A Framework for Developing a Digital System Model Taxonomy

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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

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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

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 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/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.

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

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
- SERC: Model Centric Collaborative Environment
- Defense Acquisition Guidebook Chapter 4

DoD Initiatives
- DoD Digital Engineering Working Group
- Digital Engineering Working Group
- ERS: Adapting to changing requirements
- DSM Taxonomy: Foundation for defining categories of data across acquisition

Other Partnerships
- IAWG: Inter-Agency Working Group on the Engineering of Complex Systems
- Additive Manufacturing
- NASA: Sounding Rocket Program
- NDIA: Essential Elements of the System Model
- USAF Own the Technical Baseline

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

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.

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