International Council on Systems Engineering
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Enterprise Architecting to Advance Reliability and Maintainability Decision-Making

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Hello.

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- **The Problem**
  - Lifecycle Costs
  - Sustainment Complexity
- **The Method**
  - Enterprise Architecting
  - A Reliability and Maintainability Exemplar
- **The Solution**
  - Decision-Making Architecture
  - Decision Support System
- **Conclusion**

Georgia Tech Research Institute
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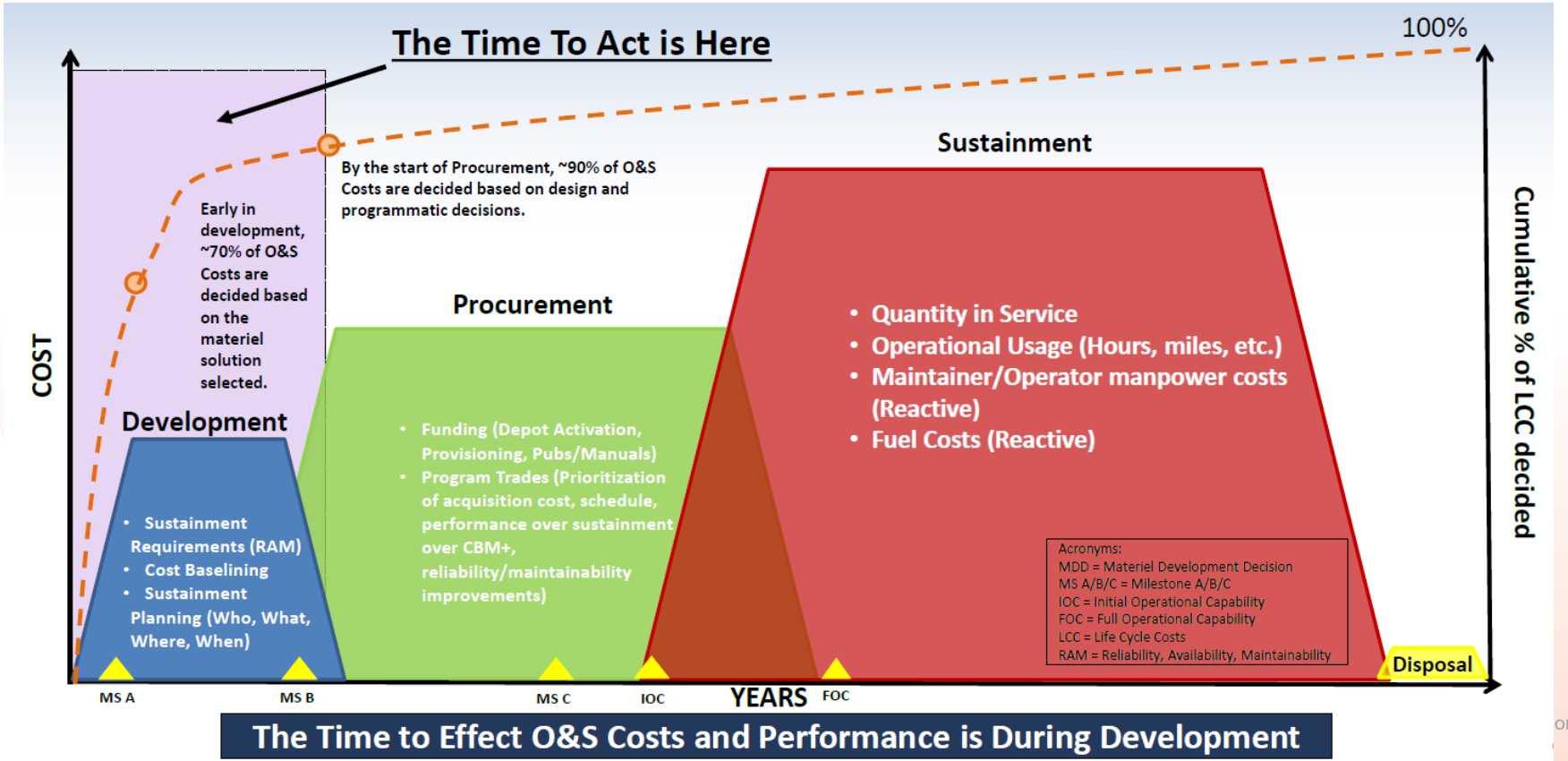
The Problem: Sustainment's Cost and Complexity

- Lifecycle Costs
- Sustainment Complexity:
  - An Enterprise of Enterprises
  - Reliability and Maintainability's Critical Role
  - Enterprise Management

Lifecycle Costs: Driven By Sustainment

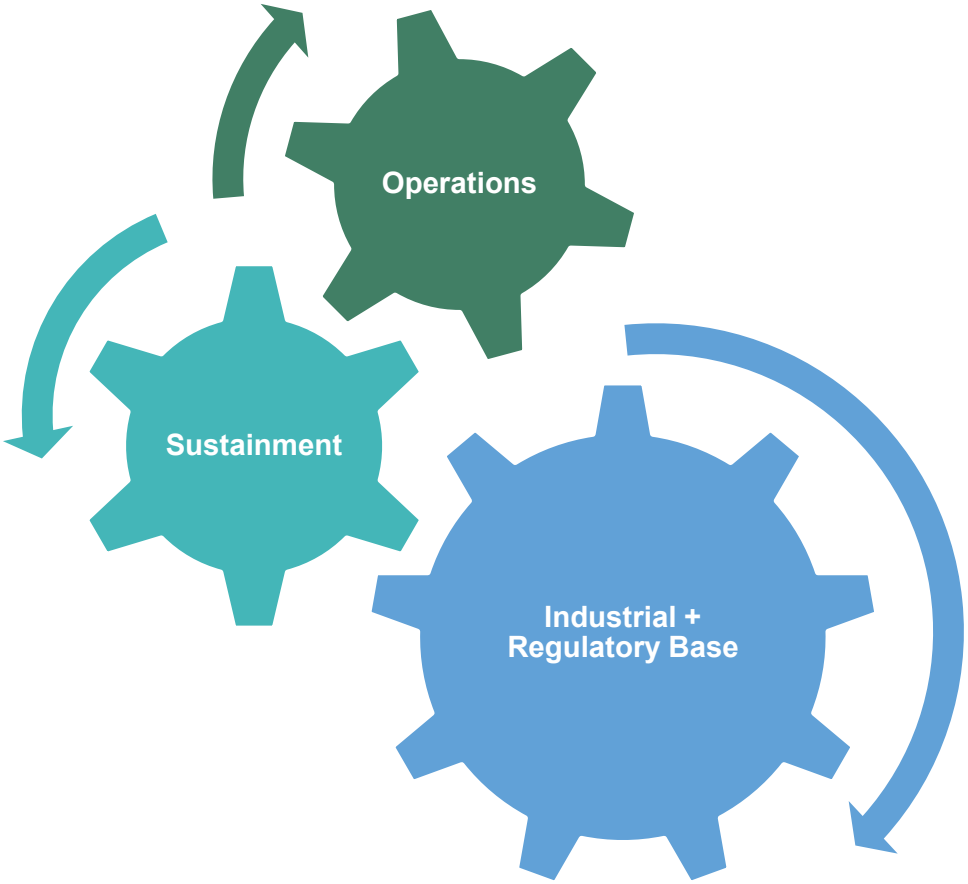


The Time to Effect O&S Costs and Performance is During Development

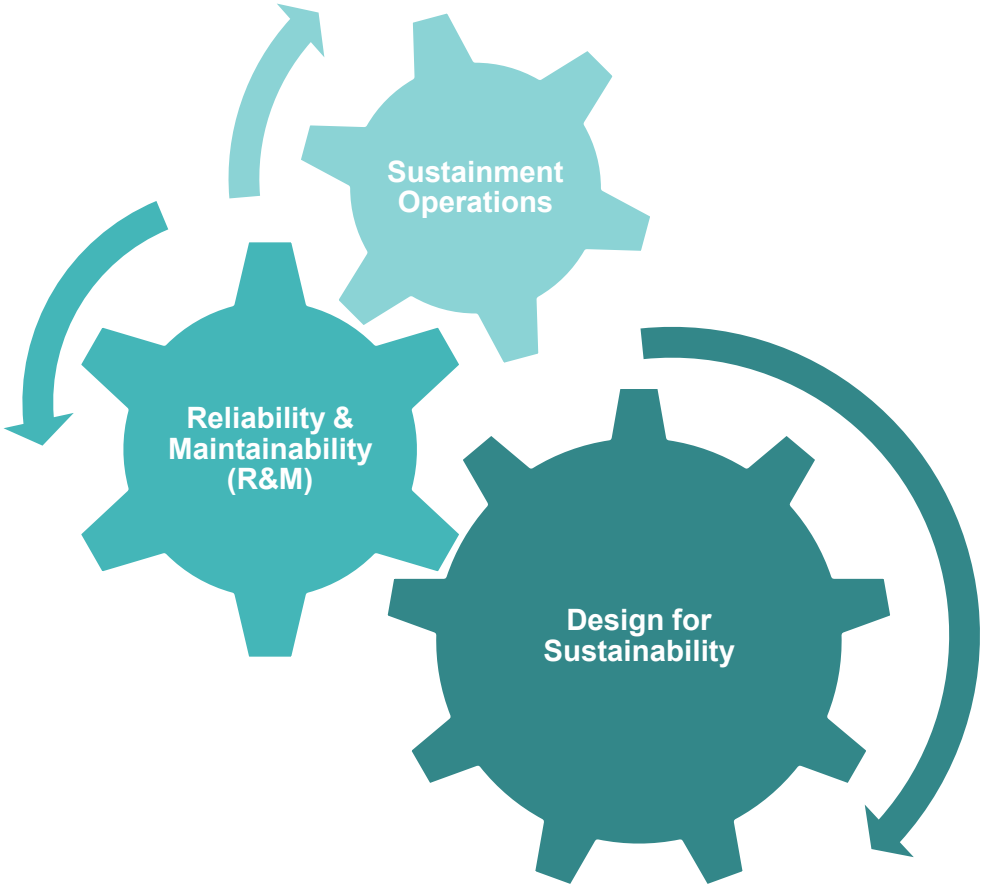
Source: 2022 DoD Product Support Managers Workshop, Principal Deputy Assistant Secretary of Defense (Sustainment)

Sustainment: An Enterprise of Enterprises

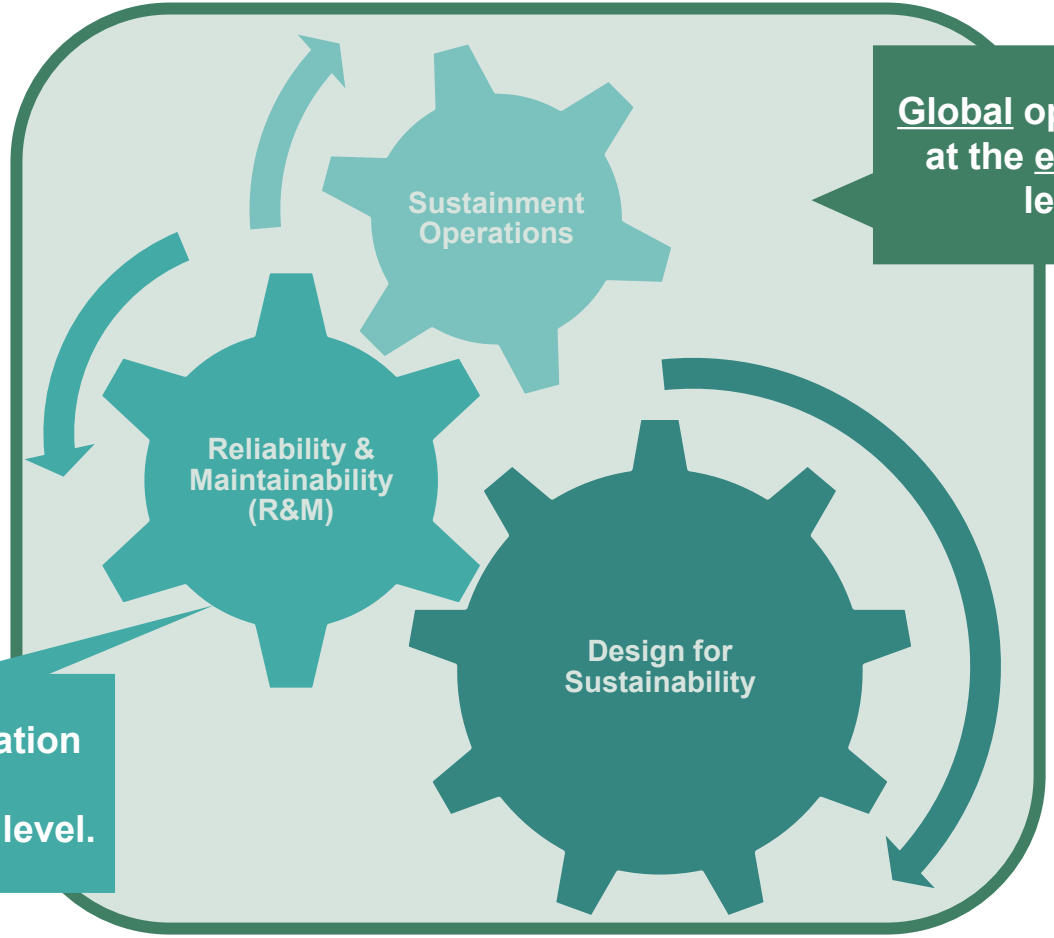
Enterprise Definition:
"A highly complex, sociotechnical systems of systems that depend on the intelligent interaction, creation, management and use of various forms of knowledge throughout their organizational policies, processes and structures."
-INCOSE Enterprise Value Working Group, 2024



Sustainment Enterprise Complexity: R&M's Critical Role



Sustainment Enterprise Management: Local vs Global Optimization



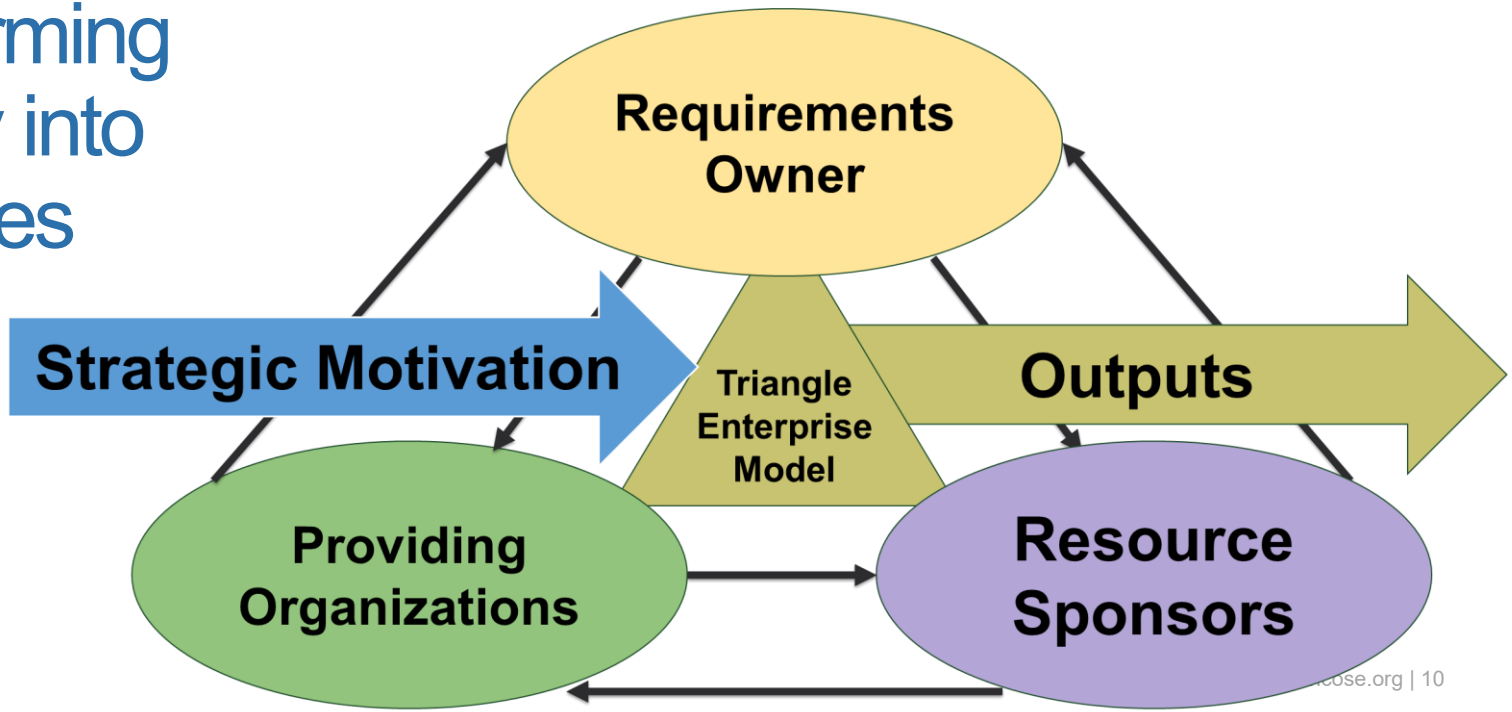
Global optimization at the enterprise level.

Local optimization at the organizational level.

The Method: An Enterprise Architecting R&M Exemplar

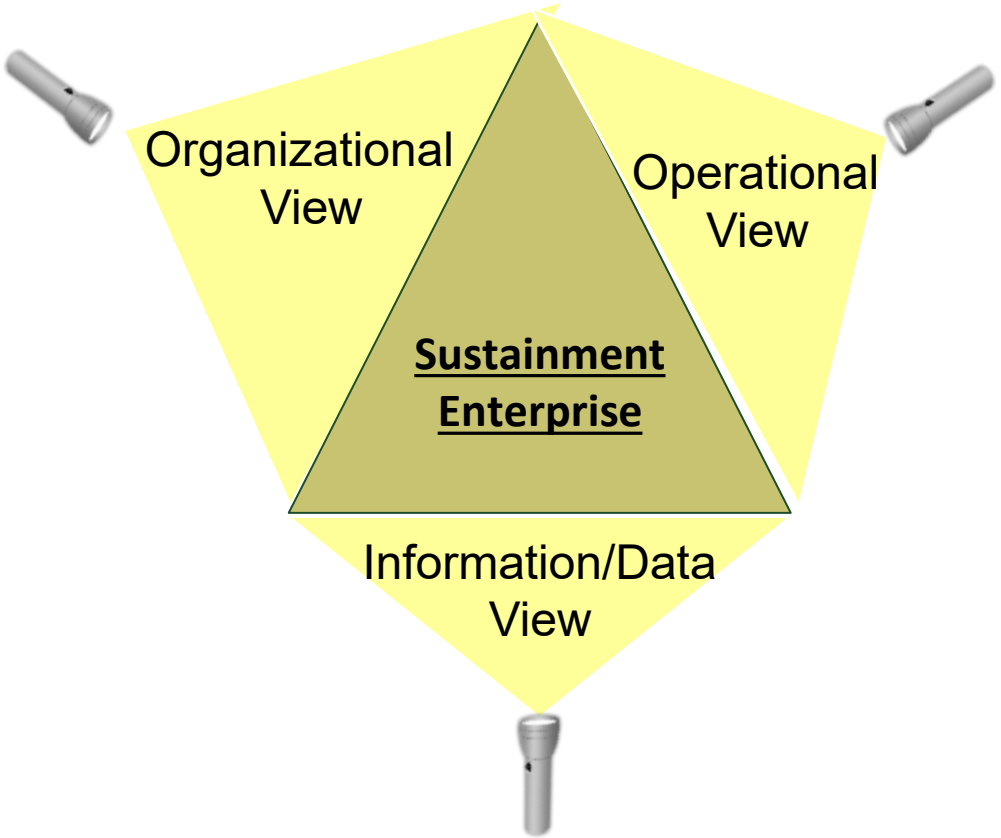
- Enterprise Decision-Making
- Enterprise Perspectives
- R&M Views

Enterprise Decision Making: Transforming Strategy into Outcomes

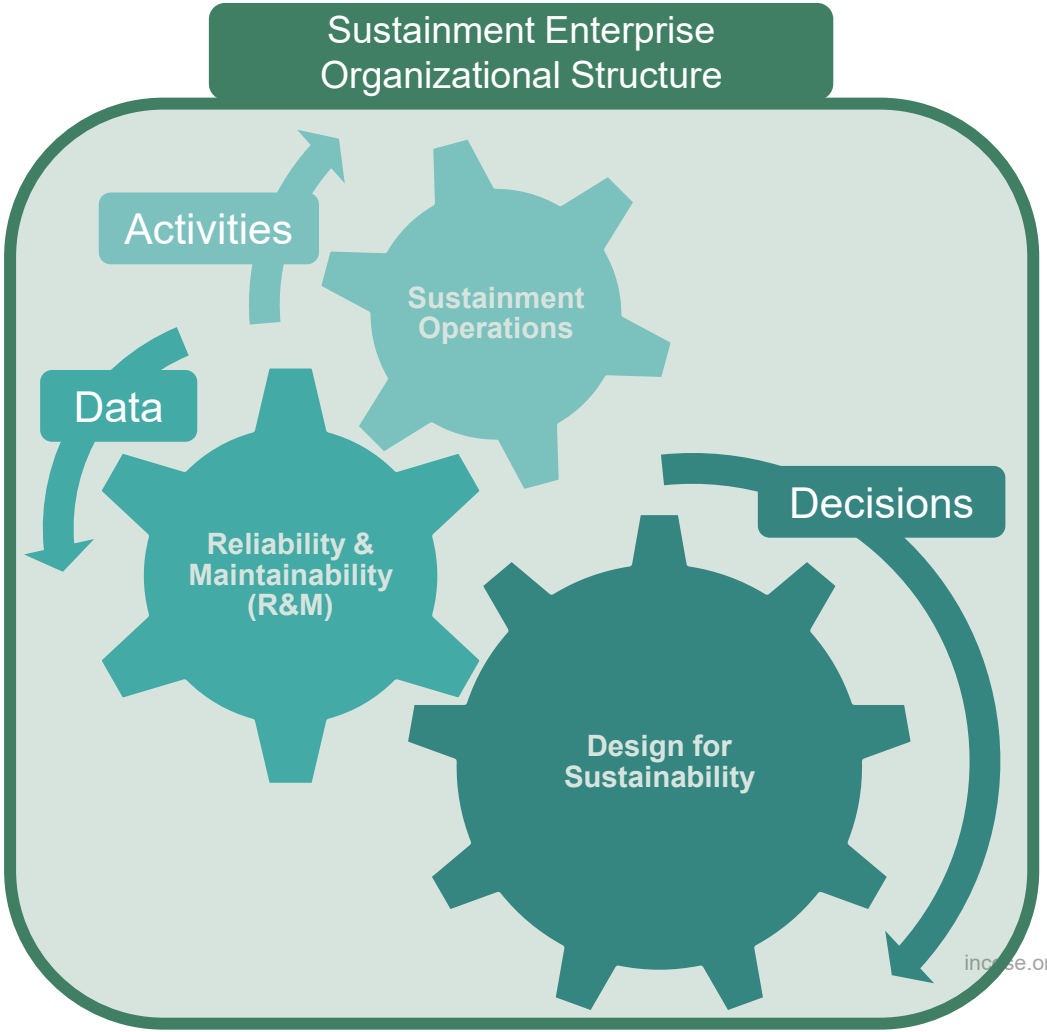


Enterprise Perspectives: Insight on Complexity

Decision-Making Architectural Approach



R&M Views: Characterizing Enterprise Decisions, Data, and Activities



R&M Exemplar: United States Air Force (USAF) Commercial Derivative Aircraft (CDA)

R&M performance monitored by a Continuous Analysis and Surveillance System (CASS).

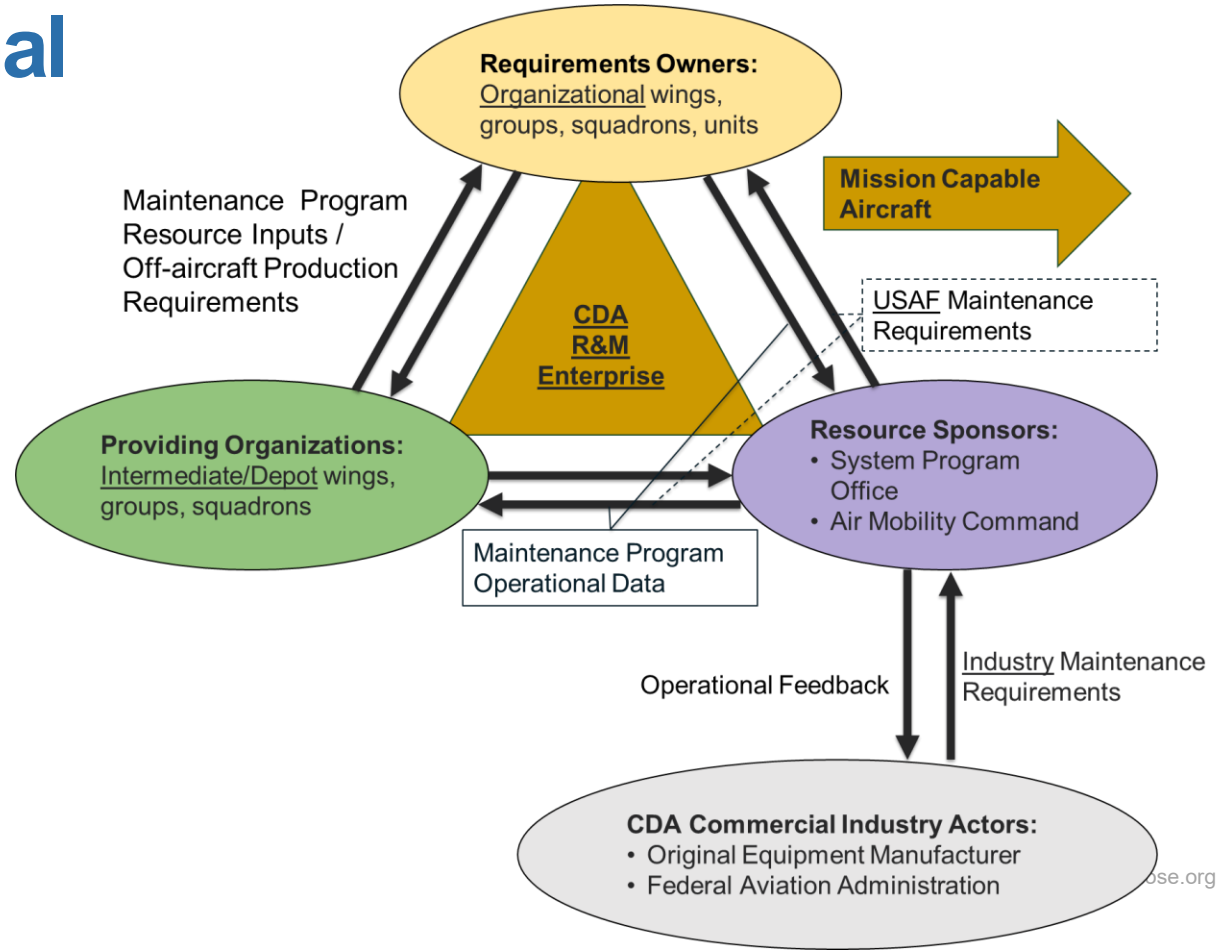
USAF KC-46A Pegasus CDA

Image Source: https://www.businessinsider.com/boeing-ramp-up-inspections-after-us-air-force-rejects-kc-46-deliveries-2019-4

The Solution: Architecture-Based R&M Enterprise Decisions

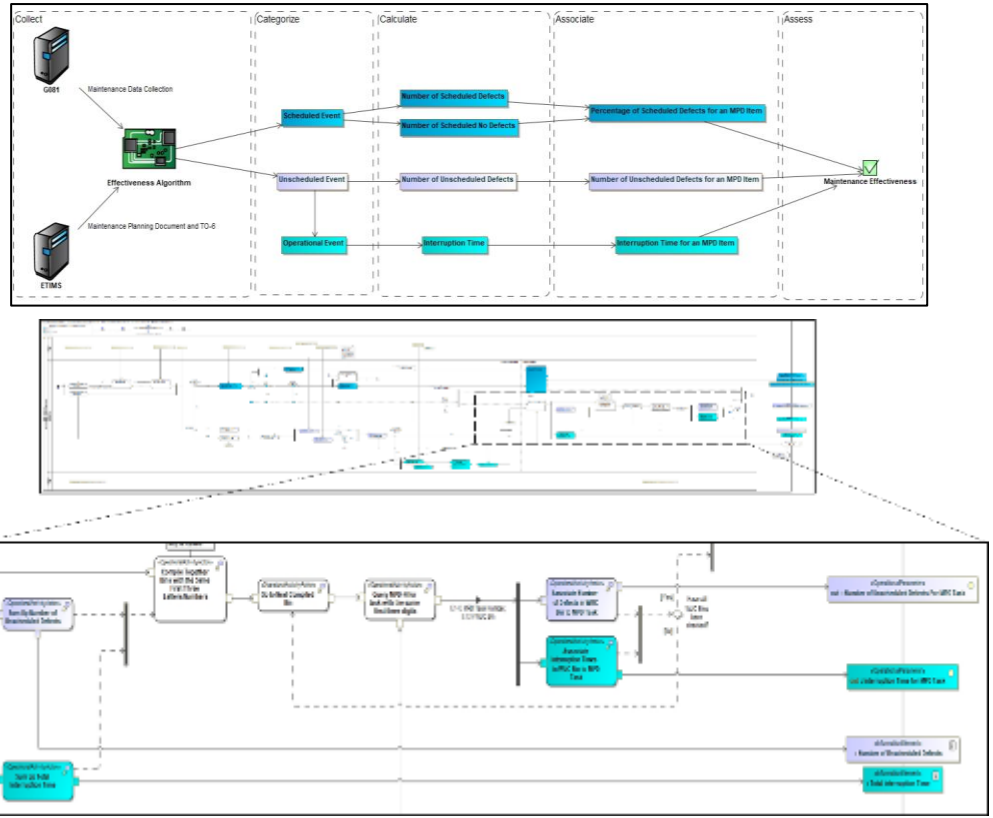
- Decision-Making Architecture:
  - Organizational View
  - Operational Views
  - Data/Information Views
- Decision Support System:
  - Framework
  - Parameters
  - Tool

Organizational View: Abstracting Enterprise Interactions in the CDA's R&M Domain



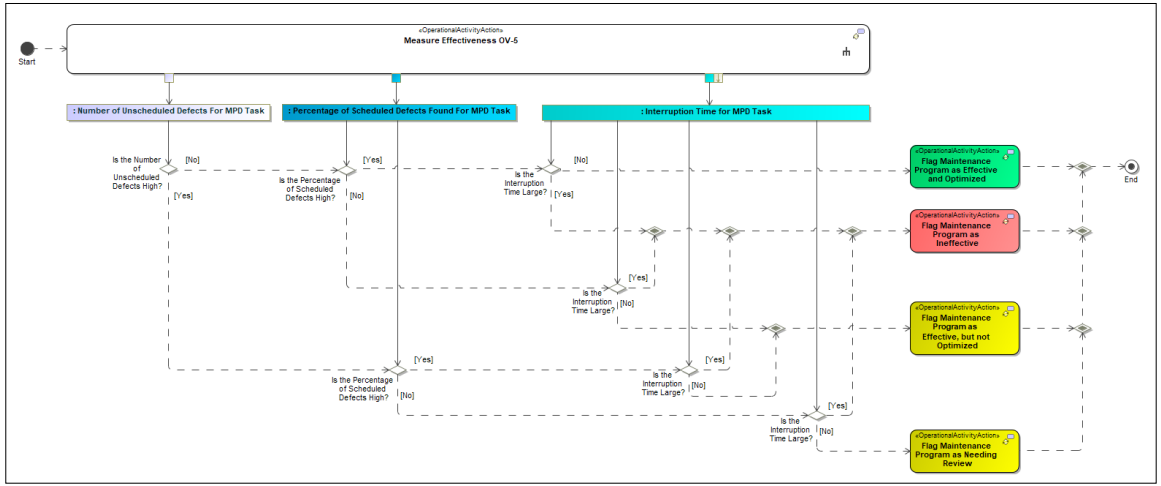
Operational Views: Abstracting Enterprise Logic and Resource Exchanges in R&M Decision-Making

CASS Maintenance Task Evaluation Models



Operational Views: Abstracting Enterprise Logic and Resource Exchanges in R&M Decision-Making

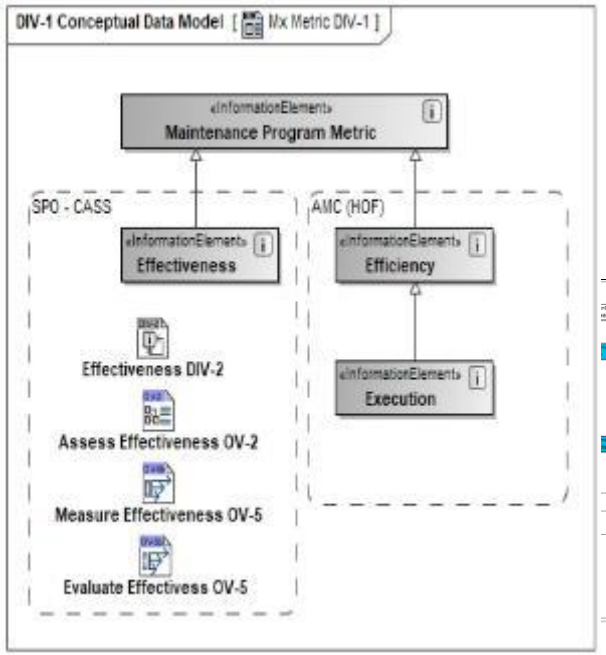
CASS Maintenance Task Performance Models

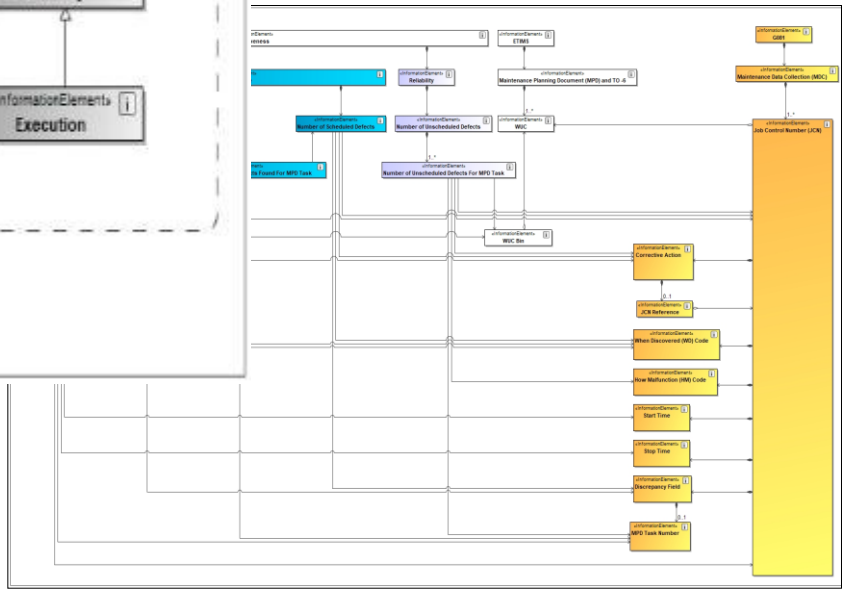


	Low Number of Unscheduled Defects		High Number of Unscheduled Defects	
	Low Operational Impact	High Operational Impact	Low Operational Impact	High Operational Impact
Low Number of Scheduled Defects	Effective, but not Optimized	Ineffective	Additional Analysis Needed to Determine Effectiveness	Ineffective
High Number of Scheduled Defects	Effective and Optimized	Ineffective	Effective, but not Optimized	Ineffective

Data / Information Views: Abstracting Enterprise R&M Decision-Making Information

CASS Maintenance Task Data Models

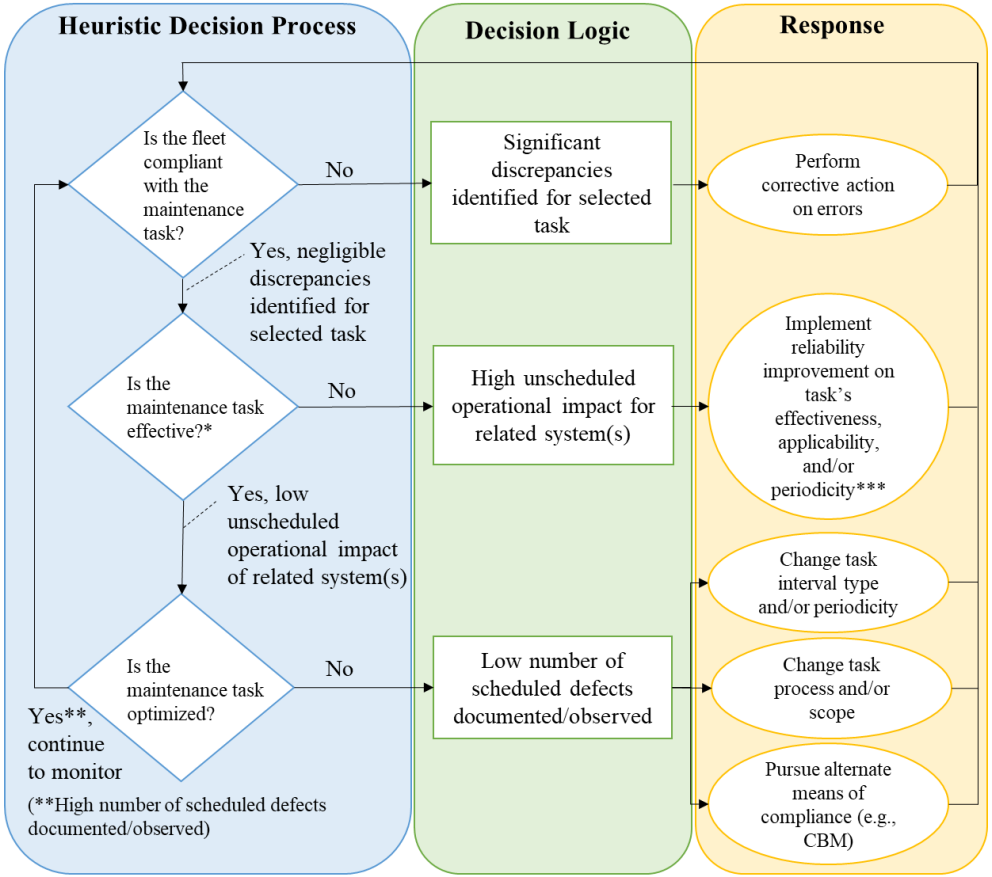




Enterprise R&M Decision Support System: Implementing Adaptive R&M

- Framework
- Parameters
- Tool

CDA R&M Decision-Making Framework: Connecting Heuristics, Decision Logic, and Enterprise Responses



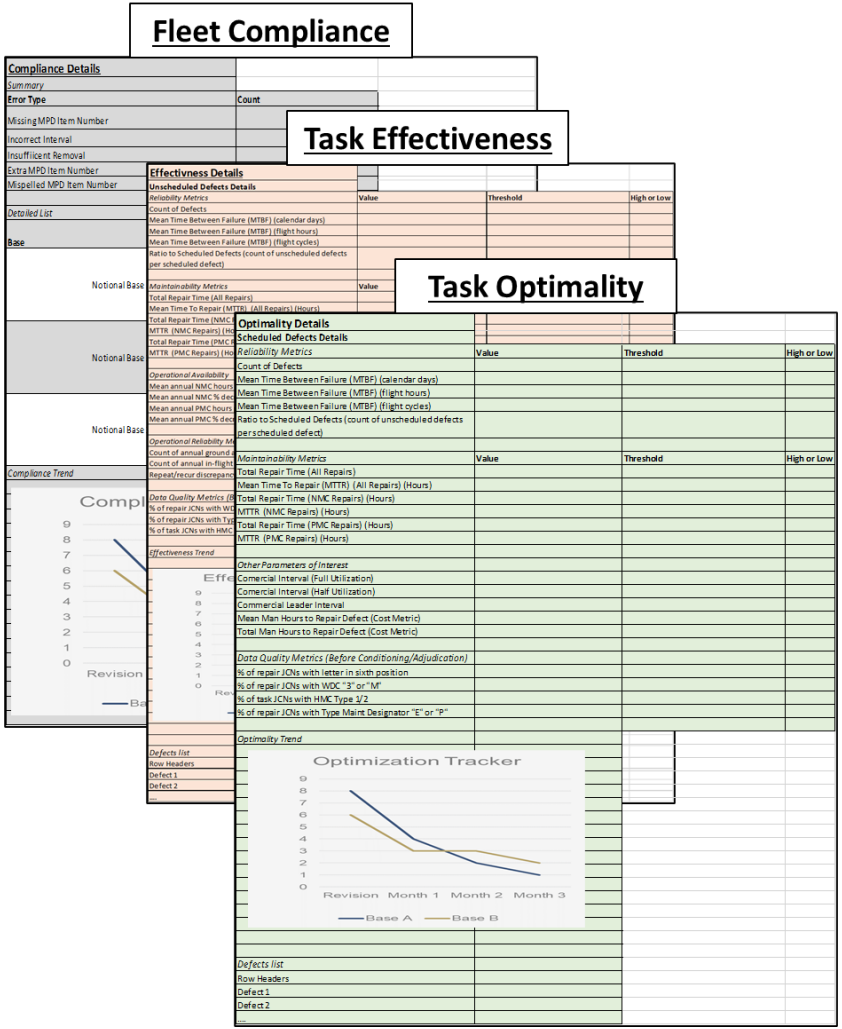
*The task's effectiveness is inconclusive when answering this heuristic if there is are low scheduled defects and unscheduled operational impact with high unscheduled defects. In this situation, more analysis is required to determine why the unscheduled defects are not being prevented by the scheduled maintenance task.

***If a maintenance task is deemed to be effective after reliability analysis, pursue an alternate root cause improvement such as an engineering design change or modification to aircrew flight procedures.

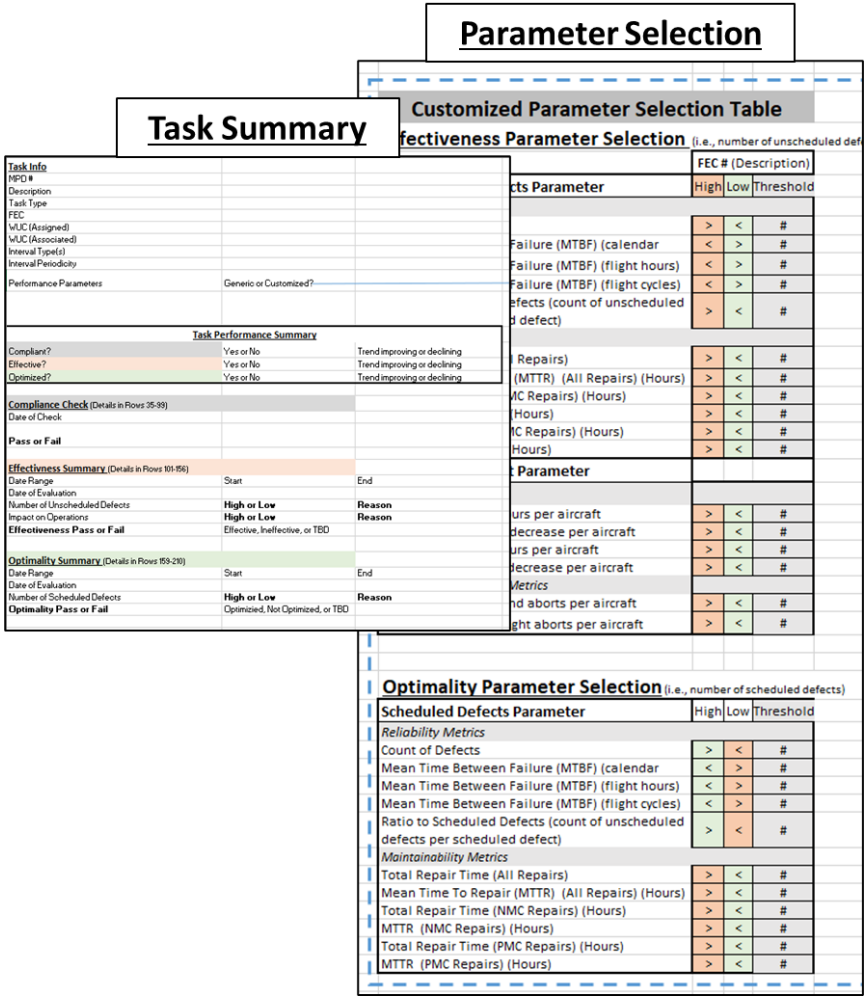
CDA R&M Decision-Making Parameters: Quantifying Performance to Satisfy Strategic Motivations

Heuristic Performance Category	Decision Logic Category	R&M Category	Metric	Example Threshold
Effectiveness	Unscheduled Defects	Reliability	Count of Defects	High > 10 > Low
			Mean Time Between Failure	High < 7 Calendar Days < Low
			Ratio to Scheduled Defects	High > 0.1 > Low
		Maintainability	Total and Mean Repair Times (Non-Mission Capable (NMC) Hours)	High > 75 (total) or 7.5 (mean) > Low
			Total and Mean Repair Times (Partial Mission Capable (PMC) Hours)	High > 25 (total) or 2.5 (mean) > Low
	Operational Impact	Operational Availability	Mean Annual NMC/PMC Hours per Aircraft	High > 100 (NMC) or 75 (PMC) > Low
			Mean Annual NMC/PMC Percent Decrease per Aircraft	High > 1.14 (NMC) or 0.86 (PMC) > Low
		Operational Reliability	Count of Annual Ground Aborts per Aircraft	High > 1 > Low
			Count of Annual In-Flight Aborts per Aircraft	High > 1 > Low
Optimality	Scheduled Defects	Reliability	Count of Defects	High > 10 > Low
			Mean Time Between Failure	High < 7 Calendar Days < Low
			Ratio to Unscheduled Defects	High > 10 > Low
		Maintainability	Total and Mean Repair Times (Non-Mission Capable (NMC) Hours)	High > 75 (total) or 7.5 (mean) > Low
			Total and Mean Repair Times (Partial Mission Capable (PMC) Hours)	High > 25 (total) or 2.5 (mean) > Low

CDA R&M Decision Support Tool: Implementing Architecture-Based Enterprise Improvements



CDA R&M Decision Support Tool: Implementing Architecture-Based Enterprise Improvements



Conclusion

- Discussion
- Recommendations
- Acknowledgements

"Digital product support uses digital engineering methods and digital data and system models to implement the Product Support Strategy, enable data-driven decision making, and deliver effective and efficient product support outcomes throughout the system lifecycle."

U.S. Department of Defense Digital Product Support Definition

Defense Acquisition University, 2025

Recommendations

1. Apply to other vehicle fleets
2. Expand to other sustainment enterprises (e.g., supply chain, repair network)
3. Develop a comprehensive enterprise architecture using UAF

Acknowledgements

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