayed, and a fill value for errant or missing data.

The ABCD file specification makes use of both global and variable attributes.

Time series Data that is Representation of Time-series data a decision would almost certainly be

|  |
| --- |
| What does it mean to be “ABCD Compliant”? … Ans: “Workable” |

### Extensible Markup Language (XML)

Abbreviated XML, Extensible Markup Language is not a language … yada yada yada …

## Logbook

Analyze Data

Flag Exceedances

## PowerLog-J

PowerLog-J has a blurb in Appendix B: Glossary … but it needs to be talked about in the body of this document … is this the right place?

# CBM and CBM+ Processes

|  |
| --- |
| CLOE / LOGSA Compliance |

Among the more obvious avoidable pitfalls that a CBM+ data producer could face would be discovering that an as-built platform did not monitor what is necessary to provide data that is useful and/or required for purposes of RCM analysis. There are other less obvious pitfalls, such as data ownership issues, units-of-measure disagreement, and file format misalignment to only name a few, that could delay or even stop the implementation of CBM+ on any given platform.

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| TODO: Project Plan Outline (reference Figure 3‑9 CBM Implementation Activity Flow (Post-CBM)) |

## Memorandum of Agreement with LOGSA

A Memorandum of Agreement (MOA) must be in place between LOGSA and any entity external to LOGSA before CBM+ data files will be accepted (from producers) or served (to consumers).

## Adding a Platform to CCBMDW

* CBM+ Identifier Synchronization (MIMOSA/NIIN/et al)

### New Platform

### Existing Platform

## Platform Data Collection

Applying sensors to and acquiring data from a platform is not new science. Leveraging existing work done by those who have gone before you will save substantial amounts of time and money. Choosing to adhere to a nationally recognized standard, recommended practice or guideline is the first step toward implementing CBM+.

### Sensors

Depends on what needs to be monitored (List of approved sensors?)

Prior experience … repair and parts data (history)

Quantify sensors that can provide needed information

Considerations: Addressing / Analog / Digital / Timing Requirements

Naming conventions for placement/orientation

### Data Bus and Messaging Recommended Practices

An important goal of collecting sensor data is to

|  |
| --- |
| https://lia.army.mil/cloe/CBM.htm : CBM+ Data Exchange … “Platform”] J1708, J1939, 1553 busses are shown |
| POC: Data and Information Standards Center of Excellence (DISCoE) |

#### SAE RP J1708

*Serial Data Communications Between Microcomputer Systems in Heavy-duty Vehicle Applications* (SAE J1708) defines a recommended practice for implementing a general-purpose bi-directional serial data communications link among modules containing microcomputers. Serial link parameters that relate primarily to hardware and basic software compatibility such as interface requirements, system protocol, and message format are covered.

SAE J1708 works in conjunction with SAE J1587. One way to understand the relationship between J1708 and J1587 is to think of J1708 as providing guidance on hardware and *message format* while thinking of J1587 as providing guidance on software and *data format*.

#### SAE RP J1587

*Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Application* (J1587) defines a recommended practice for regulating the communication and standardized data exchange between Electronic Control Units (ECU) in J1708 networks. Format of messages and data that is of general value, such as field descriptions, size, scale, internal data representation, and position within a message are covered. Also covered are recommended formats for basic vehicle and component identification and performance data.

J1587 is intended to be used with SAE J1708 which defines the requirements for the hardware and basic protocol that is needed to implement this document. It is anticipated that this document (when used in conjunction with SAE J1708) will reduce the cost and complexity associated with developing and maintaining software for heavy-duty vehicle microprocessor applications.

#### SAE RP J1939

*Recommended Practice for a Serial Control and Communications Vehicle Network* (J1939) is designed to replicate the functionality of J1708/J1587. Based on the automotive industry standard Controller Area Network (CAN) J1939 is a higher level protocol that defines a recommended practice for an open interconnect system for electronic systems. Requiring only 2 wires CAN is easily implemented and provides extremely reliable communication.

J1939 utilizes the extended CAN (2.0B) message frame which uses a 29-bit message identifier which consists of the 2.0A 11-bit base identifier) plus an 18 bit identifier extension.

J1939 is actually a collection of more than a dozen individual documents. For all practical purposes the only documents needed to understand the protocol are J1939-21 (Data Link Layer) and J1939-81 (Network Management).

#### ATA TMC RP1210B

The RP1210 specification was developed as a “Recommended Engineering and Maintenance Practice” by the Technology & Maintenance Council (TMC) of the American Trucking Association (ATA). The purpose of RP1210 was to create a standardized API for communication between vehicle ECUs and a PC using a flavor of Microsoft Windows as operating system. This standard makes it possible for third party companies to develop and sell the hardware interface needed between the PC and the ECU which is connected to a onboard communication bus (i.e. CAN).

### Existing Data Acquisition Systems

TACOM VHMS

## From Platform Data to File Creation

### Potential Data Issues

Data Rights – who owns data?

Protecting proprietary information

#### Data Ownership

Text

#### Data Stewardship

Business Rules – Who defines them, Who can change them

* LOGSA
  1. File Transfers
  2. CBM Enterprise Repository
* Business Rules
  1. Data retention (if model xxx is no longer in use should CCBMDW delete data?
* Cataloging Data
* Data Manipulation

Another area that greatly benefits from producer consumer collaboration is that of data representation standardization. Two important topics in this area are the format of collected data and time-series representation.

It is doubtful that a producer working without input from a consumer would make the decision to represent engine RPM data as an 8-byte double-precision floating-point number. And even if they did such a decision would not warrant bringing production to a halt. However, such an easily avoidable mistake could be costly over the life of the platform in terms of files sizes and bandwidth. Standard data types and their typical uses are explained in section X.Y.

Units of Measure (English/Metric, ounces/pounds, inches/feet, TF 10 tf YN yn, etc)

Time Stamps (standard way of representing time)

EAMR

## Data Access

text

## Business Rules and Processes

### Auto-Transmit Rules

### Business Rules: File Retention / Aging / Purging

# Active CBM+ Programs

## Communications-Electronics Command (CECOM)

CECOM SV-11 Physical Schema will be used to identify CECOM CBM+ data Cataloging Requirements working with LOGSA

|  |
| --- |
| Is CECOM SV-11 available? |

Failure Analysis Tools / Methodologies:

* PHM Prognostics Health Monitoring
* FMECA Failure Mode Effects and Criticality Analysis
* Pareto Analysis

Selected Systems:

* MEP-805B Tactical Quiet Generator (TQG)
* CPP Rigid Wall Shelter (RWS) DC Power Supply
* CPP RWS Environmental Control Unit

Developed failure analysis for ea subsystem based on field failure data as captured in:

* Previous work
* Technical manuals
* Engineering expertise

### System Objectives

The CECOM Logistics and Readiness Center (LRC) is conducting an Early Operational Assessment (EOA) on implementing CBM+ in the field to monitor operational conditions on identified systems, providing real-time useful and actionable knowledge to operators and maintainers through active system monitoring. This includes the collection of operation anomalies, and the transmission of CBM+ messages and CBM sensor files to the LOGSA for storage in the CCBMDW on a regular basis. The CCBMDW will receive and register the CBM data, and will furnish CBM data to CECOM authorized agents on request for analysis. The CECOM agents will transmit cleansed CBM data files and analyze the results to the CCBMDW storage.

### Exclusions

To be determined

### Stakeholders

* CECOM LRC Mr. David Pack / Pam Ludwig
* CECOM SEC
* CERDEC
* LOGSA CBM Mr. Christopher Booth
* LOGSA PFSA Mr. Shawn Howard
* AMSAA TBD

|  |  |
| --- | --- |
| **Point of Contact: CECOM** | |
| Name | Pam Ludwig |
| email |  |
| phone |  |

## Tank-Automotive and Armaments Life Cycle Management Command (TACOM)

Using ABCD



Figure ‑ TACOM CBM+ Pilot (FY12-13)

|  |  |
| --- | --- |
| **Point of Contact: TACOM** | |
| Name | Steve Colley |
| email |  |
| phone |  |

## Aviation and Missile Life Cycle Management Command (AMCOM)

Not using ABCD

|  |  |
| --- | --- |
| **Point of Contact: AMCOM** | |
| Name |  |
| email |  |
| phone |  |

## Army Depots

Description

|  |  |
| --- | --- |
| **Point of Contact: Army Depots** | |
| Name |  |
| email |  |
| phone |  |

## Army Materiel Command (AMC)

Description … CBM + IPTs

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| --- | --- |
| **Point of Contact: AMC** | |
| Name |  |
| email |  |
| phone |  |

## Platform PMs & PEOs

Description

|  |  |
| --- | --- |
| **Point of Contact: Platform PMs & PEOs** | |
| Name |  |
| email |  |
| phone |  |

## Communications-Electronics Research, Development, and Engineering Center (CERDEC)

Description

|  |  |
| --- | --- |
| **Point of Contact: CERDEC** | |
| Name |  |
| email |  |
| phone |  |

## Logistics Support Activity (LOGSA)

AV-1 / OV-1

The goal of Common CBM Data Warehouse is to develop and maintain the single Army database repository for RCM data (to include CBM data) as directed by AR 750-1 • 20 September 2007.

The objectives of the Army Material Command’s (AMC) Common CBM Data Warehouse initiative are:

* Using NASA’S Common Data Format (CDF) technology and working with the Logistics Innovation Agency (LIA) and AMCOM Software Engineering Directorate (SED) Data and Information Standards Center of Excellence (DISCOE) develop a standard Army Bulk CBM Data file (ABCD) that incorporates Machinery Information Management Open Systems Alliance (MIMOSA) field tags.
* Construct the Army’s MIMOSA Repository that will contain the MIMOSA values and definitions that have been approved by the Army’s MIMOSA Governance Committee or under consideration.
* Construct the CBM Enterprise Asset Management Registry that will contain the Army’s CBM assets and their platform component breakdown structure that relates to the Digital Source Collector (DSC) to component mappings.
* Construct a Common CBM Data Warehouse (CCBMDW) that will accept CBM files and messages to be housed as part the AMC LIW.
* Provide a cataloging service that will allow System Life Cycle Managers, Combat and Material Developers and others to identify and retrieve CBM files using the LOGSA Enterprise Service Bus.



Figure ‑ LOGSA \_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Point of Contact: LOGSA** | |
| Name |  |
| email |  |
| phone |  |

## Logistics Innovation Agency (LIA)

The Army G-4 established the Army Integrated Logistics Architecture (AILA) as the overarching logistics architecture for the logistics domain.

LIA is the Executive Agent for developing the AILA.

Proponent of AILA

LIA is managing the development of the Common Logistics Operating Environment (CLOE).

LIA CBM Implementation Guide

CBM+ is the maintenance component of CLOE

The CLOE consists of the synchronization of logistics and command and control (C2) information systems that automatically produce, consume and propagate a common sustainment picture in near-real time from "foxhole to factory. The CLOE is defined by data standards and an overarching logistics integrated architecture that ensures interoperability and net-centricity. It fuses information, logistics processes and platform/Soldier embedded sensor-based technologies to support the tactical, operational and strategic sustainment levels in a joint operating environment.

...sets common data standards, specifications, and protocols necessary for an integrated platform, information, and C3 technologies for use in the Objective Force [now Future Force] logistics sustainment.. It is termed an "operating environment" even though it is not in itself an information system. The CLOE operating environment extends to all equipment platforms used in the Objective Force, including ground combat, ground support, aviation, and watercraft.

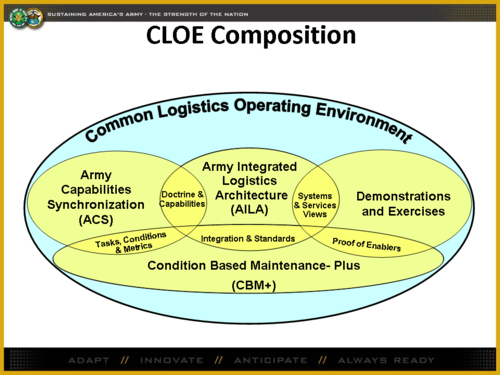


Figure ‑ CLOE Composition

Figure ‑ New CLOE Overview

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| --- | --- |
| **Point of Contact: LIA** | |
| Name |  |
| email |  |
| phone |  |

## Army Materiel Systems Analysis Activity (AMSAA)

AMSAA conducts systems and engineering analyses to support decisions on technology, materiel acquisitions, and the designing, developing and sustaining of weapon systems.

|  |  |
| --- | --- |
| **Point of Contact: AMSAA** | |
| Name |  |
| email |  |
| phone |  |

## Pennsylvania State University Applied Research Laboratory

Description

|  |  |
| --- | --- |
| **Point of Contact: Pennsylvania State University Applied Research Lab** | |
| Name |  |
| email |  |
| phone |  |

## Research, Development and Engineering Command (RDECOM)

Description

|  |  |
| --- | --- |
| **Point of Contact: RDECOM** | |
| Name |  |
| email |  |
| phone |  |

## GCSS-Army

Description

|  |  |
| --- | --- |
| **Point of Contact: GCSS-Army** | |
| Name |  |
| email |  |
| phone |  |

## OEM

Description

|  |  |
| --- | --- |
| **Point of Contact: OEMs** | |
| Name |  |
| email |  |
| phone |  |

## Platform / At-Platform

Description

|  |  |
| --- | --- |
| **Point of Contact: Platform / At-Platform** | |
| Name |  |
| email |  |
| phone |  |

Appendix A: Acronyms

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| **ACRONYM** | **Meaning** |
| ABCD | Army Bulk CBM Data |
| AILA | Army Integrated Logistics Architecture |
| AMC | Army Materiel Command |
| AMCOM | Aviation and Missile Command |
| AMSAA | Army Materiel Systems Analysis Activity |
| ARSNT | Army Serial Number Tracking |
| BFH | Bulk File Handler |
| CAISI | CSS Automated Information Systems Interface |
| CAN | Controller Area Network |
| CBM | Condition Based Maintenance |
| CBM+ | Condition Based Maintenance Plus |
| CCBMDW | Common CBM Data Warehouse |
| CCBMER | Common CBM Enterprise Repository |
| CDF | Common Data Format (NASA) |
| CECOM | Communications and Electronics Command |
| CIMS | Common Information Management Service |
| CLOE | Common Logistics Operating Environment |
| CRIS | Common Relational Information Schema |
| CSS | Combat Service Support |
| DISCoE | Data and Information Standards Center of Excellence |
| DISR | DoD Information Technology Standards Registry |
| DSC | Digital Source Collector |
| DoDAF | Department of Defense Architectural Framework |
| EAI | Enterprise Application Integration |
| EAMR | Enterprise Asset Management Registry |
| ECC | Equipment Category Code |
| ECU | Electronic Control Unit |
| GCSS-A | Global Combat Support System - Army |
| HUMS | Health and Usage Monitoring System |
| JLTV | Joint Light Tactical Vehicle |
| LIA | Logistics Innovation Agency |
| LIW | Logistics Information Warehouse |
| LOGSA | Logistics Support Activity |
| MIMOSA | Machinery Information Management Open Systems Alliance |
| NIIN | National Item Identification Number (9 digit) |
| NSN | National Stock Number |
| OPSEC | Operations Security |
| OSA | Open System Architecture |
| OSA-EAI | OSA for Enterprise Application Integration |
| PFSA | Post Fielding Support Analysis |
| PM | Program Manager |
| PMCS | Preventative Maintenance Checks and Service |
| POSIX | Portable Operating System Interface for Unix |
| RCM | Reliability-Centered Maintenance |
| SALE | Single Army Logistics Enterprise |
| SAMS-E | Standard Army Maintenance System Enhanced |
| SED | Software Engineering Directorate |
| SHARC | System Health And Reliability Computer |
| STAMIS | Standard Army Management Information System |
| TACOM | Tank and Automotive Command |
| TCI | Threshold Capability Implementation |
| USAMC | U.S. Army Materiel Command |

Appendix B: Glossary

|  |  |
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| **Army Bulk CBM Data (ABCD)** – A file based upon the National Aeronautics and Space Administration (NASA) Common Data Format (CDF) that follows the ABCD guidelines. The ABCD file guidelines integrate the Machinery Information Management Open Standards Alliance (MIMOSA) metadata into the CDF scalar and/or multidimensional data. The ABCD file guideline allows for future extensibility in terms of the metadata needed for any specific application. | |
| **Army Materiel Systems Analysis Activity (AMSAA)** - Is an analysis organization of the United States Army. AMSAA's overall goal is to provide soldiers with the best U.S. Army materiel possible. AMSAA supports the U.S. Army by conducting systems and engineering analyses to support decisions on technology, materiel acquisitions, and the designing, developing and sustaining of U.S. Army weapon systems. | |
| **Bulk File Handler (BFH)** - An external semi-intelligent physical storage application, that handles the actual storage of the CBM files. It eliminates the overhead costs and restrictions of inserting, storing and extracting bulk files into a database system. The BFH is scalable from the enterprise level down to a battalion server. The BFH is designed to run on both UNIX and Microsoft operating systems. The BFH is capable of working with different relational database systems. | |
| **Condition Based Maintenance (CBM)** - a proactive equipment maintenance capability that uses system sensor-based health indications to identify and predict functional failure in advance of the event and provides the ability to take appropriate action. CBM is based on a set of rigorously defined maintenance tasks derived from Reliability Centered Maintenance (RCM) analysis. The building blocks in the development of CBM capabilities are a collection of data on the platform, movement of data off the platform, storing the data in a data warehouse, analyzing the data and acting on the data. CBM has the potential to provide the Army unprecedented visibility of its systems. | |
| **Condition Based Maintenance Plus (CBM+)** - A proactive equipment maintenance capability enabled by using system health indications to predict functional failure ahead of the event and take appropriate action. CBM+ is the Maintenance component of CLOE. | |
| **Common Condition Based Maintenance Data Warehouse (CCBMDW)** – The single Army database/repository for Reliability Centered Maintenance (RCM) data (to include CBM data) as directed by AR 750-1, 20 September 2007. | |
| **Common Data Format (CDF)** - It is a conceptual data abstraction for storing, manipulating, and accessing multidimensional data sets. The basic component of CDF is a software programming interface that is a device-independent view of the CDF data model. The application developer is insulated from the actual physical file format for reasons of conceptual simplicity, device independence, and future expandability. CDF files created on any given platform can be transported to any other platform onto which CDF is ported and used with any CDF tools or layered applications. The CDF software, documentation, and user support services are provided by NASA and available to the public free of charge. There are no license agreements or costs involved in obtaining or using CDF. | |
| **Common Logistics Operating Environment (CLOE)** - The Army G-4's initiative to synchronize logistics concepts, architectures, organizations, and a new generation of technologies into an integrated, net-centric logistics domain. The CLOE documents the Army's logistics information infrastructure, from the weapon system up through the national level. It provides Soldiers, logisticians, and commanders with logistics situational awareness, substantially improved agility, effectiveness, and increased unit combat power. The ultimate goal is to enable operational commanders and logisticians at all levels to have total situational awareness within a common operating picture for all aspects of logistics, from factory to foxhole. At the same time, they will have a single set of interfaces to "business" processes such as calls for support, requisitioning an item from supply, in-transit visibility of equipment, and domain-wide total asset visibility that supports unity of effort and enables rapid, precise response across a wide range of military operations. These processes are described in the CLOE Operational Concept Descriptions (OCD) which detail the collection of essential logistics data from selected platforms/systems and passing it to key information collection and decision-making nodes within the unit or Brigade Combat Team. | |
| **Enterprise** - The corporate level of an organization, or the top organization structure of a non-profit or military body. Each Enterprise is associated with exactly one Enterprise Type. An enterprise uniquely registers/births Sites and may control one or more Sites (which could have formerly been controlled by other enterprises). In order for multiple enterprises to exchange MIMOSA information, every Enterprise must request and utilize its unique, unchanging MIMOSA-assigned Enterprise Unique Integration Code (Enterprise UIC) | |
| ~~J1587~~ | ~~Joint SAE/TMC - Electronic Data Interchange Between Microcomputer Systems in Heavy-duty Vehicle Applications~~ |
| ~~J1708~~ | ~~SAE - Serial Data Communications Between Microcomputer Systems in Heavy-duty Vehicle Applications~~ |
| ~~J1939~~ | ~~Recommended Practice for a Serial Control and Communications Vehicle Network~~ |
| **J1587 - oint Light Tactical Vehicle (JLTV)** – a joint (Army/Marine Corp) vehicle that will feature an open electronics architecture that will facilitate integration of future sensor, communications, and navigation systems (as they become available). | |
| **Joint Light Tactical Vehicle (JLTV)** – a joint (Army/Marine Corp) vehicle that will feature an open electronics architecture that will facilitate integration of future sensor, communications, and navigation systems (as they become available). | |
| **Logistics Management Information (LMI)** - This specification describes information required by the government to perform acquisition logistics management functions. The principal focus of this specification is on providing the DOD with a contractual method for acquiring support and support-related engineering and logistics data from contractors. The DOD uses this data in-house in existing DOD materiel management processes such as those for initial provisioning, cataloging, and item management. Data products intended primarily for in-house use by the contractor during his/her own design process or those developed internally by the DOD are beyond the scope of this document. Depending on specific program requirements, this information may be in the form of summary reports, a set of specific data products, or both. This specification identifies content requirements for information summaries and format requirement for data products. It may be used on all system/end item acquisition programs. The contractor may, and is encouraged to, suggest alternative means of satisfying requirements of this specification to make information more readily available and to utilize more efficient business practices. The mechanics of delivery (e.g., electronic data interchange, hard copy, etc.) are not within the scope of this specification and should be addressed separately. Data entry media, storage, and maintenance procedures are left to the contractor. | |
| **Logistics Information Warehouse (LIW)** - Provides a single, seamless logistics application to help the Army project and sustain the Force. LIW provides real-time logistics information in today’s web environment. | |
| **Logistics Support Analysis Record (LSAR)** - is intentionally structured to accommodate the maximum range of data potentially required by all services and all Integrated Logistic Support (ILS) element functional areas. This approach permits standardization of field lengths and Data Element Definitions (DED), and establishes “one face to industry” for government required LSAR data. However, LSA documentation must be tailored to each acquisition program and life cycle phase. The tailoring of LSAR data should be consistent with the level and depth of LSA performed In Accordance With (IAW) MIL-STD-1388-1 as required to readiness and affordability of the acquisition program IAW Department of DOD Directive (DODD) 5000.39. The general requirements of this standard also require completion of LSAR data selection sheets (DD Form 1949-1) to identify specific data for each program in order to prevent indiscriminate blanket applications of the data requirements. | |
| **Machinery Information Management Open Systems Alliance (MIMOSA)** - a not-for-profit trade association dedicated to developing and encouraging the adoption of open information standards for Operations and Maintenance in manufacturing, fleet, and facility environments. MIMOSA's open standards enable collaborative asset lifecycle management in both commercial and military applications. | |
| **National Stock Number (NSN)** – a 13-digit number assigned under the Federal Cataloging Program to each approved United States Federal Item Identification. The NSN consists of 4-digit Federal Supply Classification (FSC) and the 9-digit National Item Identification Number (NIIN). See SB 700-20 & DA] | |
| **Post Fielding Support Analysis (PFSA)** - a LOGSA "Re-engineering Logistics" initiative that was developed to improve communication and logistics support between the Army Program Executive Office (PEO), Program Managers (PM), and Major Subordinate Commands (MSC) communities for the Army combat systems. It provides a statistical method for tracking logistics metrics throughout the life cycle. PFSA uses data captured in field performance databases such as the Logistics Integrated DataBase (LIDB), acquisition databases, and other user-owned data sources. This data is used to create an analysis capability for PEO/PM, MSCs and field organizations to better manage and solve logistics and readiness problems. The PFSA itself keeps track of data availability and level of fidelity (fleet, organizational, serial numbered item) of the data to ensure related metrics and drilldowns are consistent. | |
| **PowerLOG-J** - a LOGSA acquisition logistics data management tool that satisfies requirements for the Logistics Management Information (LMI) and Logistics Support Analysis Record (LSAR). PowerLOG-J has over 5600+ registered users. It can be used to develop, evaluate, review, and integrate logistics data for materiel systems and generate logistics support summaries such as the Repair Parts and Special Tools Lists (RPSTL), Maintenance Allocation Chart (MAC), Task Analysis, Provisioning Technical Documentation, Bill of Materials, Failure Modes Effects and Criticality Analysis and more! There are 38 Reports in all. Technical Manual Reports meet MIL-STD-40051 formats. All reports have XML, HTML, and PDF outputs. PowerLOG-J can also produce exports in 2631 Formatted Work Packages and S1000D Data Modules. PowerLOG-J is designed to assist government agencies and their contractors in developing and integrating their supportability analysis data bases. It will load MIL-STD-1388-2B, 2A LSA-036, 2B, LSA-036, MIL-STD-1552 (PMR), 2361 MAC data formats. The primary purpose of this tool is Acquisition Logistics Data Management. | |
| **Reliability-Centered Maintenance (RCM)** - a process to ensure that assets continue to do what their users require in their present operating context. RCM is generally used to achieve improvements in fields such as the establishment of safe minimum levels of maintenance, changes to operating procedures and strategies and the establishment of capital maintenance regimes and plans. Successful implementation of RCM will lead to increase in cost effectiveness, machine uptime, and a greater understanding of the level of risk that the organization is presently managing. | |
| **Threshold Capability Implementation (TCI)** - an initiative to have a common (air and ground) implementation of CLOE in 2012. CLOE TCI will integrate, validate, and implement a set of threshold CLOE capabilities in the 2012 timeframe that support the initial fielding of Global Combat Service Support-Army (GCSS-Army), the Army’s Enterprise Resource Planning solution for logistics information technology. | |

Appendix C: Points of Contact

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Section** | **Organization** | **Contact** | **Phone** | **EMail** |
|  |  |  |  |  |
| 6.1 | CECOM |  | phone |  |
|  |  |  |  |  |
| 6.2 | TACOM |  |  |  |
|  |  |  |  |  |
| 6.3 | AMCOM |  |  |  |
|  |  |  |  |  |
| 6.4 | Army Depots |  |  |  |
|  |  |  |  |  |
| 6.5 | AMC |  |  |  |
|  |  |  |  |  |
| 6.6 | PMs & PEOs |  |  |  |
|  |  |  |  |  |
| 6.7 | CERDEC |  |  |  |
|  |  |  |  |  |
| 6.8 | CECOM |  |  |  |
|  |  |  |  |  |
| 6.9 | LOGSA | Christopher Booth | 256.888.8888 |  |
|  |  |  |  |  |
| 6.10 | LIA |  |  |  |
|  |  |  |  |  |
| 6.11 | AMSAA |  |  |  |
|  |  |  |  |  |
| 6.12 | Penn State |  |  |  |
|  |  |  |  |  |
|  | RDECOM |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Appendix D: Bibliography

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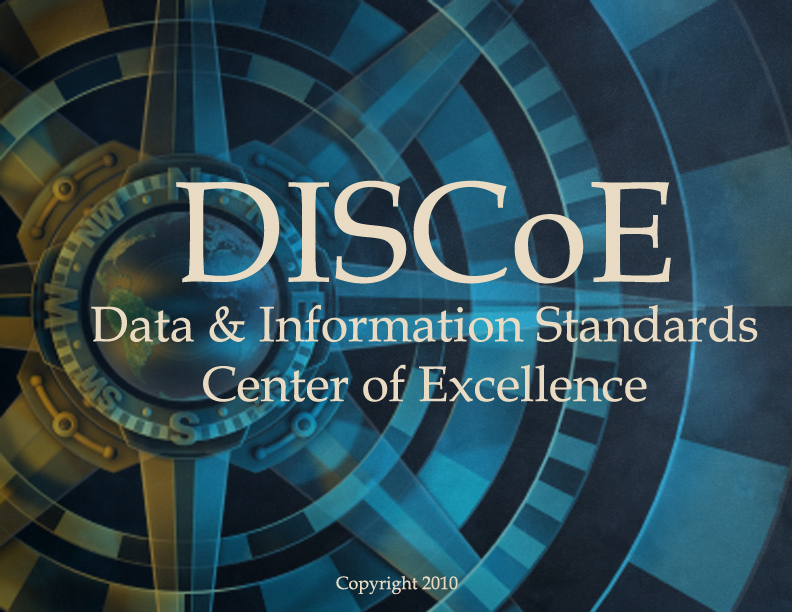
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Appendix E: Technical References

| **Date** | **Document** |
| --- | --- |
|  | DISCoE Interface Requirements Specifications |
| 2000.APR | SAE J1939 |
| 2010.DEC | SAE J1708 |
| 2008.JUL | SAE J1587 |
|  | ATA TMC RP1210B |

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This remainder of this document is temporary and will be deleted prior to release of version 1.0.

**Notes**

DataAcq: http://www.somat.com/ http://www.hbm.com/

Life-Cycle Engineering Requires Logistics to be addressed from Concept through Disposal

Reduce unintended consequences

AMSAA Provides Critical Systems Analysis … That Enables Senior Army Decision Makers

Questions

1. Is there a list of PMs who are the intended audience of this document?
2. Will depots upgrade / retrofit equipment to be “CBM Compliant”?
3. Is there a list of “CBM Compliant” sensors?
4. Is there a list of “CBM Compliant” data acquisition systems?
5. Are any acquisition systems owned by the DoD/Army?
6. Where does/should conversion to ABCD take place?
7. How far will CBM+ go in the next 10 years?

Serialized Vehicle Components?

Engine / Transmission

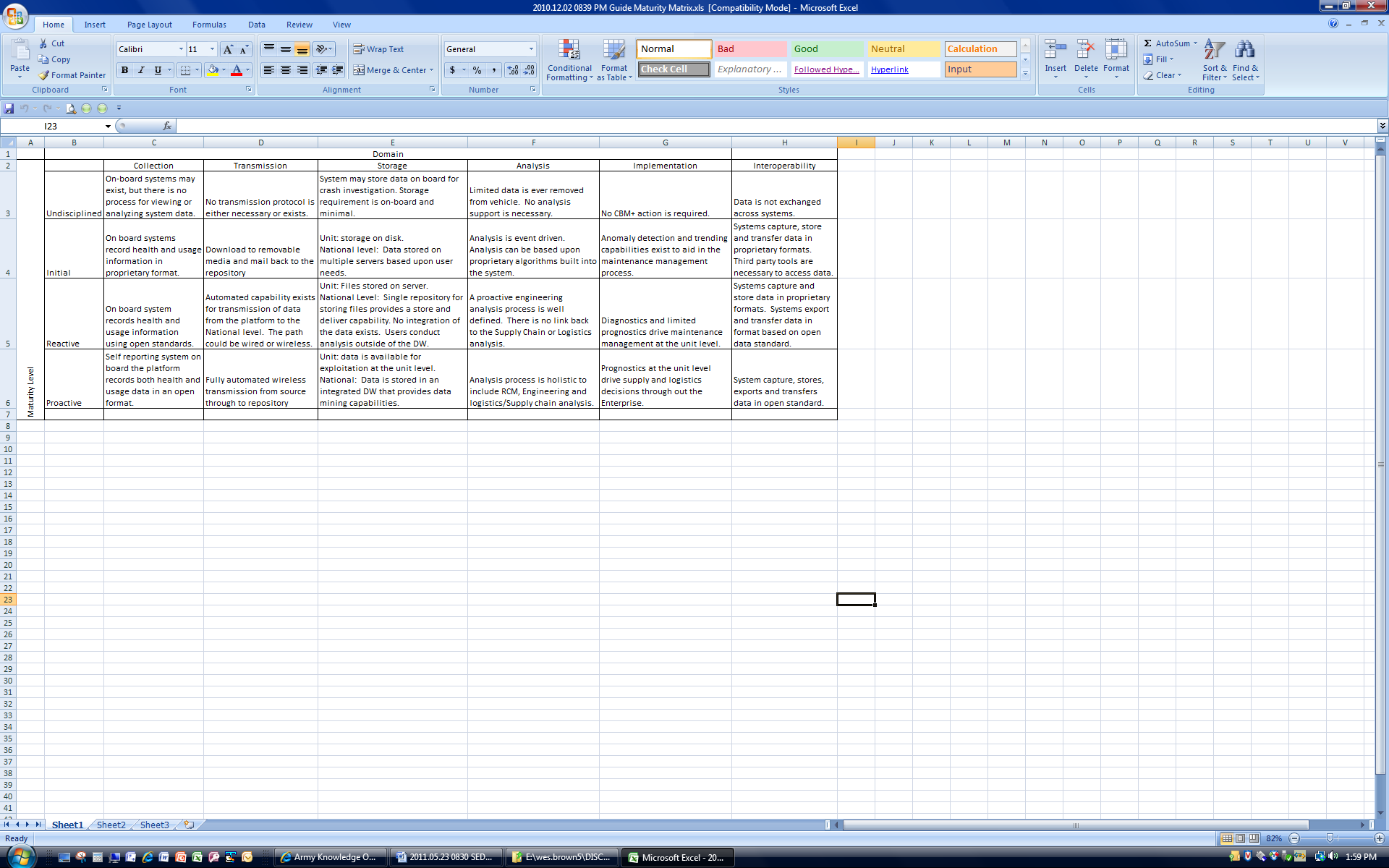
Anything with a motor?

Generators / Cranes /

Snippets

There are 6 Data Domains

1. Collection
2. Transmission
3. Storage
4. Analysis
5. Implementation
6. Interoperability



PEO GCS - Program Executive Office Ground Combat Systems

PM HBCT - Project Management Office, Heavy Brigade Combat Team

Abrams

Bradley

M88

M113

M109 -

Armored Knight Family of vehicles

The purpose of this section is to provide a reference that can be used to restore the styles used in this document when they become corrupt.

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## Heading 2 Arial 13 B 0.2 0.55 12 6

H2 Text TNR 12 0.2 6 0 1.15

### Heading 3 Arial 12 B 0.4 0.60 12 6

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