Presentation to the CBM+ AG

Enabling Condition Based Maintenance + through Capability Based Logistics

Malcolm B. “Mac” Armstrong, LTG/USAF ret

CEO Blue Water Solutions, Inc.

April 19, 2006

Malcolm B. “Mac” Armstrong, LTG/USAF (ret)

Mac Armstrong most recently served as the Senior Vice President, Operations & Safety of the Air Transport Association (ATA) where he represented commercial aviation industry interest before the US Congress, Department of Transportation (DOT) and Federal Aviation Administration (FAA). Prior to this, LTG Armstrong was the EVP Operations at Delta Air Lines and VP Safety & Regulatory Compliance at US Airways.

As EVP Operations, LTG Armstrong oversaw the safety, operations and maintenance of over 600 aircraft executing over 2000 daily departures. During his tenure, Delta realized the largest growth in revenue, net profits and customer load factor in its seventy years of operations while significantly increasing employee satisfaction. Before entering the airline industry, he served a 31 year career with the U.S. Air Force, including extensive duty as a fighter pilot and in operations command and staff positions. One assignment included a three year tour in aircraft maintenance, where he was in charge of over 130 aircraft across multiple locations. He served his final three years commanding the 21st Air Force, which provided air cargo & air tanker services for U.S. defense needs over half of the globe with over 54,000 people and over 530 aircraft from active duty, air reserve & air national guard forces. LTG Armstrong’s expertise is centered on leading large, diverse, often disparate groups to united pursuit of common mission goals with particular expertise in aviation operations.

LTG Armstrong holds a BS in Geology from Louisiana State University, a MS in Business Administration from Auburn University and various certificates of study from the Air Command and Staff College, Industrial College of the Armed Forces, National War College and the National and International Security Program at the Kennedy School of Government, Harvard University.

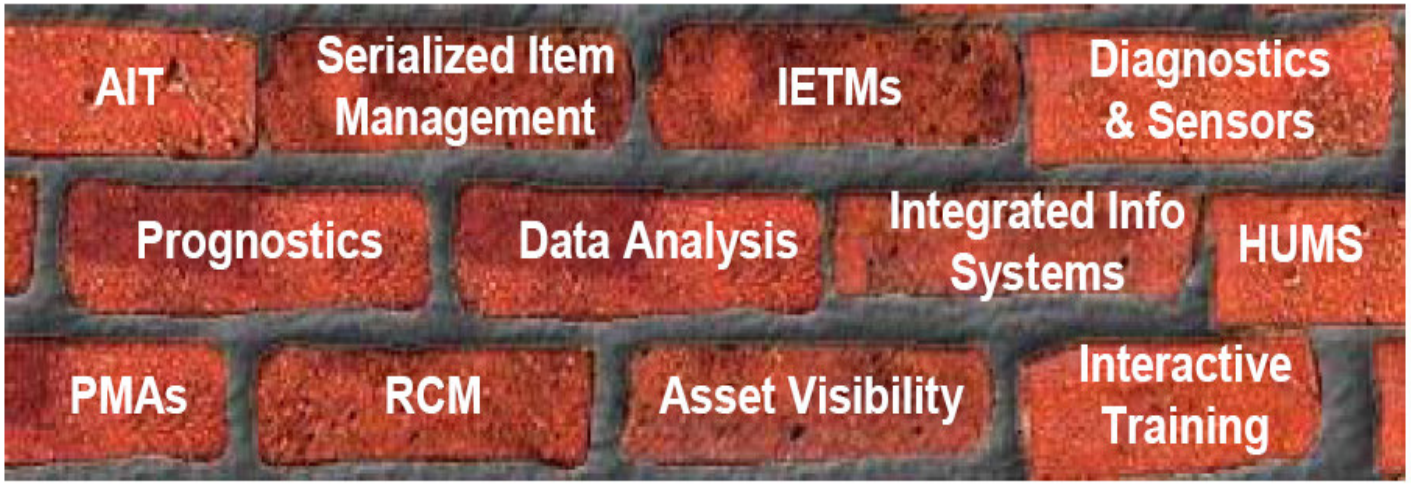
macarmstrong@comcast.net 770.833.3274

Our understanding of OSD's CBM+ initiative

CBM+ implements:

— Practices, techniques, and technologies that improve maintenance capabilities and execution

- in new systems during acquisition
- in legacy systems *where applicable* and *cost effective*



CBM+ Plan of Attack & Milestones, ADUSD MR&MP, dtd March 2006
DoD Directive 5000.1, "The Defense Acquisition System," May 12, 2003
DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003
DoD Directive 4151.18, "Maintenance of Military Materiel," 03/31/2004
DoD Directive 4630.5, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," January 11, 2002

Our understanding of OSD's CBM+ initiative

3.1 Provide strategic review and advice as necessary.

3.2 Coordinate approaches to collect, review, validate and distribute information on proven methods and products.

3.3 Recommend policy guidance on maintenance and reliability improvements.

3.4 Provide overviews and summaries of CBM+ programs and funding levels proposed and executed throughout DoD.

3.5 Monitor and track progress of CBM+-related activities.

3.6 Develop strategies for tracking CBM+ costs and its impact on readiness and safety.

3.7 Provide guidance for improving maintenance and training plans.

3.8 Ensure that CBM+ technologies are fully considered throughout the life cycle of DoD systems and infrastructure.

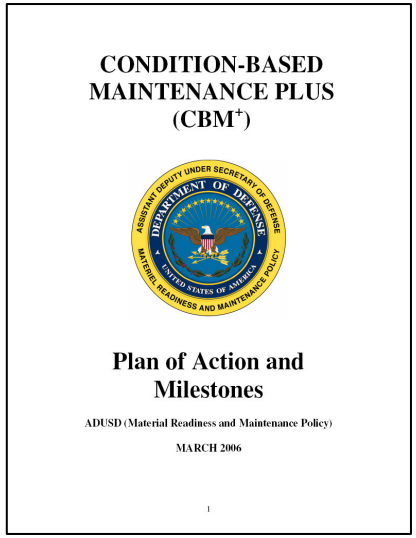
4.1 Revise DoD policy to encourage and promote CBM+. Develop policy recommendation (OCT 06).

4.2 Review implementation and execution of the Services' CBM+ plans and selected programs and recommend improvements. Establish Service review cycle & Service-level IPT Charters (APR06)

4.3 Establish and maintain an active clearinghouse for government and commercial CBM+ applications, benefits, lessons learned and research. Populate CBM+ web site (quarterly review by CBM+ AG)

4.4 Monitor and coordinate CBM+ development efforts among the Services and across DoD. As necessary (ongoing)

4.5 Advise the MRSSG and other organizations on CBM+ issues. Prepare a universal CBM+ presentation for use (APR 06) & Prepare CBM+ article for distribution to select publications (APR 06)


CONDITION-BASED MAINTENANCE PLUS (CBM+)

Plan of Action and Milestones

ADUSD (Material Readiness and Maintenance Policy)

MARCH 2006

1

Our definition of CBM

Condition Based Maintenance is

a set of “real time” capabilities (people, processes and tools)
which capture, analyze, and report to decision makers
information related to equipment functional condition
in order to efficiently
improve and optimize asset readiness
by maintaining or returning a component of an asset
to a regulatory specification
usually Structural or Functional Configuration.

See Appendix for Terminologies & Definitions of Maintenance, Repair, Overhaul, Configuration Management and Lifecycle Management

Questions which arouse out of our review of OSD's current Policy and Plans

How do these capabilities relate to one another and what hierarchical interdependencies exist which would require one capability to define the data, decision support and, or technology requirements of another?

How do these capabilities relate to other DOD initiatives (BMMP, TLCSM, DMP, PBL, CPI, Six Sigma, TOC, E2ELM, HR/HCM, …)?

How do CBM+ capabilities figure into the Business Transformation Agency's (BTA) Core Business Missions (CBM), Business Enterprise Priorities (BEP) and BEP's transformation "*capabilities*"?

How will CBM+ capability requirements be enabled by the component services Enterprise Transition Plans (ETP) and who is responsible for verifying and validating compliance?

What commercial technology standards will CBM+ use and how will these technical requirements be embedded into the component services ETPs (e.g., AECMA S1000D, MIMOSA, OASIS, STEP…)?

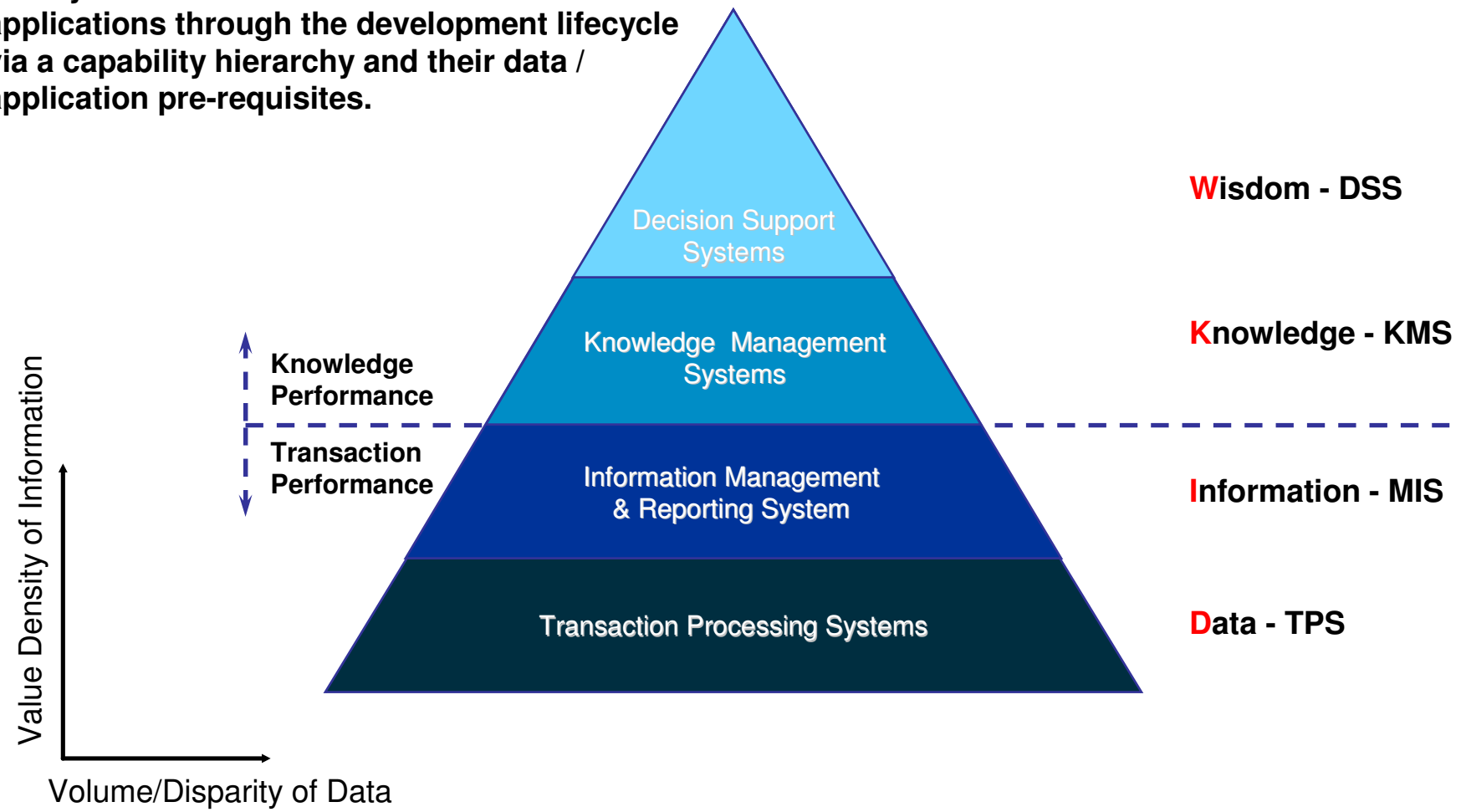
What CBM and MRO technologies will DOD receive through weapons systems acquisitions and how could OSD and the services leverage these opportunities?

What are the operational and financial goals of OSD's logistics initiatives and what contribution does CBM+ play? How does / will OSD decide on CBM+ funding and ROIC measurement?

How could OSD accelerate CBM+ in concert with other DOD initiatives?

A hierarchical capability framework and Capability Maturity Model (CMM) are commonly used by MRO organizations to make capability development and sourcing decisions.

The DIKW Model developed by IEEE visually and readily identifies the roll-out schedule of applications through the development lifecycle via a capability hierarchy and their data / application pre-requisites.

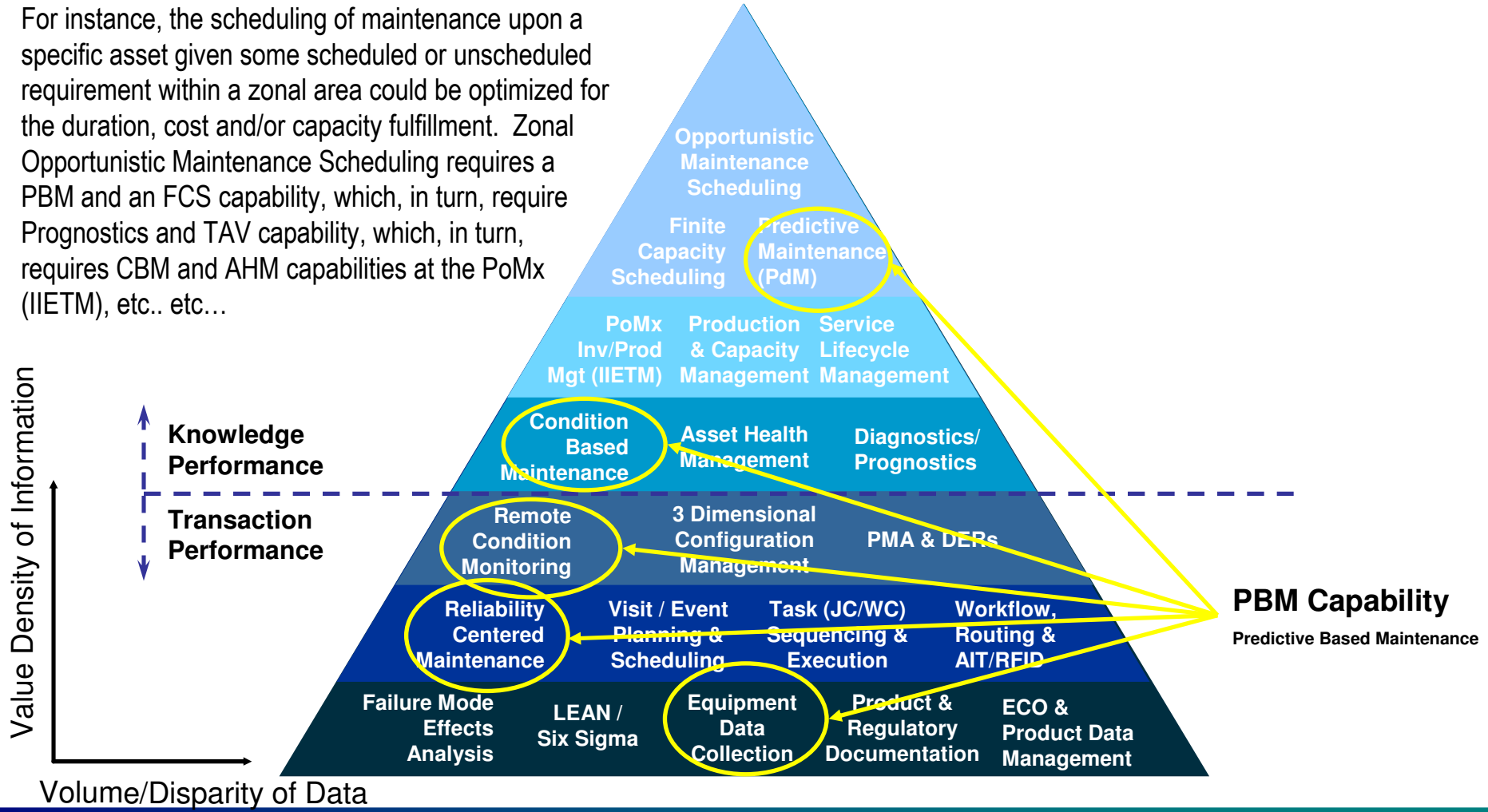


A hierarchical capability model identifies the relationships and dependencies between individual capabilities as well as the maturity level requirements given a business strategy.

Engineering & Maintenance Programs, Planning, Scheduling & Execution

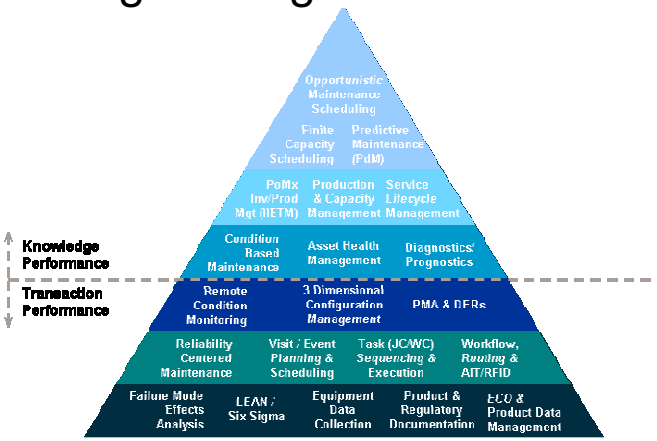
(1 of 4 Capability Views of the Enterprise)

For instance, the scheduling of maintenance upon a specific asset given some scheduled or unscheduled requirement within a zonal area could be optimized for the duration, cost and/or capacity fulfillment. Zonal Opportunistic Maintenance Scheduling requires a PBM and an FCS capability, which, in turn, require Prognostics and TAV capability, which, in turn, requires CBM and AHM capabilities at the PoMx (IIETM), etc.. etc…

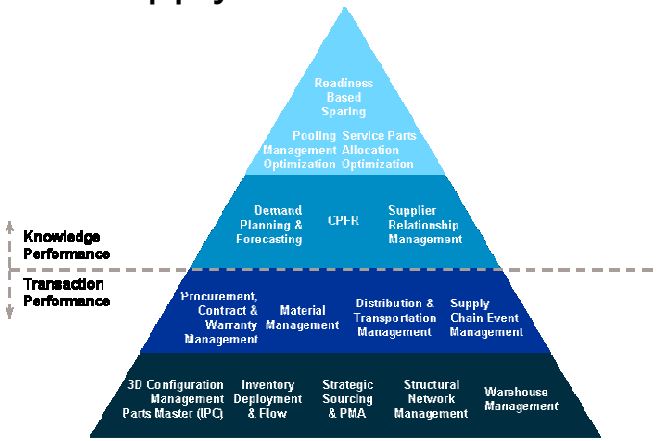


People and organizations in aviation MRO have four functional views of the enterprise.

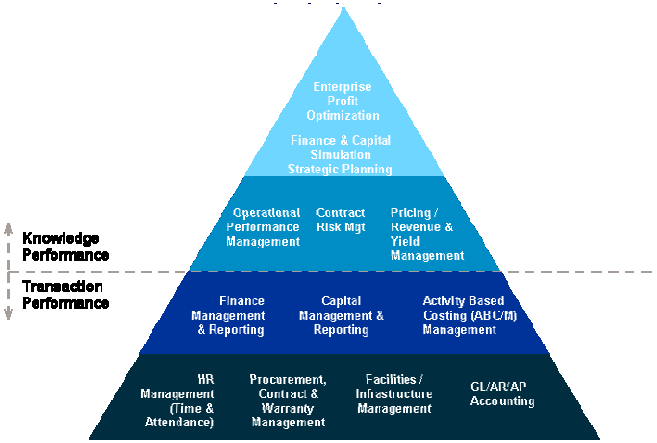
Engineering & Maintenance



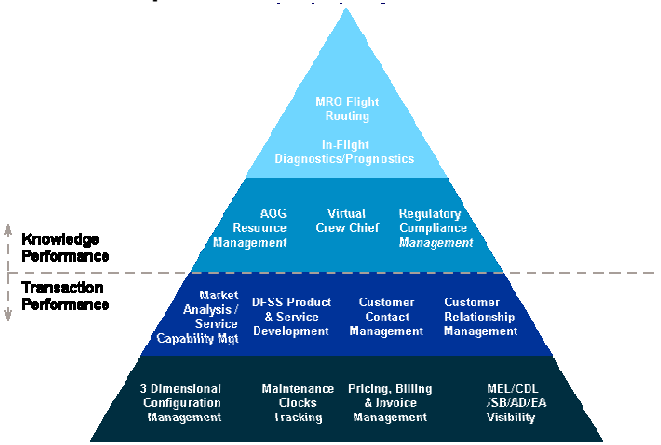
Supply Chain & Service



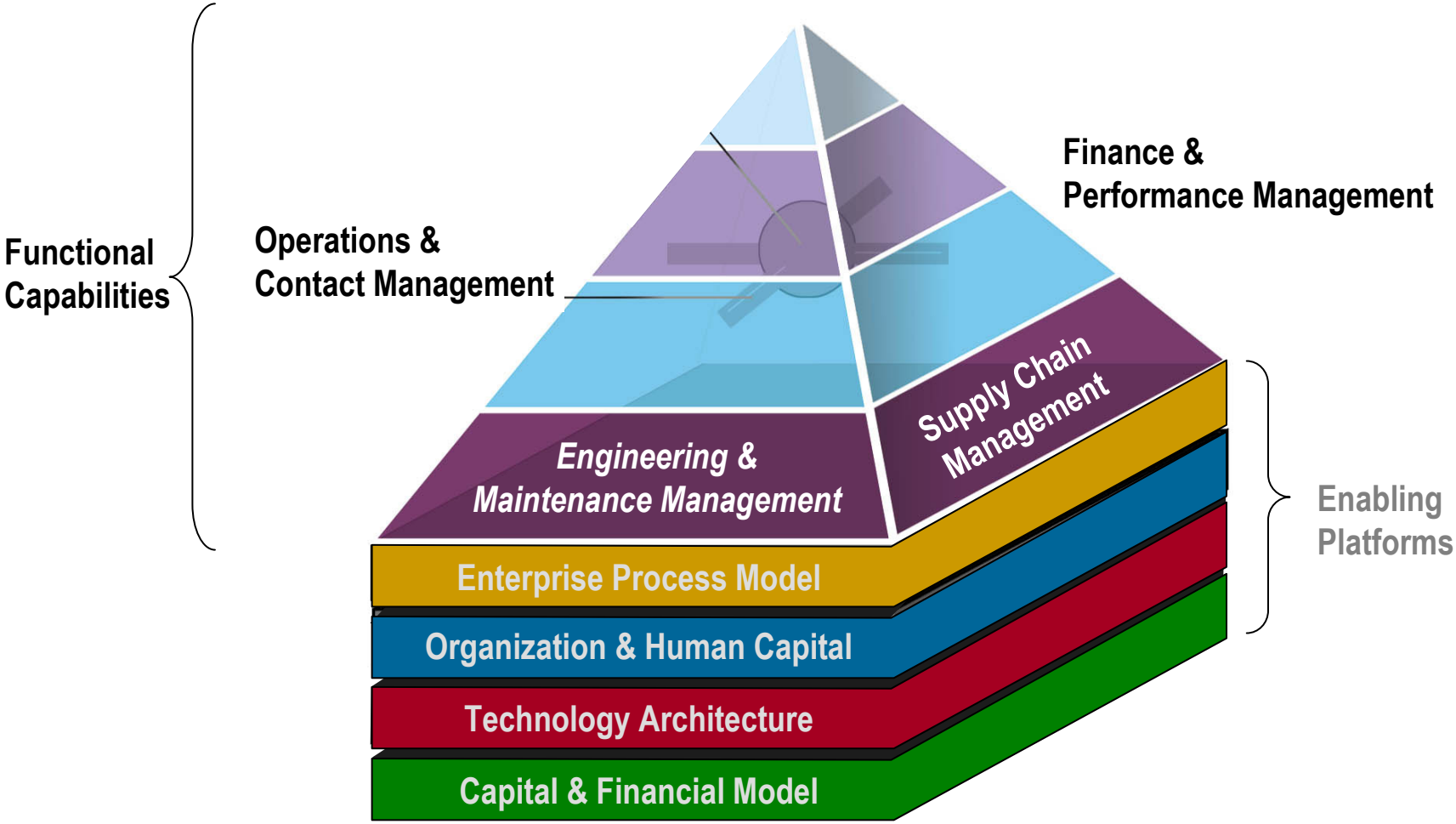
Finance & Performance



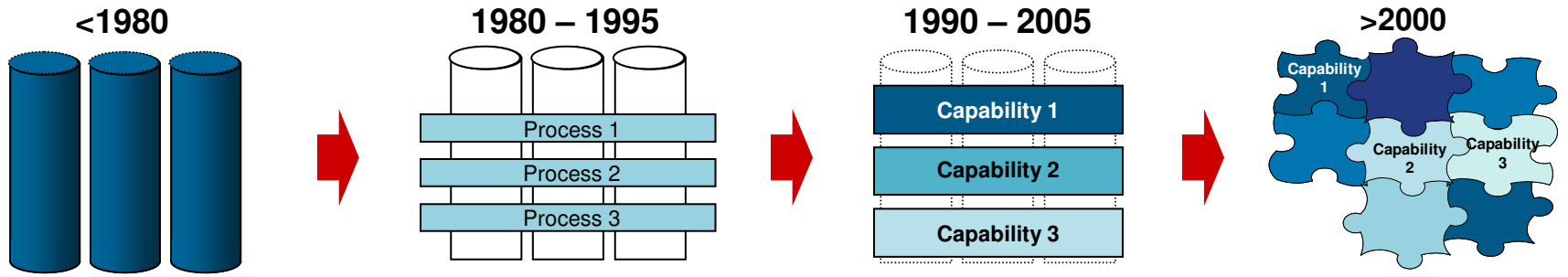
Operations & Contact



The four capability views with their enablers create a complete “Business Architecture” which synchronizes processes across organizational boundaries and the external value network.

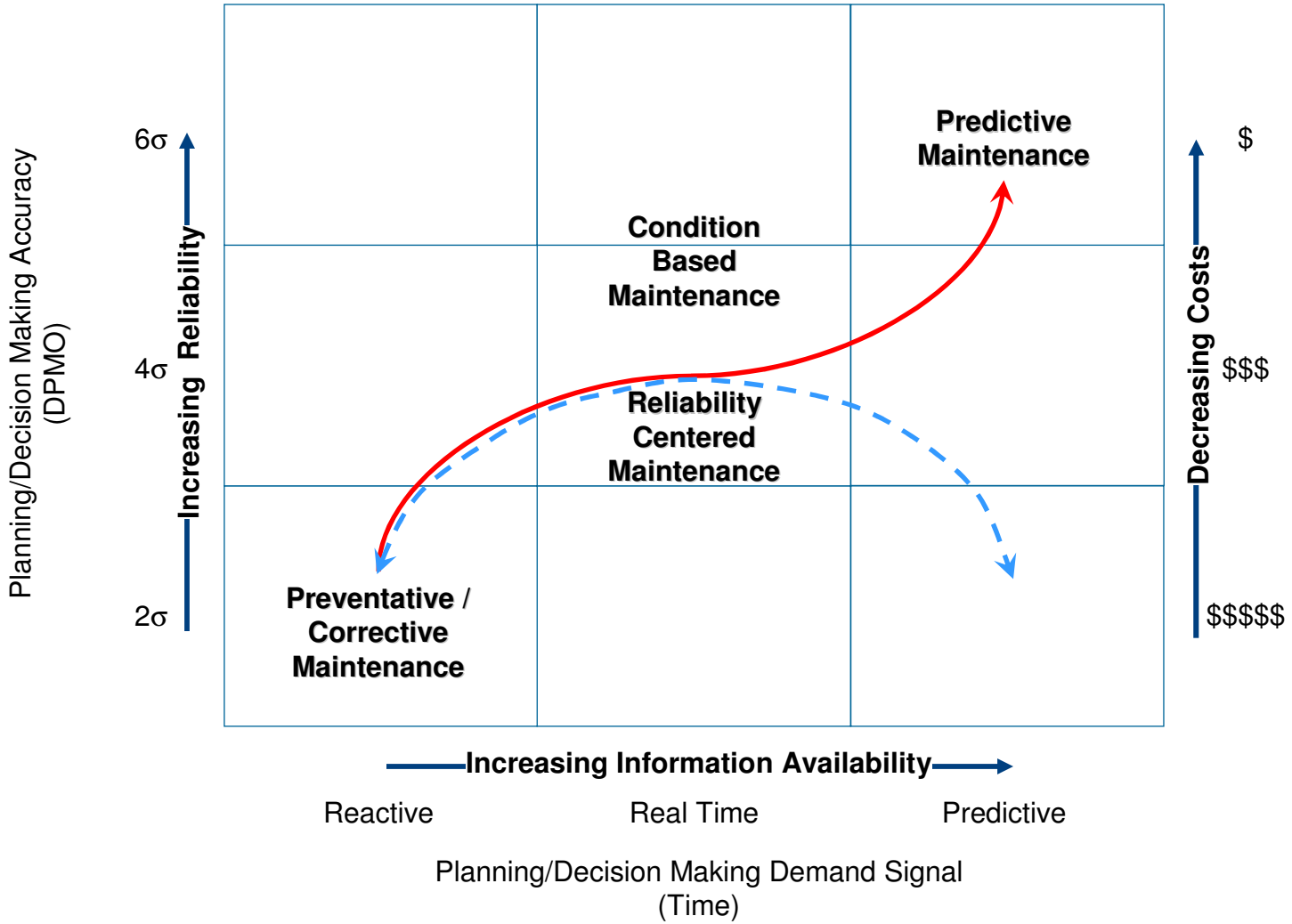


Business strategy, business models and technology have matured in parallel over the past twenty years - moving toward an agile collaboratively sourced capability based approach.

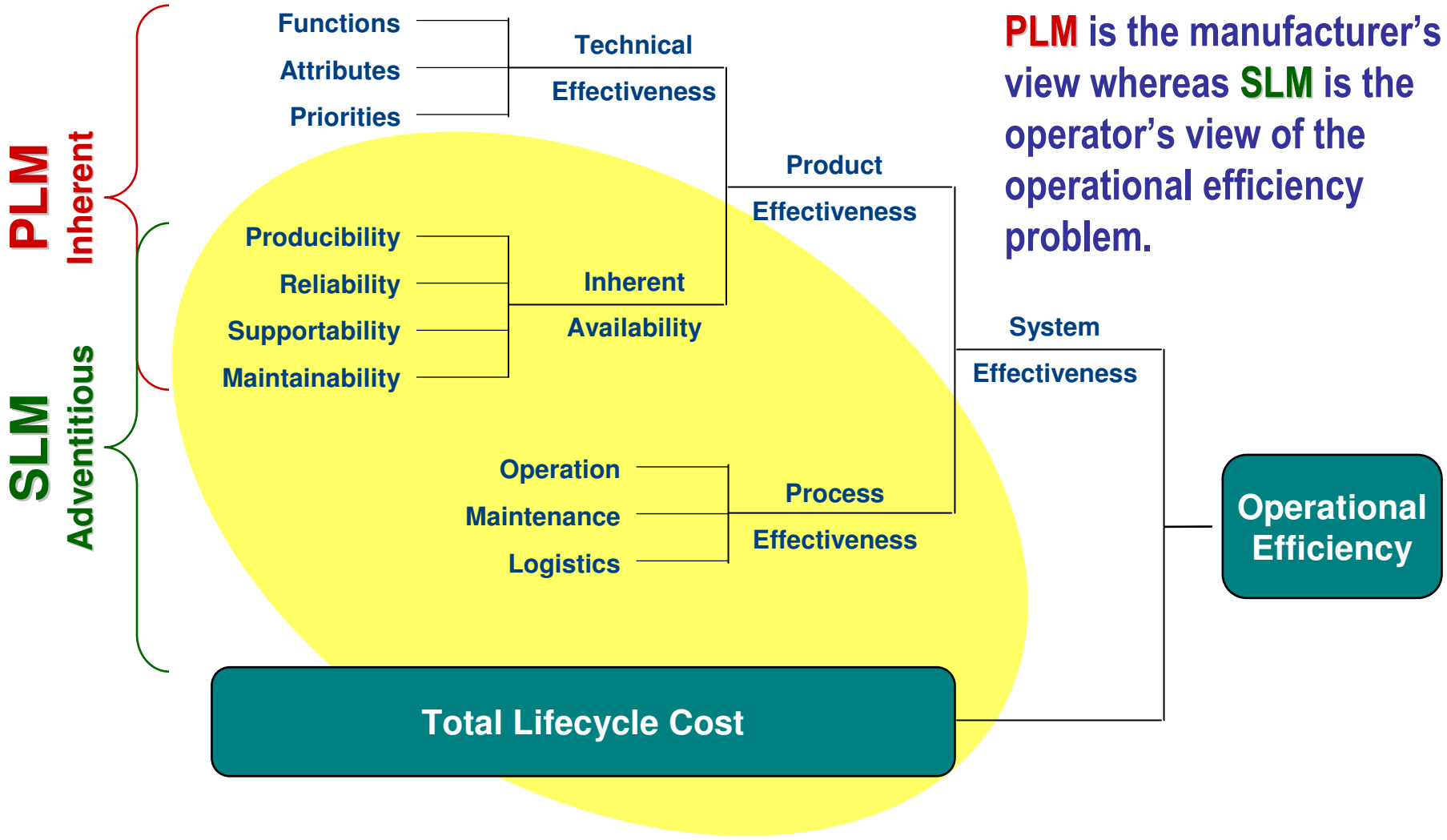


Functional Orientation	Process Orientation	Optimization Orientation	Synchronization Orientation
Input Centric Thinking	Output Centric Thinking	Outcome Centric Thinking	Effects Centric Thinking
Preventative & Corrective Based Maintenance	RCM - Reliability Centered Maintenance MSG2	CBM - Condition Based Maintenance MSG3	PBM - Predictive Based Maintenance MSG4?
Transaction Base Logistics	Integration Base Logistics	Performance Based Logistics	Capability Based Logistics
Contractor Logistics Support (CLS)	Integrated Logistics Support (ILS)	Total Support Performance Responsibility	Joint Autonomic Sustainment Support (JASS)
Military on Military Planning Approach	Military Deterrence Planning Approach	DIME Planning Approach (Diplomatic, Information, Military, Economic)	PMESII Planning Approach (Political, Military, Economic, Social, Information, Infrastructure)
Task Operations System of Functions Metrics: Days of Supply ($ or assets) Risks: Internal / Departmental	Service Operations System of Processes Metrics: Flow Time / Cycle Time / CWT Risks: Internal / Enterprise	Joint Operations System of Systems (Primarily Internal) Metrics: Assets Ready for Tasking Risks: Shared / Internally Controlled	Collaborative Operations System of Systems (Primarily External) Metrics: Systems Ready for Tasking Risks: Shared / Collaboratively Controlled
Adam Smith and Alfred P. Sloan orientation of operational excellence through task allocation and organizational design.	Edward Deming (TQM) and Michael Hammer (BPR) orientation of operational excellence through process design and statistical process control (SPC).	Robert Kaplan & David Norton (Balanced Scorecard) and Mikel Harry (LEAN / 6σ) operational excellence through the design and implementation of multivariate capabilities.	Arnoldo Hax (Delta Strategy), Mark Gottfredson (C Sourcing), William J. Hughes (C Alliances) excellence through agility and fast adaptation of multivariate capabilities.
Motivation: Individual & Departmental intrinsic value motivation through "incentives & rewards" and "taxation & penalties". Competitive (zero-sum) gamming theory.	Motivation: Enterprise employee focused intrinsic value motivation. Coordination in cooperative games (internal) with competitive zero-sum (external) gamming theory.	Motivation: Customer focused extrinsic value motivation. [John] Nash Equilibrium in non-cooperative games. Cyclic equlibria of relational Markov games.	Motivation: Eco-system extrinsic value motivation. Bayesian-Nash & Nash-Q equilibrium in imperfect knowledge non-cooperative games. WoLF – Win or Learn Fast
Mainframe & Terminal Emulation 1 tier	4GL & Thick Client-Server 2 tier	Thin Client-Server 3 tier	SOA Architecture & native Web Services n tier

For instance, maintenance management methodologies have matured significantly thru technological advances which support “on condition” and “predictive” capabilities.



There is a difference between Product “inherent” and Service “adventitious” Lifecycle Management of an asset, as well as who controls and executes changes in each.



Inherent: 1. Existing as an essential constituent or characteristic; intrinsic, 2. Bio-Medical definition: Occurring as a natural part or consequence.

Adventitious: 1. Not inherent but added extrinsically, 2. Bio-Medical definition: Coming from an external source or occurring in an unusual place or manner.

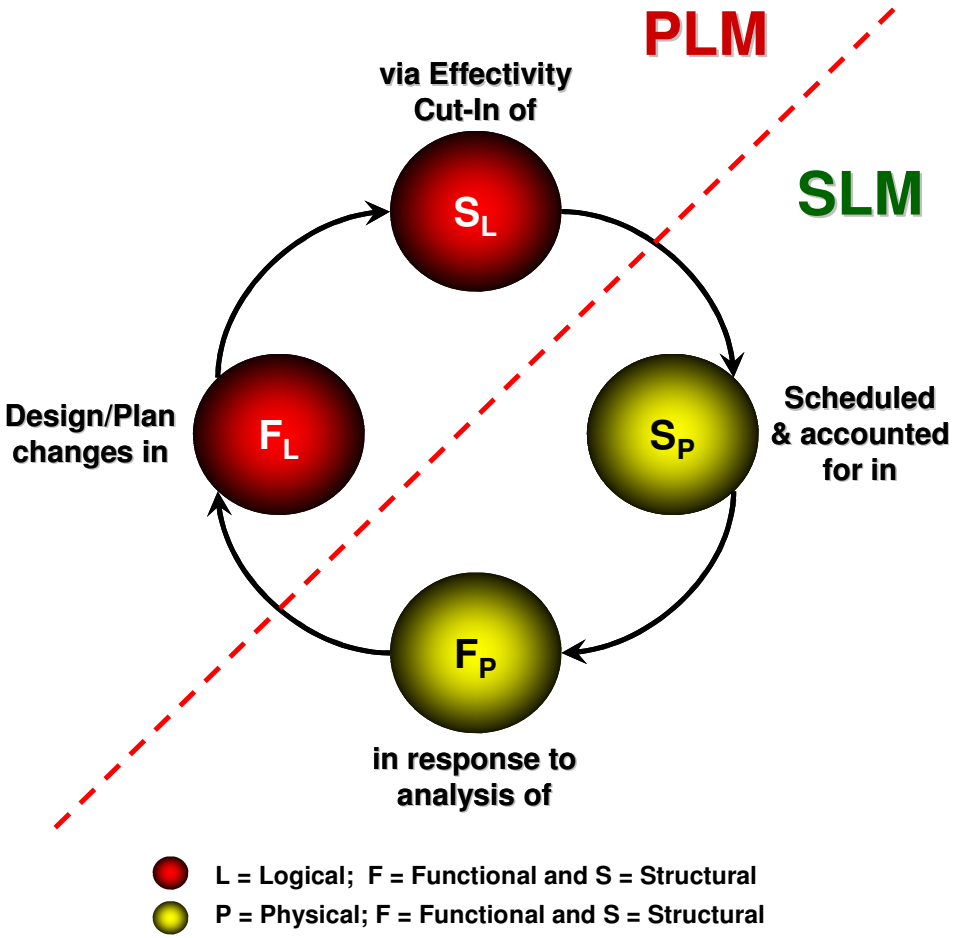
For “on condition” / “predictive” capabilities to work, the multiple dimensions of configuration management must be synchronized across PLM & SLM lifecycles for Form, Fit and Function

Multi-Dimensional Configuration Management (MDCM)

Functional Configuration Management **(CM_F)** is the tracking, analysis and management of the functional design and operating performance parameters of an asset, assembly or component. There is a Logical “as-designed” (F_L) and Physical “as-operated” (F_P) version.

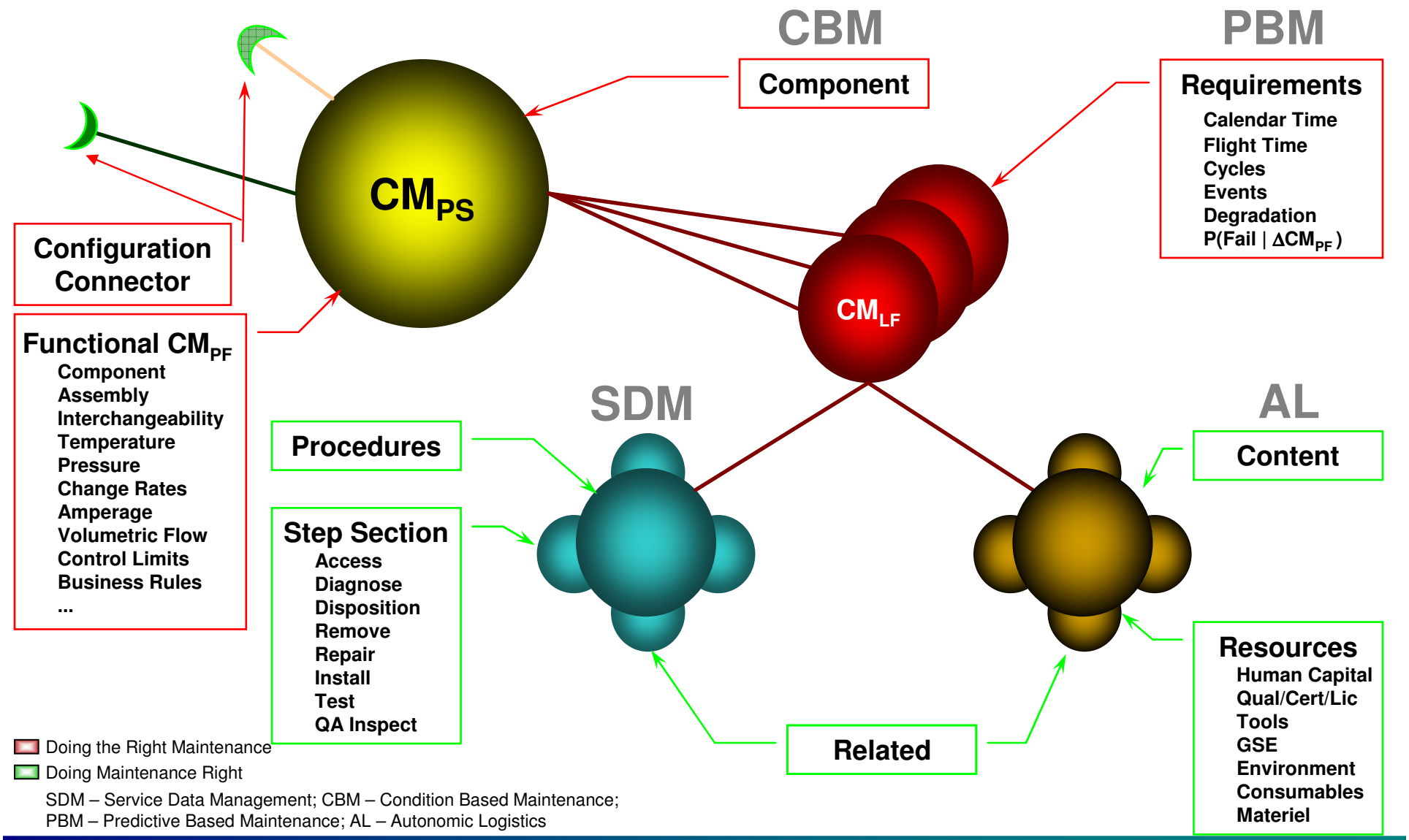
Structural Configuration Management **(CM_S)** is the tracking, analysis and management of the structural piece of an assets Bill of Material (BOM, EBOM, MBOM). There is a Logical “as-allowed” (S_L) structure and Physical “as-maintained” (S_P) version.

Effectivity (∂E) is the dimension that tracks and schedules changes in one or more of the previous two dimensions CM_F or CM_S in accordance with a specific derivative. Change derivatives can include: (EO/EAs, Airworthiness Directives (AD), Service Bulletins (SB), calendar time, operating time, cycles, environment or events (e.g., lightening/EM radiation, bird strike, hard landing …).



PDM: Product Data Management; PLM – Product Lifecycle Management = OEM functions
SDM: Service Data Management; SLM: Service Lifecycle Management = Operations & Maintenance functions

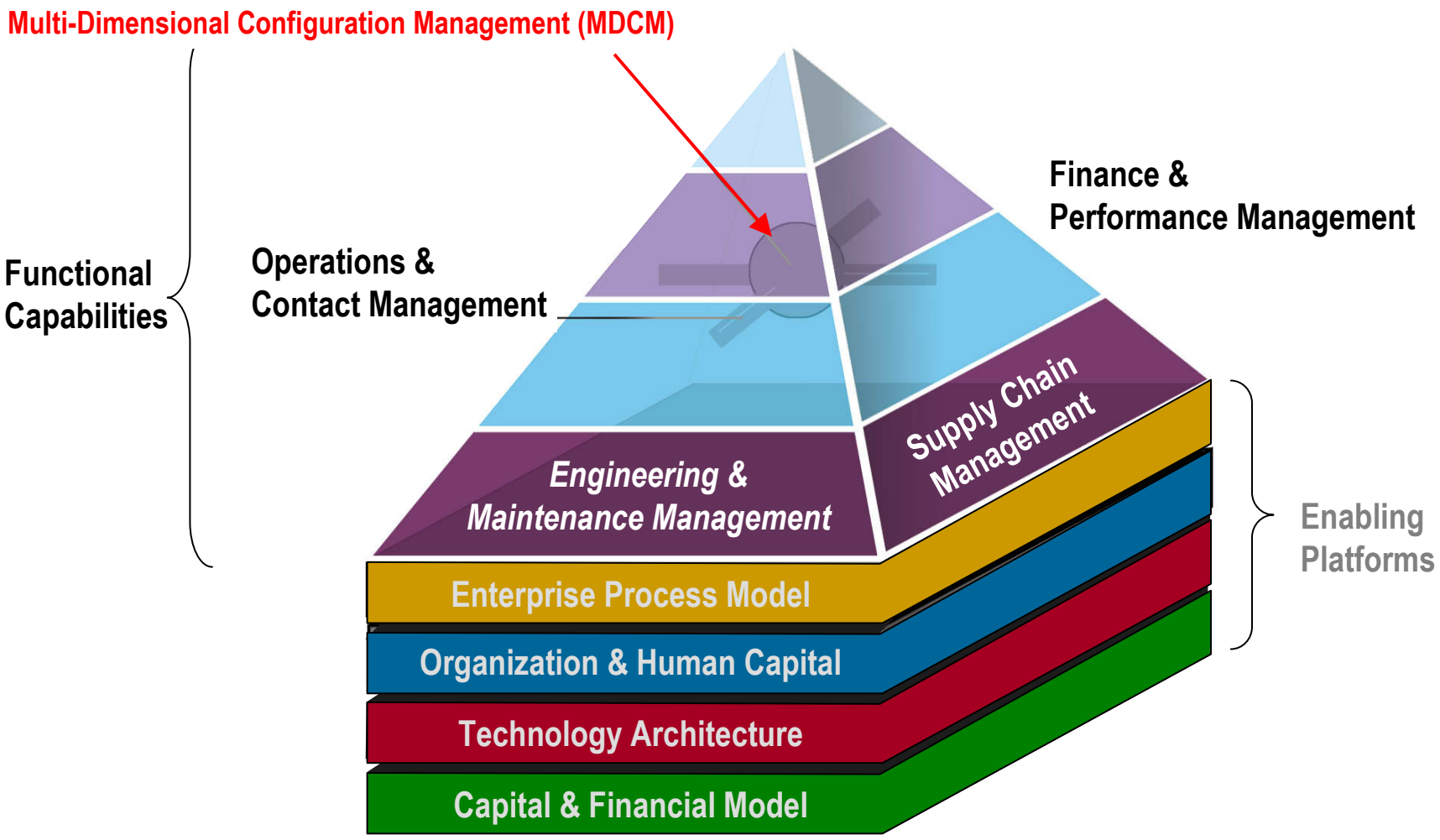
Doing the Right Maintenance and Doing Maintenance Right requires MDCM to autonomically synchronize decision knowledge to decision makers at the time of need.



Doing the Right Maintenance
Doing Maintenance Right

SDM – Service Data Management; CBM – Condition Based Maintenance;
PBM – Predictive Based Maintenance; AL – Autonomic Logistics

MDCM is the “glue” and critical key capability for synchronizing sustainment capabilities both internally across the enterprise as well as externally across the value chain.



Commercial MSG-3 (RCM II) compliant IT is both Component Centric & Mechanic Centric

Asset & Component Centricity

Doing the right maintenance

Full object structural and functional / logical and physical configuration management (3DCM)

Component centric data management and dB

Reliability Centered Maintenance with condition based monitoring in order to enable on Condition Based Maintenance (CBM)

Embedded diagnostics, degradation analysis and prognostics in order to enable Predictive Based Maintenance (JHUMS / PHM)

Finite Capacity Scheduling in order to enable Economic Opportunistic Maintenance Scheduling (FCS / OMS)

Enterprise Total Asset Visibility - all fleets, all times, all locations (JTAV)

Performance Based Logistics asset & component performance risk shifting via asset specific total lifecycle costing (PBL)

Mechanic & Process Centricity

Doing maintenance right

The right qualified/certified person

The right asset / component specific and task specific procedures

Mechanic role based workflows

The right supplies, parts, calibrated tools, support equipment, etc…

All, at the right maintenance location scheduled at the right time to fulfill operational or depot commitments and warfigher needs

Activity Based Costing (ABC) work execution capture seamless embedded within the actual work process technology

Continuously process improving via Lean, Six Sigma, Theory of Constraints, Case Based Learning, etc…

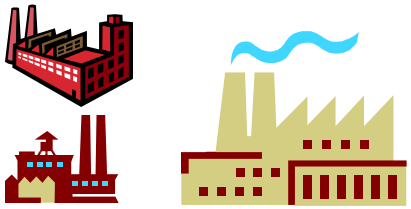
Identifying authoritative sources of data and the "centricity" & "workflow" orientation of solutions helps discern which IT systems should manage which capabilities and data sets.

PLM

CAD,
CAM,
CAE,
PDM

PDM systems are "component" centric and use "transaction" based workflows

The Authoritative Source of Logical (As-Designed) Configuration (CM_{LS} & CM_{LF}) is a Blueprint.



ERP

HR,
FI/CO,
ABC,
SCM,
MRPII

ERP systems are "order" centric and use "transaction" based workflows

SLM

Off-Board PBM & CMMS

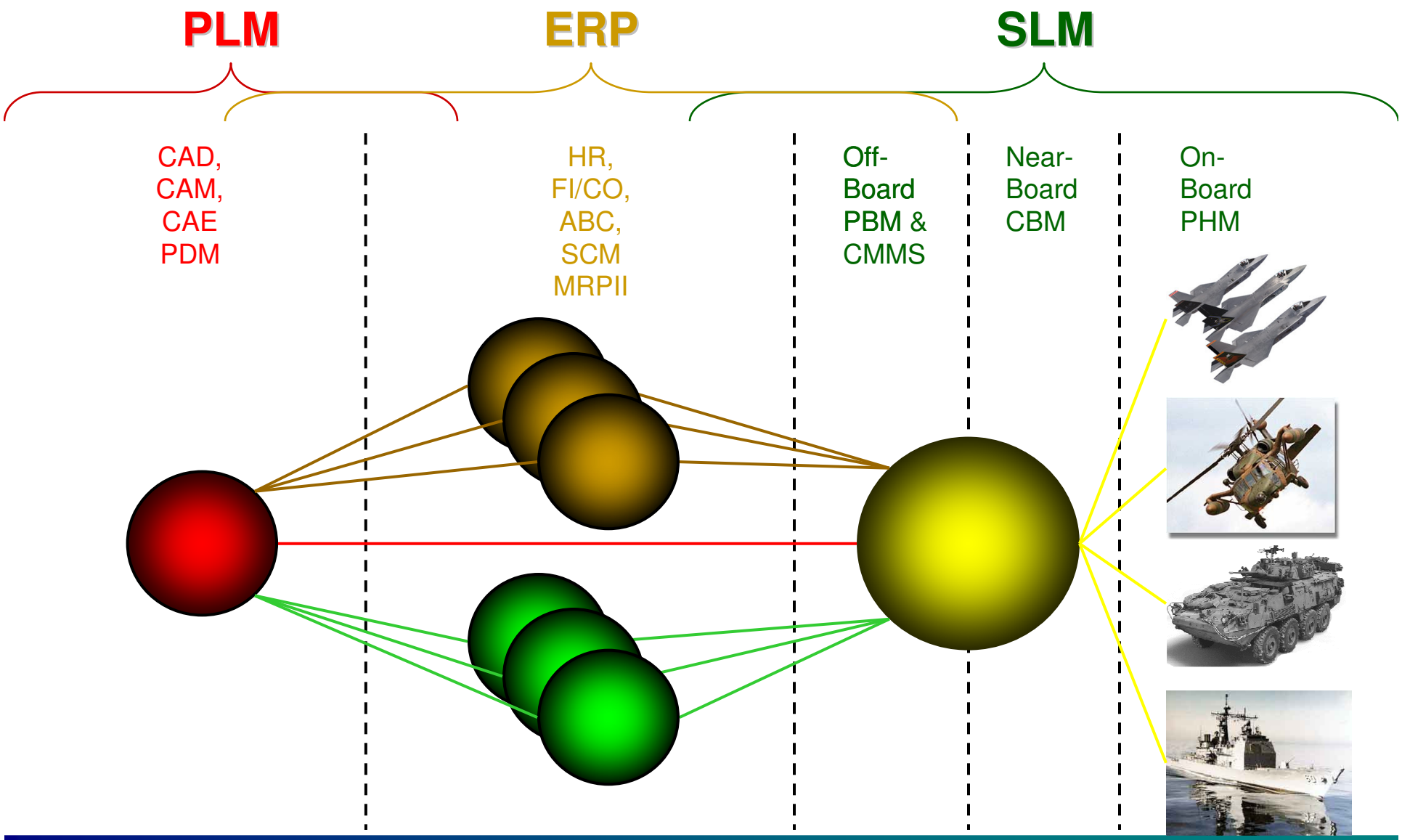
Near-Board CBM

On-Board PHM

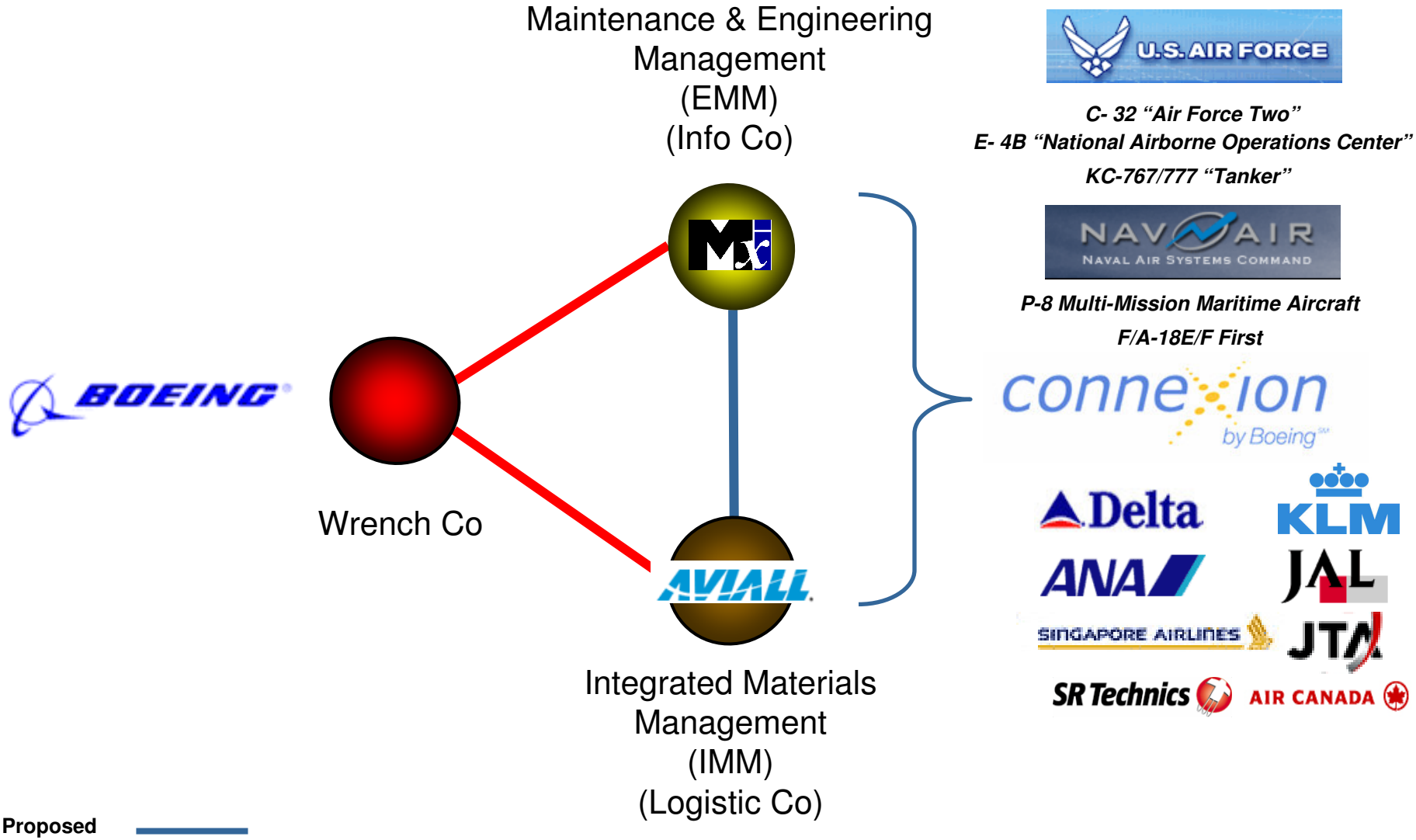
MRO systems are "component" centric and use "mechanic" role based workflows

The Authoritative Source of Physical (As-Operated) Configuration (CM_{PS} & CM_{PF}) is the Aircraft

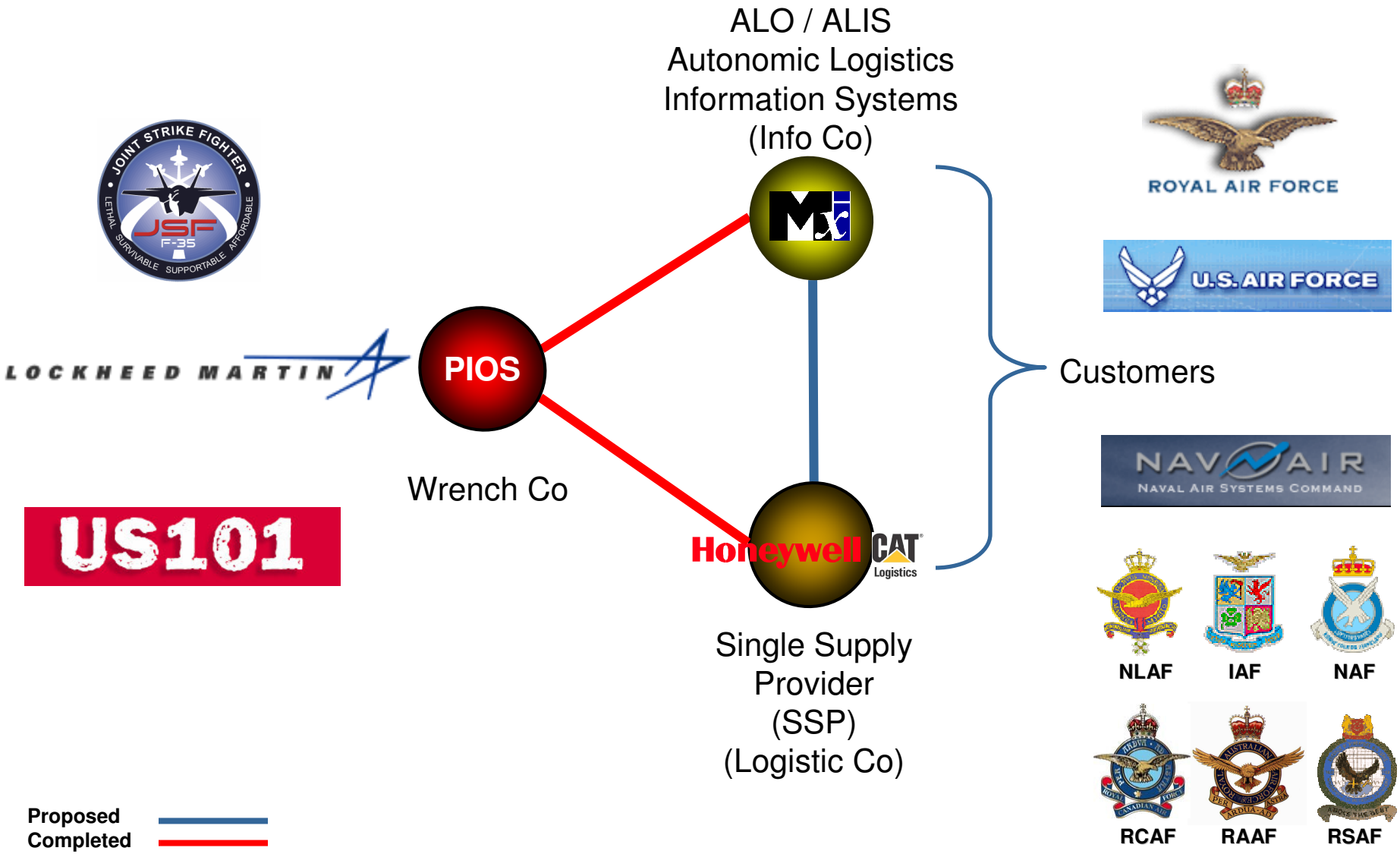
A single SLM and corresponding single PLM capability can integrate and synchronize multiple ERP instances to create a Joint Autonomic Sustainment System (JAZZ).



Boeing is standardizing delivery of a “shared infrastructure”, collaborative MRO capability and business model for their customers.



Lockheed Martin's sustainment synchronization initiative is enabled by a CBM / PHM capability, based on the JSF Autonomic Logistics Information System (ALIS) solution.



OSD's Business Transformation Agency (BTA) Goals

The BTA enables support to the warfighter and provides accountability to the American taxpayer by systematically improving DoD's business processes, systems and investment governance. To achieve goals providing consistency, consolidation and coordination across the Department of Defense, the DoD produced the Enterprise Transition Plan (ETP), an integrated and executable roadmap aligned to the Business Enterprise Architecture (BEA). The ETP and the BEA enable the Department to transform business operations to achieve improved warfighter support while enabling financial accountability across the Department of Defense.

2011 O&S goal / measurement of success:

- Increase asset availability and readiness by 20%
- with a corresponding 10% decrease in O&S costs.

Who pays for inefficient CBM and the lack of PLM / SLM synchronization?

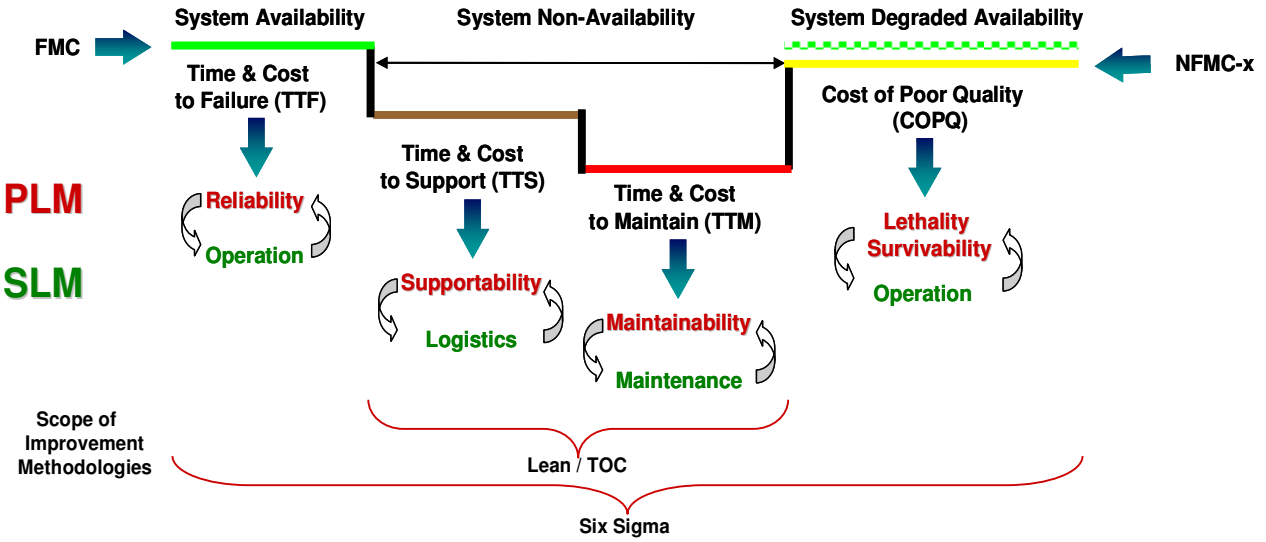
There is a high cost to aircraft operators for the business complexity of collaboration and synchronization due to the information gap between PLM and SLM and it's impact on labor, facilities, materiel and transportation.

Time & Cost of Failure

Time & Cost to Support

Time & Cost to Maintain

Time & Cost of Poor Quality



All costs are ultimately borne by operators since manufacturers embed and pass them back in the form of new products, services, R&D and sustainment costs.

Summary

- A hierarchical capability framework and maturity model explains the interdependencies which exist between CBM+ capabilities and technology requirements as well as other DOD BTA initiatives, thus facilitating executive program decisions and capability sourcing.
- Product Lifecycle Management and Service Lifecycle Management are fundamentally different capability sets, controlled and executed by different organizations yet must be synchronized across the joint lifecycles for fit, form AND function.
- Multi-dimensional configuration management is the “glue”, the critical key capability for synchronizing sustainment capabilities across the enterprise and external value chain.
- ERP systems are “order” centric and “transaction” workflow based whereas best of breed MRO systems are “component” centric and “mechanic” roll workflow based, therefore supporting MDCM and CBM+ capabilities.
- OEMs and commercial MROs are standardizing MRO technologies on systems which functionally support CBM and PBL and technically support IPv6, Web-Native, Open Source, n-tiered and a Services Oriented Architecture (SOA).
- All costs of inefficient PLM, SLM, MRO and Logistics are ultimately borne by operators.

Recommendations

OSD Policy (top down)

- Construct a simplified hierarchical decision support matrix for CBM+ capabilities which specifies functional capabilities, technical requirements and an execution framework.
- Strengthen OSD CBM+ policy for the individual services in accordance with item 1.
- Stand up an Independent Verification and Validation (IV&V) team for CBM+ compliance.
- Develop a econometrics based financial model to measure CBM+ impact as well as assist the services with investment decisions, business cases and ROIC determination.

Pilot Projects (bottom up)

- Investigate ways to leverage commercial MRO / CBM technology standardization in order to reduce the organizational resistance to change.
- Invest in one or more pilot projects to develop a COMPLETE and JOINT CBM+ capability through NCMS CTMA, SBIR / STTR, AC/JCTD … programs.

C-17 CBM CTMA Preliminary Proposal

Project Title	Joint Autonomic Sustainment System (JASS) C-17 TICR Integration - Phase 1
Problem Statement	C-17 Technology Integrated Change Roadmap (TICR) focuses CBM+ efforts on on-board and near-board capabilities but is challenged by "user IT infrastructure" and current "technology immaturity".
Potential Solution	Design and demonstrate a composite COTS application to receive CBM+ data from on-board and near-board diagnostics/prognostics and Integrated System Health Management (ISHM) to interface with IETM and current CAMS/REMIS and future ECSS back end logistics systems via a MRO Pathfinder.
Anticipated Benefit(s)	Increased Mission Capable Rates, Reduced Un-scheduled Maintenance, Improved Mission Effectiveness, Reduced Mission Aborts & Delays, Reduced O&S Costs, Reduced Labor, Reduced Technology Overhead, Reduced RTOK/CND Events, Reduced Spares Costs
Anticipated Deliverable(s)	System design for a CBM+ compliant Joint Autonomic Sustainment System
Potential DOD Participants	AMC, WR-ALC, AF/A4M
Potential Industry Participants	Boeing IDS, Boeing PhantomWorks, Mxi Technologies, MCA Solutions
Point of Contact	Malcolm B. Armstrong, BWSI, macarmstrong@comcast.net , 770.833.3274

xC-130J CBM CTMA Preliminary Proposal

Project Title	Joint Autonomic Sustainment System (JASS) C-130J Joint CBM+ Integration - Phase 1
Problem Statement	The C-130 variants represent possibly the most widely distributed "joint" aircraft globally yet no common CBM / CMMS tool currently exists to gather, aggregate and manage multi-dimensional configuration management information across the PLM / SLM lifecycles. Aircraft health, usage, maintenance program scheduling and engineering information is not being shared optimally across the services, USCG and coalition forces.
Potential Solution	Design and demonstrate a composite COTS application to receive CBM+ data from on-board and near-board systems which can interface to USAF, USMC / NAVAIR and USCG back office logistics systems.
Anticipated Benefit(s)	Increased Mission Capable Rates, Reduced Un-scheduled Maintenance, Improved Mission Effectiveness, Reduced Mission Aborts & Delays, Reduced O&S Costs, Reduced Labor, Reduced Technology Overhead, Reduced RTOK/CND Events, Reduced Spares Costs
Anticipated Deliverable(s)	System design for a CBM+ compliant Joint Autonomic Sustainment System
Potential DOD Participants	AMC, WR-ALC, AF/A4M, USCG, USMC, NAVAIR, NADEP Cherry Point
Potential Industry Participants	Rolls Royce, Lockheed Martin Aeronautics, PEMCO, Mxi Technologies
Point of Contact	Malcolm B. Armstrong, BWSI, macarmstrong@comcast.net , 770.833.3274

P-3 CBM CTMA Preliminary Proposal

Project Title	Joint Autonomic Sustainment System (JASS) P-3 Fleet Readiness - Phase 1
Problem Statement	The Georgia Tech Research Institute's Logistics and Maintenance Applied Research Institute (GTRI LandMARC) has developed multiple P-3 on-board and near-board CBM capabilities yet no common CMMS tool exists to efficiently manage this information across the Navy and third party MRO providers.
Potential Solution	Design and demonstrate a composite COTS application to receive CBM+ data from on-board and near-board diagnostics/prognostics and Integrated System Health Management (ISHM) to interface with IETM and current legacy and future back end logistics systems via a MRO Pathfinder.
Anticipated Benefit(s)	Increased Mission Capable Rates, Reduced Un-scheduled Maintenance, Improved Mission Effectiveness, Reduced Mission Aborts & Delays, Reduced O&S Costs, Reduced Labor, Reduced Technology Overhead, Reduced RTOK/CND Events, Reduced Spares Costs
Anticipated Deliverable(s)	System design for a CBM+ compliant Joint Autonomic Sustainment System
Potential DOD Participants	NAVAIR, NADEP Jax
Potential Industry Participants	Rolls Royce, GTRI LandMARC, PEMCO, Mxi Technologies
Point of Contact	Malcolm B. Armstrong, BWSI, macarmstrong@comcast.net , 770.833.3274

xH-60 CBM CTMA Preliminary Proposal

Project Title	Joint Autonomic Sustainment System (JASS) H-60 Joint Readiness Integration - Phase 1
Problem Statement	H-60 variants represent one of the most widely distributed "joint" aircraft globally yet no common CBM / CMMS tool currently exists to gather, aggregate and manage multi-dimensional configuration management information across the PLM / SLM lifecycles.
Potential Solution	Design and demonstrate a composite COTS application to receive CBM+ data from on-board and near-board diagnostics/prognostics and Integrated System Health Management (ISHM) to interface with IETM and current legacy and future back end logistics systems via a MRO Pathfinder.
Anticipated Benefit(s)	Increased Mission Capable Rates, Reduced Un-scheduled Maintenance, Improved Mission Effectiveness, Reduced Mission Aborts & Delays, Reduced O&S Costs, Reduced Labor, Reduced Technology Overhead, Reduced RTOK/CND Events, Reduced Spares Costs
Anticipated Deliverable(s)	System design for a CBM+ compliant Joint Autonomic Sustainment System
Potential DOD Participants	AMCOM, CCAD, NAVAIR, NADEP Cherry Point
Potential Industry Participants	Sikorsky, GEAE
Point of Contact	Malcolm B. Armstrong, BWSI, macarmstrong@comcast.net , 770.833.3274

Presentation to AFMC/A4

Appendix

Terminology

- References
  - ISO 10303 also known as STEP – STandards for the Exchange of Product model data
  - MIMOSA
  - AECMA S1000D
  - ATA iSPEC 2200
  - AECMA S1000M
  - ATA SPEC 2000

Physical Configuration: The hierarchical view of the current "as-maintained" end-item (aircraft, engine, landing gear) down to the part serial number level of the lowest component which requires inspection and maintenance activities to ensure reliability of a system and the end-item.

Logical Configuration: The hierarchical view of the "as-allowed" end-item (aircraft, engine, landing gear) down to the part serial number level of the lowest component which requires inspection and maintenance activities to ensure reliability of a system and the end-item.

Structural Configuration: The sub-set of Logical and Physical Configuration which specifies the hierarchical components and rules (interdependencies, relationships between components) of a part or system. There exist both an "as-allowed" Logical and "as-maintained" Physical set of Structural Configuration data.

Functional Configuration: The sub-set of Logical and Physical Configuration which specifies the properties (temperature, pressure, volume, …) of a part or system. There exist both an "as-designed" Logical and "as-operated" Physical set of Functional Configuration data.

Terminology

Maintenance: the set of PREEMPTIVE activities (tasks, inspections, operations) executed in order to ENSURE 1) Regulatory Compliance of Structural Configuration and 2) Reliability of Functional Configuration – on parts, systems and end-items which ARE Physically operating within Logical specifications.

Repair: the set of REACTIVE activities (tasks, inspections, operations) executed in order to RESTORE 1) Regulatory Compliance of Structural Configuration and 2) Reliability of Functional Configuration – on parts, systems and end-items which are NOT Physically operating within Logical specifications.

Overhaul: the set of activities (tasks, inspections, operations) executed in order to return a component of a system or asset to original "like new" Fit, Form and Function or to a new regulatory approved Fit, Form and Function – with a corresponding "rolling" of the part number.

Configuration Management: a process that provides the knowledge of an end item (aircraft, engine, system, component) down to the part/serial number level at any given point in time in order to manage safety ,regulatory compliance and reliability.

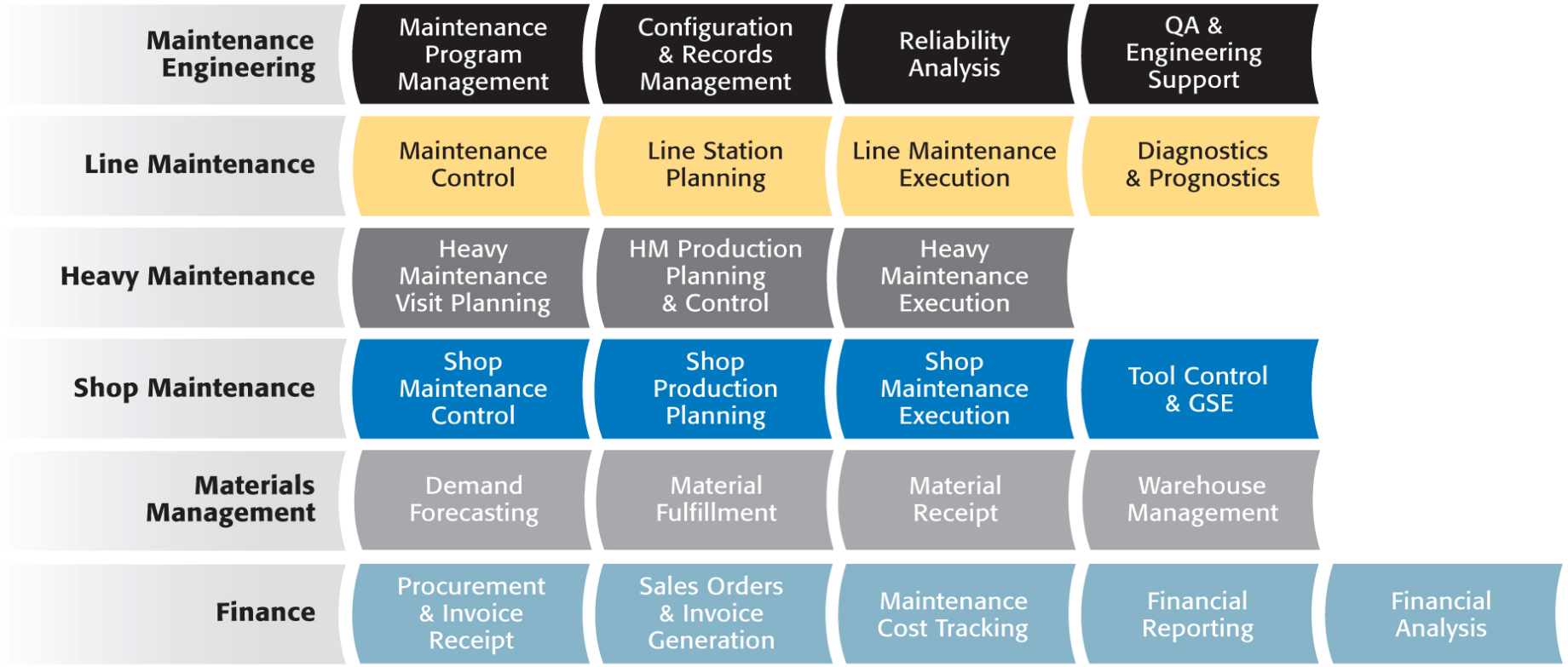
Multi-Dimensional Configuration Management (MDCM): a capability that provides the knowledge of an end item (aircraft, engine, system, component) down to the part/serial number level at any given point in time in order to manage safety ,regulatory compliance and reliability by constantly comparing the state and changes of Physical Configuration to Logical Configuration in order to measure current condition, diagnose potential causes of degradation and prognosticate the point in time when regulatory compliance will expire.

Terminology

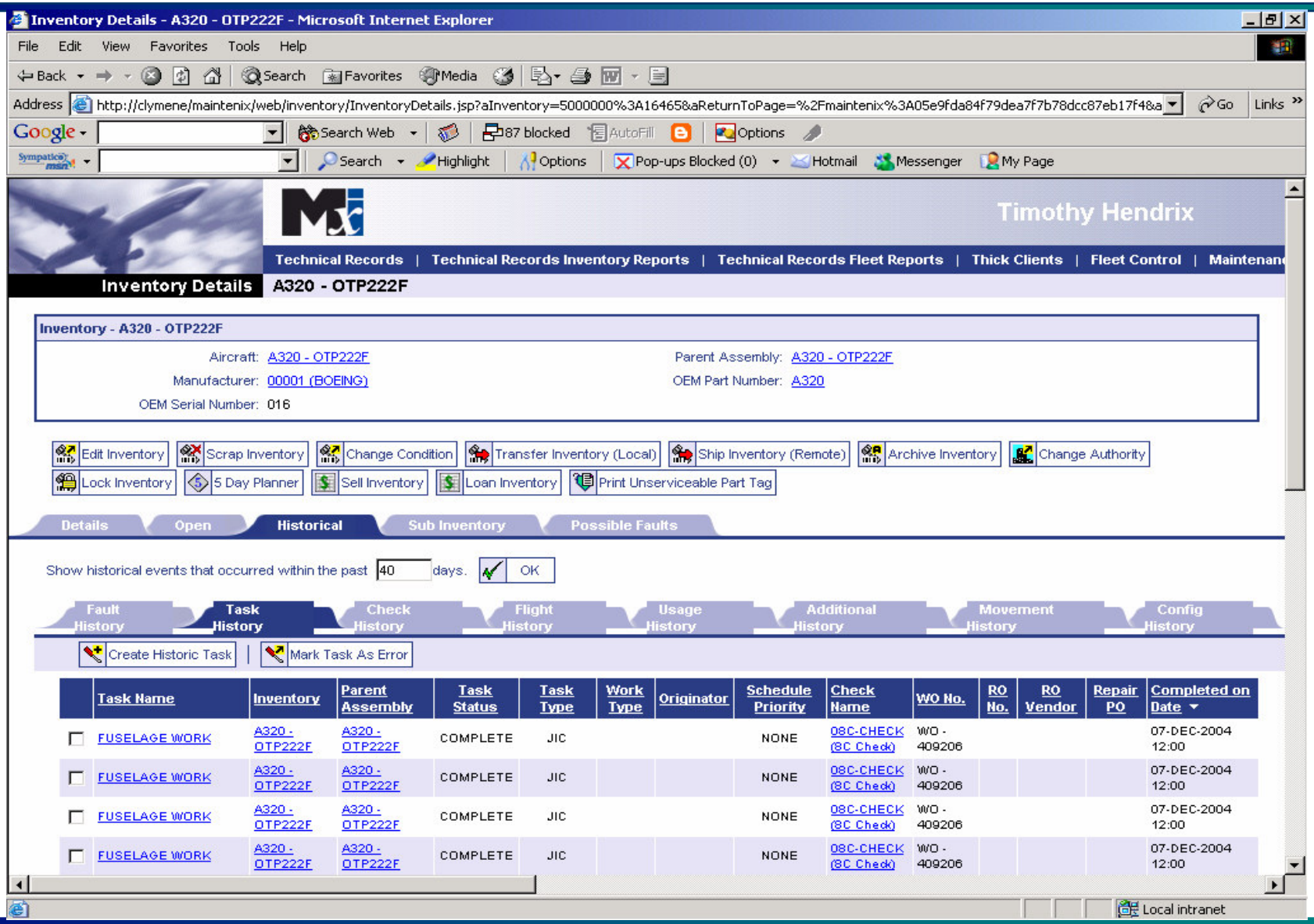
Product Lifecycle Management (PLM): A business approach that applies a consistent set of capabilities in support of the collaborative creation, management, dissemination, and use of product definition (PD) information across the extended enterprise from concept through manufacturing to end of life by integrating people, processes and information through the use of technology. PLM technologies include CAD, CAM, CAE and PDM.

Service Lifecycle Management (SLM): A business approach that applies a consistent set of capabilities in support of the collaborative sustaining engineering, servicing, maintaining, repairing and, or overhauling of a component or asset in order to maintain or return a component or asset to a set of regulatory specifications by synchronizing the enterprise and extended value network and integrating people, processes and information through the use of technology. SLM technologies include CMMS, ECM, DCM, IETM, RCM / MSG-2, CBM / MSG-3, PBM, HUMS and PHM / AHM.

Maintenix functionality is enterprise wide Service Lifecycle Management.



Maintenix uses a J2EE web native, component centric, mechanic role based workflow approach versus the traditional ERP order centric and transaction workflow approach.



Maintenix via Boeing's AME (Automated Maintenance Environment) is the key enabler of NAVAIR's largest & most successful PBL program to date.

Maintenix at the US Navy :

- Maintenance Management of F/A-18 fleet

Scale:

- Fleet of over 1000 aircraft and 2200 GE engines (F404 and F414)
- Operated from more than 120 separate sites and 12 aircraft carriers

Functions:

- Configuration management
- Engineering change management
- Life usage tracking
- Planning & Scheduling
- Electronic log book
- Electronic integration with airframe and engine OEMs

Results:

- Operation Enduring Freedom Sortie rate for VFA-115 was 97.5%
- Operation Iraqi Freedom VFA-115 Averaged over 55 Flight Hours/day
- Depot Turn-around-Time and awaiting parts backlog reduced from 90- 45 days
- F404 Engine Availability went from 55% to a current 85%

Mxi product usage by DOD through Boeing

Maintenix at Boeing "Enterprise One":

- Boeing is a non-exclusive reseller of Maintenix (part of "Enterprise One" offering)
- Primary target market is commercial airlines
- Also targeted for internal Boeing applications
- Also targeted for defense applications
  for Commercial Derivative Aircraft (DAP): C-32 (VIP 757) & C-40 (737-700)
- Multi-Mission Maritime Aircraft (737-800 P-8A)

US Air Force C- 32 "Air Force Two"

US Navy Multi-Mission Maritime Aircraft

Boeing's proposed future use of Mxi for the USAF

Maintenix in consideration to support E- 4B "National Airborne Operations Center" through Boeing

Maintenix was selected by Boeing for the USAF Tanker Fleet Modernization Program

Mxi Commercial Business Client List

Organization	Consideration	Selected	Delivery	Production	Notes
Air Mauritius	✓	✓	✓		
Aloha Airlines	✓	✓	✓	✓	
China Airlines	✓	✓	✓		Taiwan's flag carrier.
Hawaiian Airlines	✓	✓	✓		
KLM Royal Dutch Airlines	✓	✓	✓	✓	International carrier with fleet of 219 aircraft.

Mxi OEM Client List

LOCKHEED MARTIN We never forget who we're working for™	C	S	D	P	Notes
F-35 JSF	✓	✓	✓	✓	Maintenix core component of ALIS
F-22	✓				
C-130J	✓				
US-101	✓	✓			Maintenix selected & procured for ISS demonstration tool to support LMCO's US-101 bid to the Navy.
ALRT	✓				Balance of all LMCO organizations working to standardize on "Autonomic Logistics Readiness Tool" (ALRT) = ALIS Lite
Global Corporate Wide ISS Tool	✓				LM Aero leaning towards core ALIS as standardized ISS solution
DASSAULT AVIATION					
Falcon	✓	✓	✓	✓	
Mirage	✓	✓	✓	✓	
Rafale	✓	✓	✓	✓	
Global Corporate Wide ISS Tool	✓	✓	✓	✓	Includes all FMS In-Service Support
BOMBARDIER Bombardier					
Flexjet	✓	✓	✓	✓	Executive business jet program In-Service Support tool

Legend: C-Consideration, S-Selected, D-Delivery, P-Production

Mxi OEM Client List

BOEING	C	S	D	P	Notes
MES	✓	✓	✓		Boeing “Maintenance Engineering Services” provides complete airline outsourced engineering services and maintenance program optimization
787 GoldCare	✓	✓	✓		Maintenix is at the core of Boeing's "e-enabled" suite of products supporting their flagship OEM insourced fleet management program for the 787 Dreamliner
USN F/A-18 FIRST	✓	✓	✓	✓	Maintenix is the core enabling technology supporting USN F/A-18 “Automated Maintenance Environment” (AME)
USN EA-18G	✓	✓	✓	✓	
USAF C-40B/C	✓	✓	✓	✓	The C-40B's primary customers are the combatant commanders, and the C-40C’s customers include members of the Cabinet and Congress
USAF C-32	✓	✓	✓	✓	The primary customers are the Vice President, using the distinctive call sign "Air Force Two," the First Lady, and members of the Cabinet and Congress.
USAF E-4B	✓				The E-4B serves as the National Airborne Operations Center for the President and Secretary of Defense in case of national emergency
USAF KC-767 Tanker	✓	✓			Maintenix selected as In-Service Support tool in 2003 for Boeing DAP Tanker program
USN C-40A	✓	✓	✓	✓	The C-40A "Clipper" flies the Navy Unique Fleet Essential Airlift (NUFEA) mission.
USN P-8A (MMA)	✓	✓	✓		USN “Multi-Mission Maritime Aircraft “ Program
SAAB VOLVO					
SAAB Gripen & RM12 Powerplant	✓	✓	✓		

Mxi OEM Client List

NORTHROP GRUMMAN	C	S	D	P	Notes
USN E-2D Advanced Hawkeye	✓				
USAF Global Hawk	✓				
Global ISS Tool	✓				Maintenix is under consideration as NGIS' and possibly NG corporate-wide's In-service Support tool
Rolls-Royce					
AE3007	✓	✓	✓	✓	
V2500	✓	✓	✓		
F-136	✓	✓			
Global IS "Service Data Mgmt" Tool	✓				In final stage of negotiations as corporate-wide Commercial, Defence & Maritime Propulsion Systems ISS tool
Sikorsky					
CDN DND MHD S-92	✓	✓	✓		Government of Canada selected the Sikorsky Aircraft-led Maritime Helicopter Team for the $3-billion Maritime Helicopter Project (MHP)= 20 Year PBL Contract.
Global Customer Support (GCS)	✓				Implementing Maintenix in a evaluation environment in consideration of Sikorsky's Global ISS - Customer Support tool.

Mxi Defense Client List

Description	C	S	D	P	Notes
USN F/A-18	✓	✓	✓	✓	Maintenix = Core enabling technology supporting USN F/A-18 "Automated Maintenance Environment" (AME)
USCG Wide In-Service Support Tool	✓				Maintenix in consideration as the US Coast Guard (USCG) fleet-wide ISS tool for all asset types
FMV DoD Wide ISS Tool	✓	✓	✓		Maintenix implementation soon to be complete for Swedish DoD-wide ISS tool for all asset types including all Gripen FMS ISS requirements & major OEMs' I and D level repair work.
CDN. DND					
F/A-18	✓	✓	✓	✓	
MHP	✓	✓	✓		
CDN. DND Wide ISS Tool	✓				
Australian Defence Force	✓				
KAF F/A-18	✓	✓	✓	✓	

Mxi Defense Client List

Description	C	S	D	P	Notes
Czech A/F Gripen	✓	✓	✓		
Hungarian A/F Gripen	✓	✓	✓		
South African Air Force Gripen	✓	✓	✓		
NATO Flight Training					Foreign Military Fighter Pilot Training School. O-level A/C turnaround of 12 minutes. Allowed target SGR with the procurement of 10% fewer A/C.
BAE Hawks	✓	✓	✓	✓	
Raytheon Texan II	✓	✓	✓	✓	