



# A Framework for Developing a Digital System Model Taxonomy

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**for Systems Engineering**

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# Abstract

The current DoD acquisition of major weapons systems and information technology is a linear process that spans over a number of years. Beginning with fixed requirements and a small number of early designs, the process is built for acquisition support, and not easily modifiable. Over the years, the trend has been towards independent activities and data sources, which has led to redundant processes, miscommunication, errors and rework. As a result, there is no commonly instantiated method or taxonomy for organizing, tracking, and sharing the authoritative technical data and associated artifacts across the lifecycle.

The DSM is an ongoing initiative in Office of the Deputy Assistant Secretary of Defense for Systems Engineering (ODASD(SE)) to build an integrated authoritative taxonomy to address this issue. This paper continues the discussion on the work done to date to develop the DSM taxonomy, as a means for organizing technical data that span from requirements through sustainment. Successes, observations, challenges and areas of future work are also presented.



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# DASD, Systems Engineering



 **DASD, Systems Engineering**  
**Stephen Welby**  
**Principal Deputy Kristen Baldwin** 

 **Major Program Support**  
**James Thompson**

*Supporting USD(AT&L) Decisions with Independent Engineering Expertise*

- Engineering Assessment / Mentoring of Major Defense Programs
- Program Support Assessments
- Overarching Integrated Product Team and Defense Acquisition Board Support
- Systems Engineering Plans
- Systemic Root Cause Analysis
- Development Planning/Early SE
- Program Protection

 **Engineering Enterprise**  
**Robert Gold**

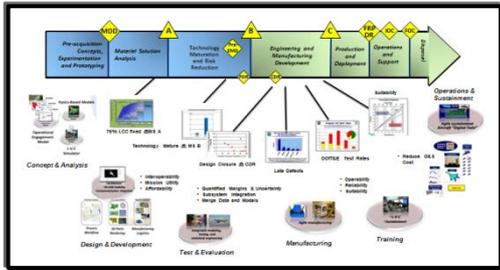
*Leading Systems Engineering Practice in DoD and Industry*

- Systems Engineering Policy and Guidance
- Technical Workforce Development
- Specialty Engineering (System Safety, Reliability and Maintainability, Quality, Manufacturing, Producibility, Human Systems Integration)
- Security, Anti-Tamper, Counterfeit Prevention
- Standardization
- Engineering Tools and Environments

**Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs**



# Overview of Engineering Tools and Environments

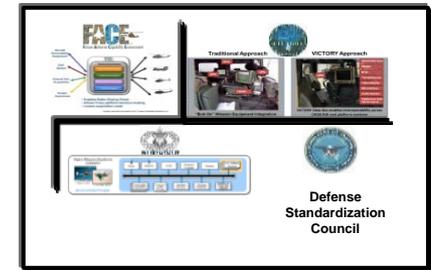


- Digital System Model/Digital Thread
- Education
- Policy & Guidance
- Data Rights



## Engineered Resilient System

Developing integrated suite of modern engineering tools: models and related capabilities, tradespace assessment and visualization tools; all within an architecture aligned with acquisition and operational business processes.



- BBP 3.0
- Technical Standards
- Curriculum Development

## Modular Open Systems Architecture

Identifying Data, Standards, and Tools for Modular and Open Systems Design

Identifying acquisition approaches and support for more capable, modular, and rapidly upgradeable systems

## Digital Engineering Design

Transforming DoD towards model-centric practices by shifting away from a linear, document-centric acquisition process towards a dynamic digital model-centric ecosystem

*Digital System Model: Develop a structure for organizing programs' technical data*

**Engineering processes, tools and techniques incorporating the latest digital practices for making informed decisions throughout the acquisition life cycle**

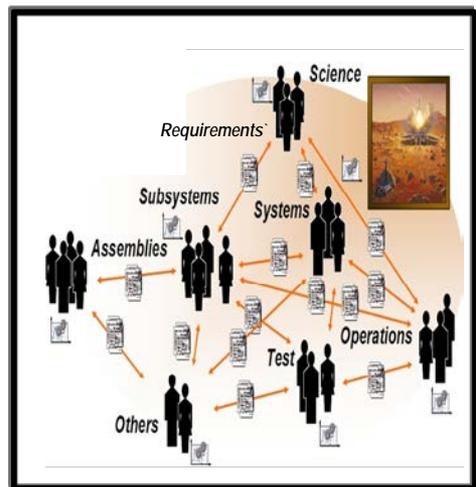


# Vision of Digital Model-Centric Engineering



Shifting away from a linear, document-centric acquisition process towards a dynamic digital model-centric ecosystem

- Digital Models: Data – or – algorithm – or – process – or – hybrid
- Low fidelity, implicit representations shift to high fidelity, explicit models serving as the “single source of truth” for all uses (e.g. ecosystem overlap with CADE, TRMC data efforts, etc.)
- Documents shift from the primary role of specification to the secondary role of communication



Today: Stove-piped data sources



Future: Dynamic Digital Model-Centric Ecosystem



# Leveraging Multiple Activities to Advance Digital Engineering within DoD



## Infusion in Policy and Guidance

DoDI 5000.02, Enclosure 3, Section 9: Modeling and Simulation

Defense Acquisition Guidebook Chapter 4

DoD Digital Engineering Fundamental

Defense Acquisition Guidebook Chapter 4

<http://www.acq.osd.mil/se/pg/guidance.html>

## DoD Initiatives

Digital Engineering Working Group

DoD Digital Engineering Working Group

ERS: Adapting to changing requirements

SERC: Model Centric Collaborative Environment

DSM Taxonomy: Foundation for defining categories of data across acquisition

## Other Partnerships



Additive Manufacturing

IAWG

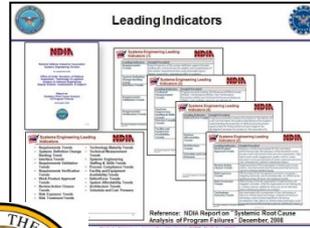
Inter-Agency Working Group on the Engineering of Complex Systems



NASA: Sounding Rocket Program

NDIA: Essential Elements of the System Model

Leading Indicators



USAF Own the Technical Baseline



# Advancing the state of practice for Digital Engineering within DoD



# Digital System Model: Concept



## Current Issue

- There is no commonly instantiated method or taxonomy for organizing, tracking, and sharing the technical data and associated artifacts across the life cycle.

## Current Vision

- The Digital System Model (DSM) is an ongoing initiative in ODASD(SE) to build an integrated taxonomy to provide stakeholders a structure for the types of data that should be considered across the life cycle.
- The Digital Thread (DT) provides the analytical framework, based on the DSM, to access, integrate and transform disparate data into actionable information that informs decision making.

## Digital System Model Definition

- A digital representation of a defense system, generated by all stakeholders that integrates the authoritative technical data and associated artifacts which define all aspects of the system for the specific activities throughout the system life cycle.

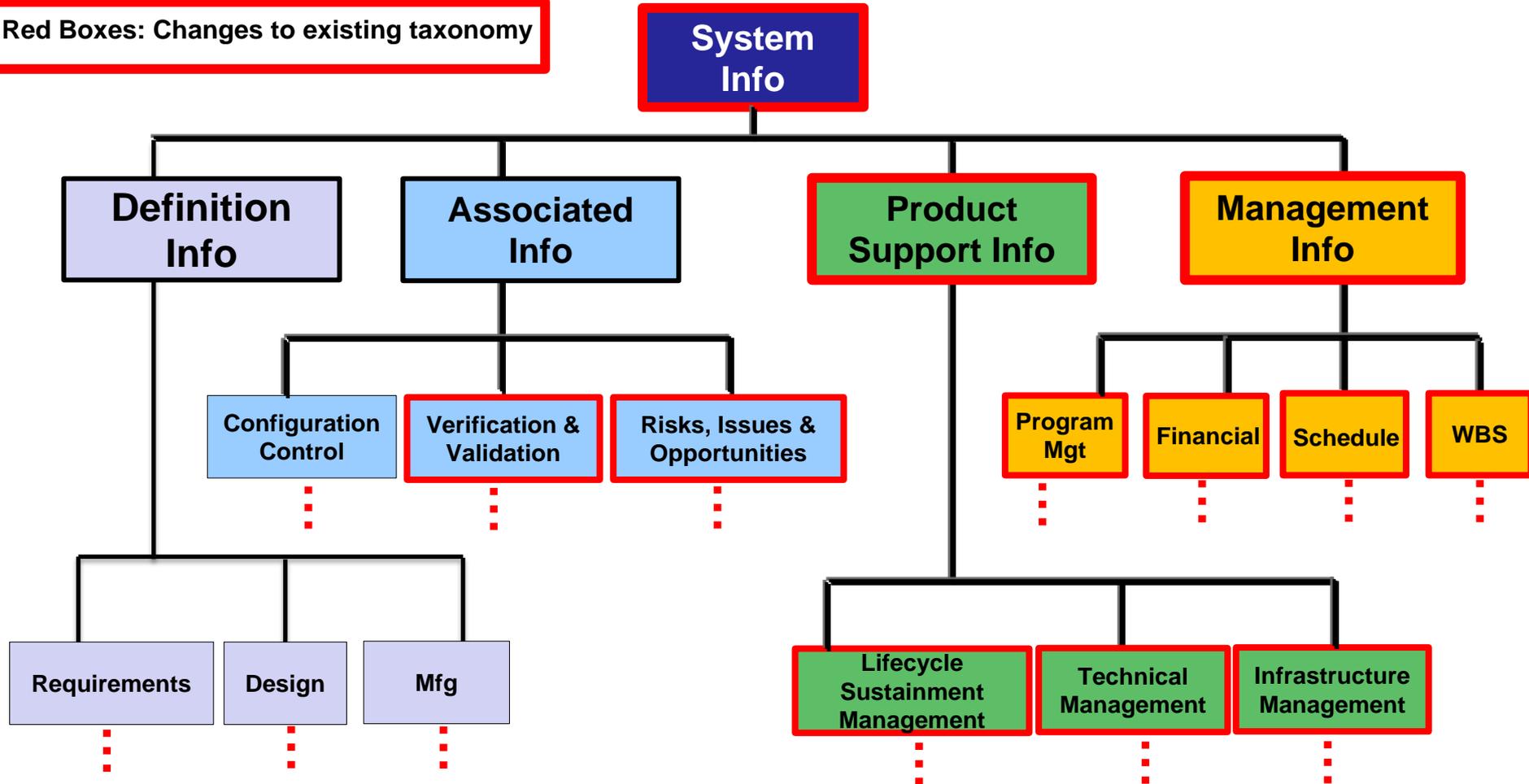
<https://dap.dau.mil/glossary/pages/3384.aspx>



# Proposed Taxonomy Extending DAG Chapter 4



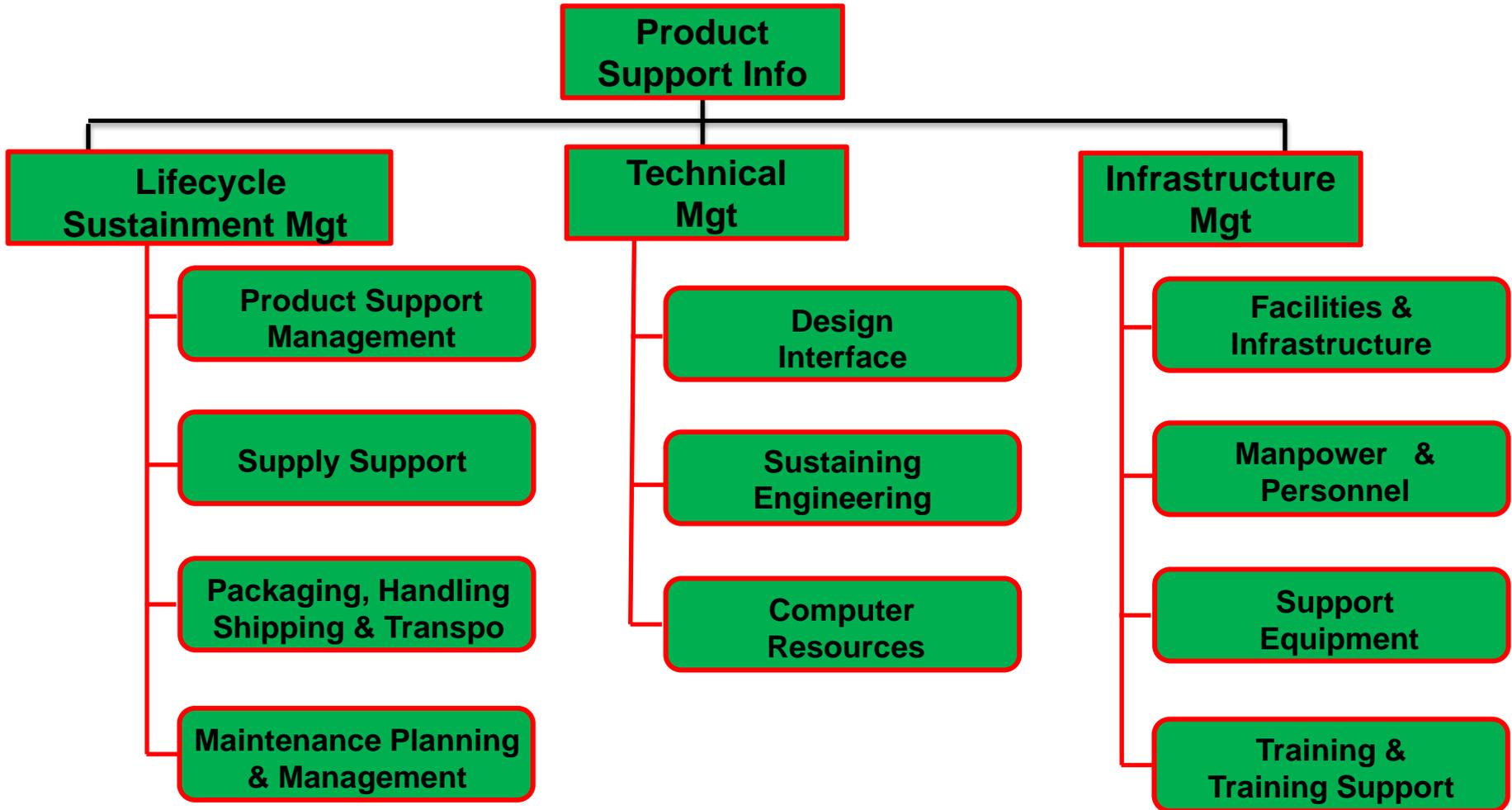
Red Boxes: Changes to existing taxonomy



The Digital System Model Taxonomy expands on level 4 of the data taxonomy in Chapter 4 of the Defense Acquisition Guidebook



# Product Support Information



Collaborated with CAPE/AFCCA and LM&R to develop the product support information



# Gap Analysis of Current Taxonomy



- **DAG Ch. 4 taxonomy was based on work done by the Army Product Data & Engineering Working Group (PEWG).**
  - Provided definition of data from a product oriented perspective
- **Management, financial, and computer software were based on DFARS**
  - The current taxonomy is based on acquiring the system vs. engineering the system
- **No delineation between the DAG Ch. 4 Technical Management and Technical Processes**
  - All area are not accounted for in the current taxonomy (e.g., conceptual and detailed design, implementation, and product support info)
- **There are no standards, policy or guidance to define the lower levels of the taxonomy**
  - As an example, the ISO/IEC 15288, MIL-STD 961E, and DAG Ch. 4 all include various requirement types



# Digital Engineering Digital System Model



## Technical Management Processes

**Technical Planning**  
4.3.2

**Decision Analysis**  
4.3.3

**Technical Assessment**  
4.3.4

**Reqs Mgt**  
4.3.5

**Risk, Issues, & Opp Mgt**  
4.3.6

**Configuration Mgt**  
4.3.7

**Tech Data Mgt**  
4.3.7

**Interface Mgt**  
4.3.8

## Technical Processes

**Definition Info**

**Concept Def**  
4.3.10

**System Reqs**  
4.3.11

**Architecture**  
4.3.12

**Design**  
4.3.12

**Realization Info**

**Integration**  
4.3.14

**Verification**  
4.3.15

**Validation**  
4.3.16

**Implementation**  
4.3.13

**Deployment & Use**

**Transition**  
4.3.17

**Product Support**

***Incorporates DAG Ch 4 technical management processes and technical processes from concept through disposal***



# Other Initiatives to Enable the Digital System Model



- **Modular Open Systems Architecture**

- Promote necessary license rights for planning, management, and proper use of data
- Identifying common data models (owning modularity and interface data)
- Identifying methods, processes and tools for assessing MOSA implementation
- Standardized data description for openly defined data formats
- Ensures the system stakeholders can share and exchange data consistently

- **Digital Engineering Working Group**

- Explore transitioning traditional acquisition processes to a digital model-centric environment by shifting towards a dynamic ecosystem that would supplant documents/models.
- Develop the Digital Engineering concept that will be implemented across engineering functions and subsequently within the Defense Acquisition System.



# Challenges



## Taxonomy and Use

- ❖ Determining what data are needed
- ❖ Creating and associating metadata tagging
- ❖ DSM architecture and infrastructure
- ❖ Standards and shared definitions
- ❖ Use in Contracting

## Tools

- ❖ Communicating information to decision-makers
- ❖ Usability and cost-effectiveness
- ❖ Interoperability
- ❖ Training

## Data Access and Use

- ❖ Accessing and sharing data across the lifecycle and organizations
- ❖ Protecting data while enabling sharing across security domains
- ❖ Re-using of technical work products
- ❖ Defining governance process
- ❖ Data Rights



# Summary/Next Steps



## Summary:

- Digital Model-Centric Engineering will continue to enable our Systems Engineering workforce and practices
- Leveraging multiple activities, industry and professional organizations to advance digital model-centric engineering within DoD
- Many unknowns still exist in use of the digital engineering artifacts
  - Continuing to develop the DSM to provide a structure for organizing program technical data

## Next Steps:

- Further develop the DSM taxonomy based on an aircraft use case
- Vet the taxonomy with the consortium of collaborators
- Work with DASD(SE) to incorporate updates to policy and guidance



# Systems Engineering: Critical to Defense Acquisition



***Defense Innovation Marketplace***  
<http://www.defenseinnovationmarketplace.mil>

***DASD, Systems Engineering***  
<http://www.acq.osd.mil/se>



# Information



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