Advancing Digital Model-Centric Engineering: Digital System Model/Digital Thread

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Systems Engineering (ODASD(SE))
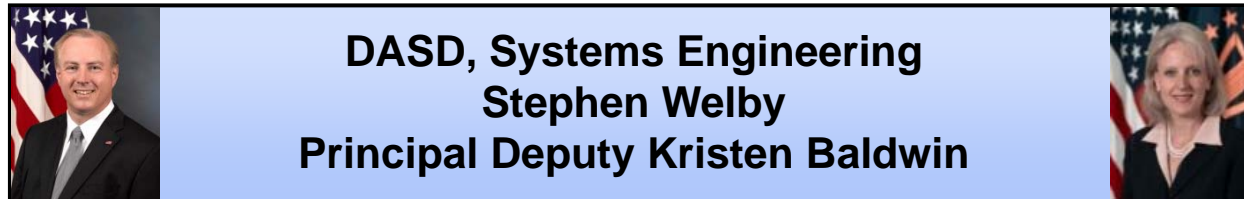
NDIA M&S Committee

August 17, 2015

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- **DASD (SE) Organization**
- **Overview & Foundation for Advancing Digital Model-Centric Engineering**
- **Digital System Model/Digital Thread**
- **Challenges / Issues**
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DASD, Systems Engineering

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

**Major Program Support
James Thompson**

**Engineering Enterprise
Robert Gold**

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

*Leading Systems Engineering Practice
in DoD and Industry*

- **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**

- **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

Engineering Tools and Environments

ETE

Promote the Following:

- **Digitally shareable information**
- **Collaborative design and decision support**

- **Dynamic ecosystem of competition and cooperation**

- **Reuse of historical and current data**
- **Sensible business practices**

Digital Engineering Design

- **Digital System Model/Digital Thread**
- **Education**
- **Policy & Guidance**
- **Data Rights**
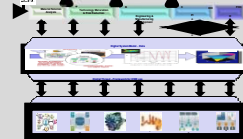
Engineered Resilient Systems

- **Trade Space Analysis**
- **SERC**
- **CREATE/HPCMO**

Modular Open Systems Architecture

- **BBP 3.0**
- **Technical Standards**
- **Curriculum Development**

Defense Standardization Council

Outreach: NASA, FAA, VA, DHS, INCOSE, NDIA, MBE Summit, DoD Components

Engineering processes, tools and techniques incorporating the latest digital practices for making informed decisions throughout the acquisition lifecycle.
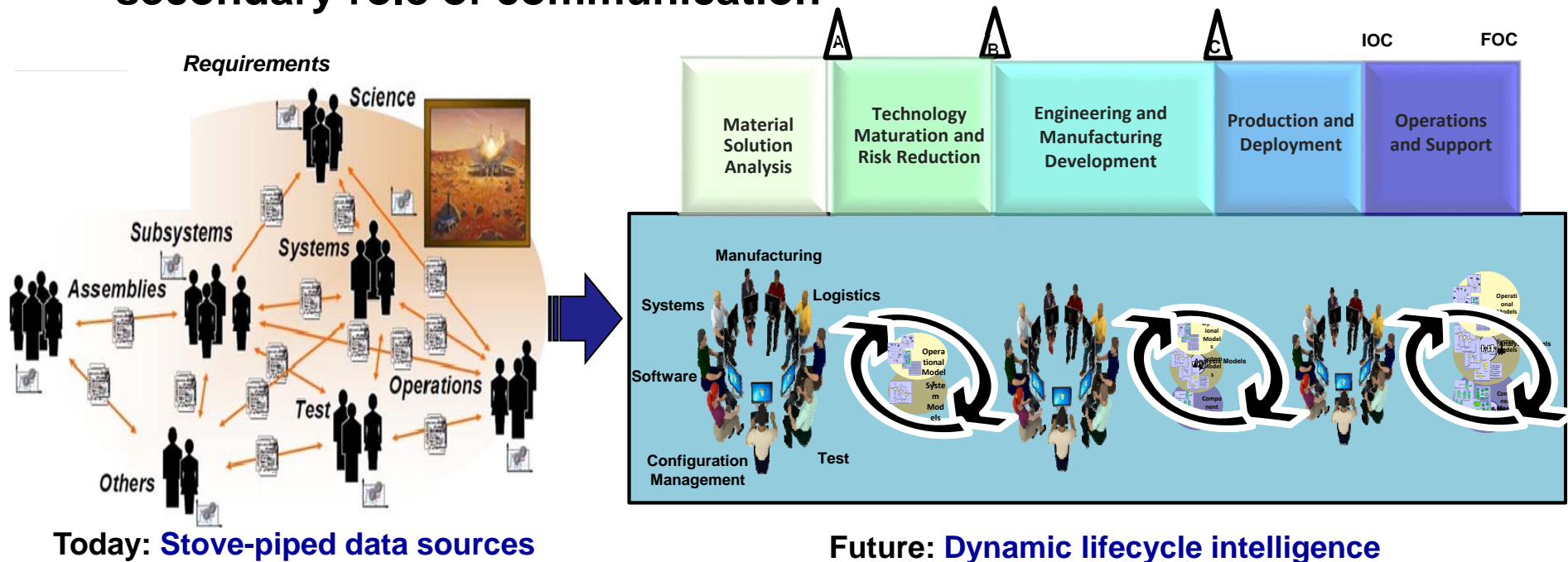
Overview of Digital Model-Centric Engineering

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

- **Low fidelity, implicit representations shift to high fidelity, explicit models serving as the "single source of truth"**
- **Documents shift from the primary role of specification to the secondary role of communication**

Today: Stove-piped data sources

Future: Dynamic lifecycle intelligence

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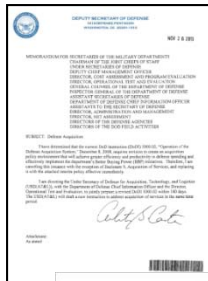
Foundation for Advancing Digital Model-Centric Engineering within DoD
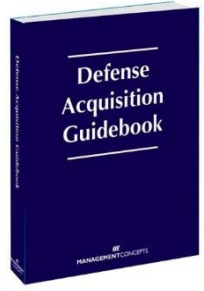
Language in Policy and Guidance

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

Defense Acquisition Guidebook Chapter 4

Digital System Model and Digital Thread Definitions

DoD Systems Engineering Fundamental

DoD Initiatives

DoD Digital Engineering Working Group

Digital Engineering Working Group

SERC: Model Centric Collaborative Environment
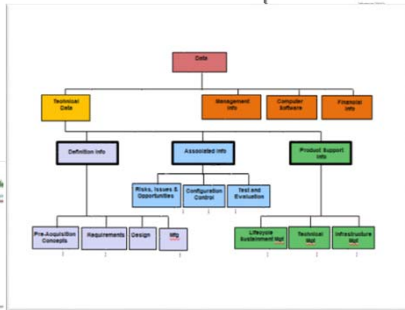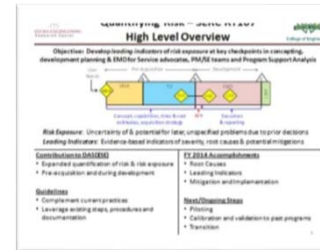
DSM Taxonomy: Foundation for defining categories of data across acquisition

Other Initiatives

NDIA: Essential Elements of the System Model

Inter-Agency Working Group on the Engineering of Complex Systems

IAWG

NASA: Sounding Rocket Program
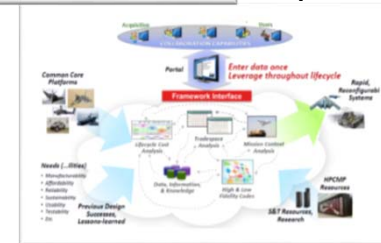
ERS: Adapting to changing requirements
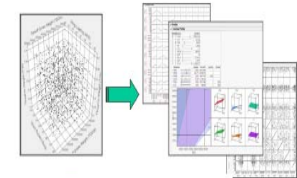
HPCMP CREATE: Physics Based Modeling

Advancing the future state of Digital Engineering within DoD

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Involving Digital Models
Engineering Across the Lifecycle

MDD | **A** | **Pre-EMD** | **B** | **C** | **FRP DR** | **IOC** | **FOC**

| Pre-acquisition Concepts, Experimentation and Prototyping | Materiel Solution Analysis | Technology Maturation and Risk Reduction | Engineering and Manufacturing Development | Production and Deployment | Operations and Support | Disposal |

PDR | **CDR**

75% LCC fixed @MS A

Technology Mature @ MS B

Design Closure @ CDR

Suitability

Operations & Sustainment

Concept & Analysis

Late Defects

DOTT&E Teat Rates

- Reduce O&S Cost

- Interoperability
- Mission Utility
- Affordability

- Quantified Margins & Uncertainty
- Subsystem Integration
- Merge Data and Models

- Operability
- Reliability
- Suitability

Design & Development

Test & Evaluation

Manufacturing

Training

Enabling rapid development and continuity from concept to disposal

Digital System Model/Digital Thread Framework for Communication

Material Solution Analysis	Technology Maturation and Risk Reduction	Engineering and Manufacturing Development	Production and Deployment	Operations and Support

Ⓐ   Ⓑ   Ⓒ   IOC   FOC

Primary System Engineering Data

Eq. Data: Size, Weight, Power, Performance, etc.

Supporting Data (Program and System)

Data Rights   RAM   Cost   Training

Manufacturing   Sustainment   Facilities

Test and Evaluation   Schedule

Digital Thread (DT) Tools, Analytics Processes, Governance

Decision Support   *Visualization*   *High & Low Fidelity Codes*

Analytical Framework

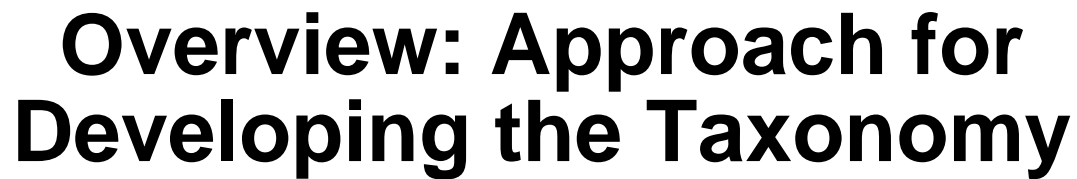*Data, Information, & Knowledge*   *Tradespace Analysis*
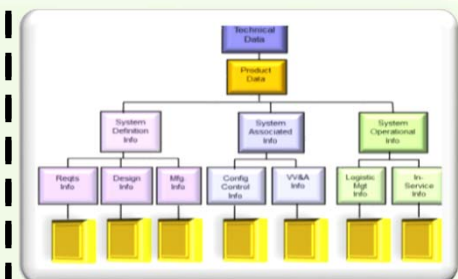
Digital Thread / Digital Thread Definitions

Digital System Model – A digital representation of a defense system, generated by all stakeholders, that integrates the authoritative data, information, algorithms, and systems engineering processes which define all aspects of the system for the specific activities throughout the system lifecycle. (M&S Glossary proposed)

Digital Thread – An extensible, configurable and component enterprise-level analytical framework that seamlessly expedites the controlled interplay of software, authoritative data, information, and knowledge in the enterprise data-information-knowledge systems, based on the Digital System Model template, to inform decision makers throughout a system's life cycle by providing the capability to access, integrate and transform disparate data into actionable information. (M&S Glossary proposed)

Technical Data – means recorded information, regardless of the form or method of the recording, of a scientific or technical nature (including computer software documentations). The term does not include computer software or data incidental to contract administration, such as financial and/or management information. (DFARS 252.227-7103(a)(15))

Overview: Approach for Developing the Taxonomy

(1) Identify	(2) Define	(3) Inventory	(4) Develop

- Develop a framework to:
  - Identify the processes, artifacts, and key decision points across the lifecycle

- Use the framework to :
  - Define the data and analytics to support key decisions

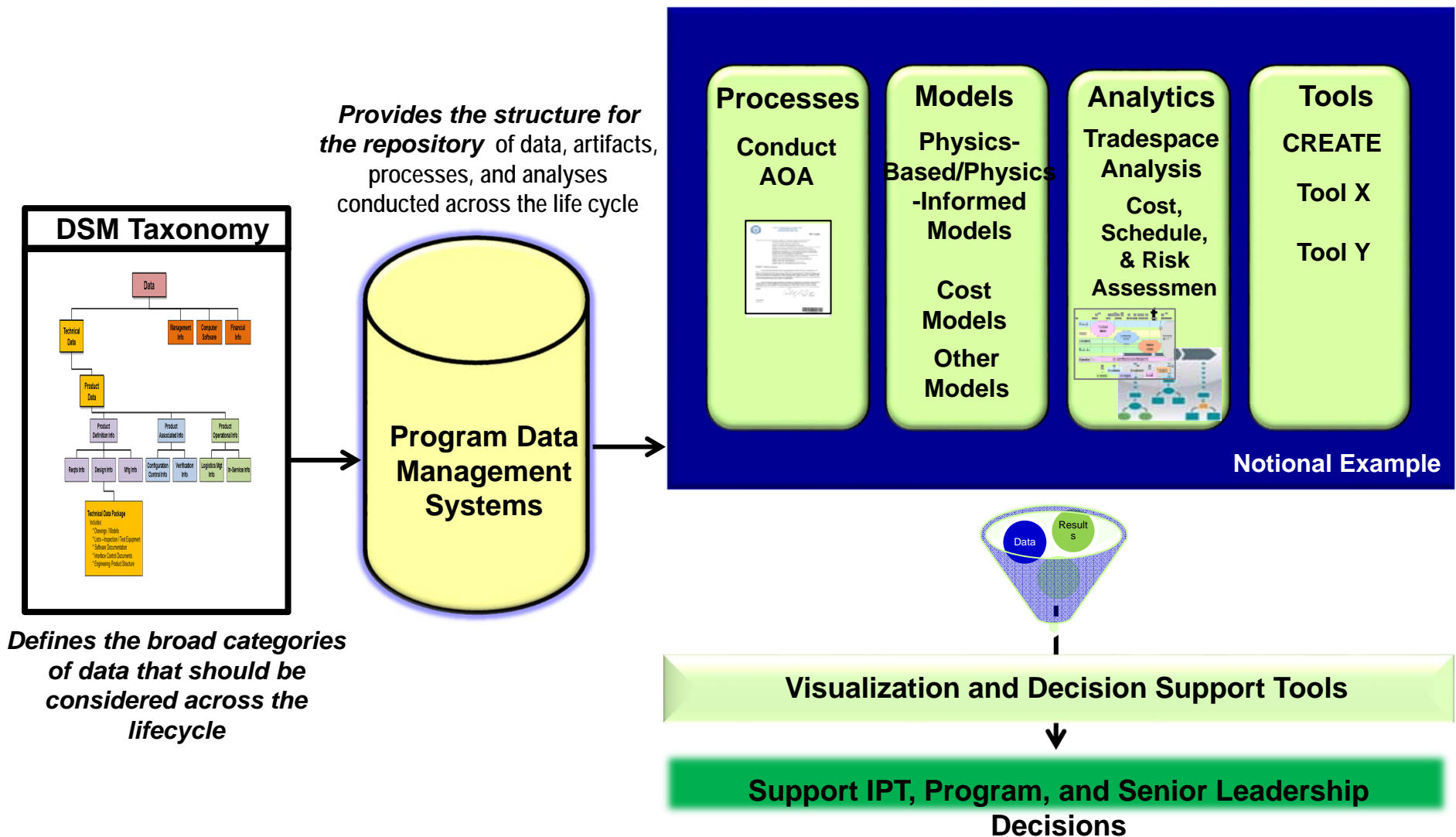- Inventory existing data, models, and algorithms to support key decisions

- Develop data taxonomy to support key decision points across the lifecycle

Developed generic approach to develop taxonomy for DSM weapon system data and supporting data

DSM Taxonomy Intended Use

DSM Taxonomy

Defines the broad categories of data that should be considered across the lifecycle

Provides the structure for the repository of data, artifacts, processes, and analyses conducted across the life cycle

Program Data Management Systems

Processes

Conduct AOA

Models

Physics-Based/Physics-Informed Models

Cost Models

Other Models

Analytics

Tradespace Analysis

Cost, Schedule, & Risk Assessmen

Tools

CREATE

Tool X

Tool Y

Notional Example

Data   Results

Visualization and Decision Support Tools

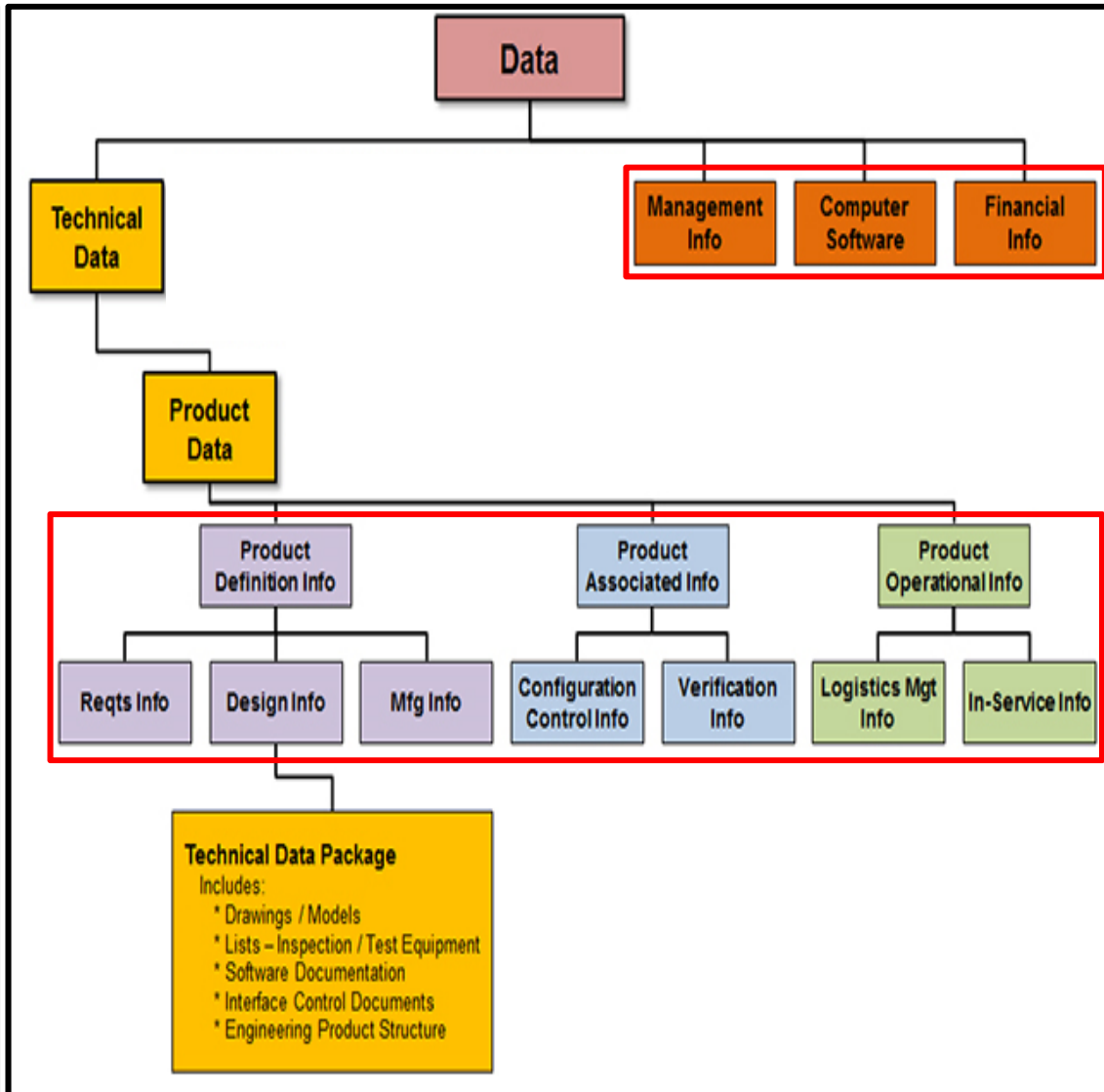## Support IPT, Program, and Senior Leadership Decisions

DSM Taxonomy Development

- **DAG Chapter 4 Data Taxonomy**
- **Technical Data**
  - Product Definition Info Taxonomy
  - Product Associated Info Taxonomy
  - Product Operational Info Taxonomy
- **Management Info**
- **Computer Software**
- **Financial Info**

Challenges

- **Getting the complete picture of current digital engineering practices for DoD**

- **Identifying insertion points for digital artifacts into the Defense Acquisition System**

- **Early consideration of manufacturability and supportability of design concepts**

- **Objective selection of proper tools for program use**

- **Properly train the workforce in Digital Model-Centric Engineering methods and concepts**

- **Availability of data that will be needed for future use**

- **Cost savings vs. cost avoidance**

- **Do not oversell the methods, processes, and tools**

Summary

- **Leveraging industry and professional organizations in the shift to digital model-centric engineering**

- **Policy / guidance changes sufficient for shift to digital engineering**

- **Addressing challenges facing systems engineering application of digital artifacts**

- **Digital Models will continue to enable our Systems Engineering workforce and practices**

- **Digital Models provide continuity of the system from concept development through disposal**

- **Many unknowns still exist in use of the digital engineering artifacts**

Information

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