Understanding and Delivering the System Model

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Office of the Deputy Assistant Secretary of Defense for Systems Engineering

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DASD, Systems Engineering Mission

Systems Engineering focuses on engineering excellence − the creative application of scientific principles:

- To design, develop, construct and operate complex systems
- To forecast their behavior under specific operating conditions
- To deliver their intended function while addressing economic efficiency, environmental stewardship and safety of life and property

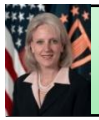
DASD(SE) Mission: Develop and grow the Systems Engineering capability of the Department of Defense – through engineering policy, continuous engagement with component Systems Engineering organizations and through substantive technical engagement throughout the acquisition life cycle with major and selected acquisition programs.

A Robust Systems Engineering Capability Across the Department Requires Attention to Policy, People and Practice

- ***US Department of Defense is the World's Largest Engineering Organization***
- ***Over 99,000 Uniformed and Civilian Engineers***
- ***Over 39,000 in the Engineering (ENG) Acquisition Workforce***

DASD, Systems Engineering

DASD, Systems Engineering
Stephen Welby
Principal Deputy Kristen Baldwin



Systems Analysis
Kristen Baldwin (Acting)

Addressing Emerging Challenges on the Frontiers of Systems Engineering

- Analysis of Complex Systems/Systems of Systems
- Program Protection/Acquisition Cyber Security
- University, FFRDC and Industry Engineering and Research
- Modeling and Simulation

Major Program Support
James Thompson

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

- Engineering Assessment / Mentoring of Major Defense Programs
- Program Support Reviews
- OIPT / DAB / ITAB Support
- Systems Engineering Plans
- Systemic Root Cause Analysis

Mission Assurance
Vacant

Leading Systems Engineering Practice in DoD and Industry

- Systems Engineering Policy & Guidance
- Development Planning/Early SE
- Specialty Engineering (System Safety, Reliability and Maintainability Engineering, Quality, Manufacturing, Producibility, Human Systems Integration)
- Counterfeit Prevention
- Technical Workforce Development
- Standardization

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

Problem Statement

ISSUE: **Current DoD acquisition activities do not develop, or maintain a single, integrated authority/artifact (aka system model) for a TBD subset of program data. Further, relevant data between acquisition activities is not adequately shared.**

VISION: **Use of a single model (aka system model) as an evolving, cohesive representation and unifying instantiation of the program under conceptualization, development, manufacture, and/or support:**

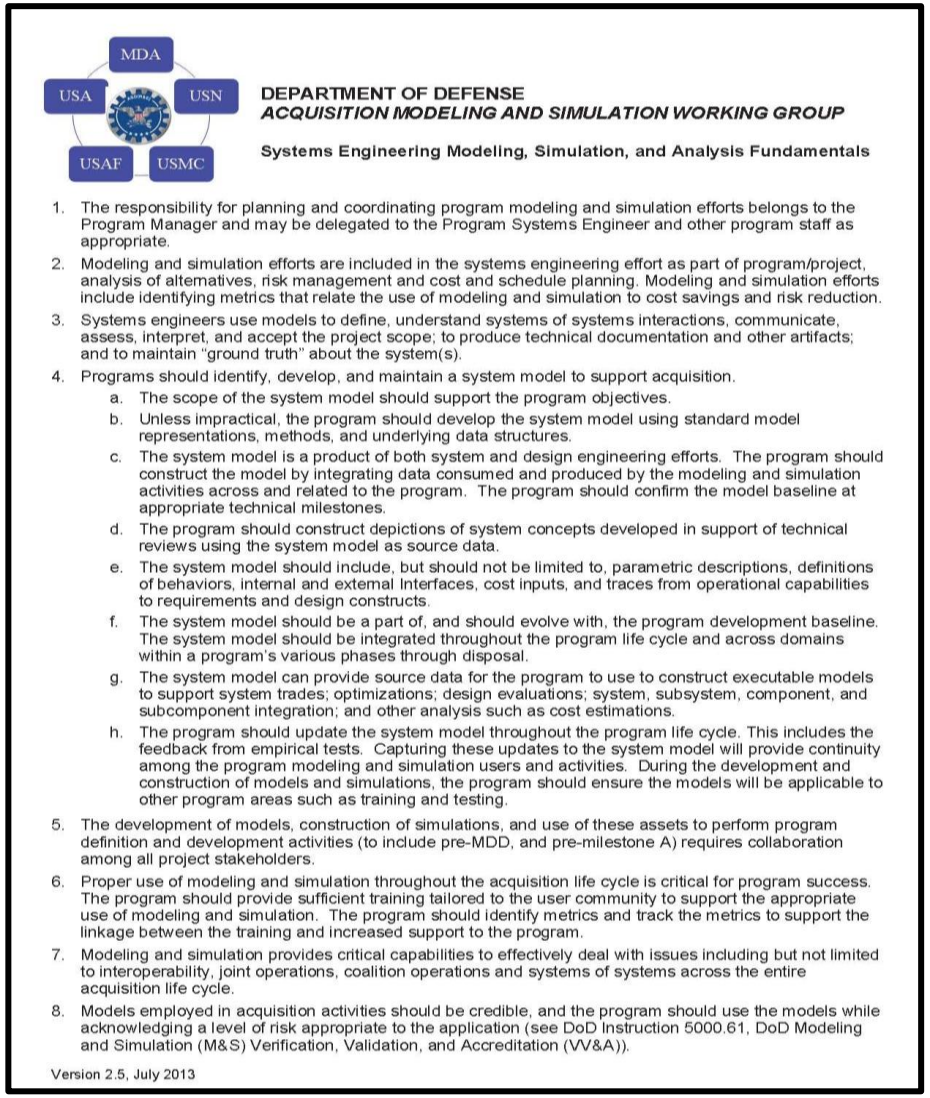
- **will increase efficiency of DoD system acquisition lifecycle activities, and**
- **increase confidence in decisions made regarding an acquisition program when the single (system) model (data) for that program is used.**

METHOD**: A system model will be instantiated by using artifacts and processes which already exist, or are already required by DoD acquisition policies, guidance, and best practices.**

OUTCOME: **It is a framework for "technical communication". The system model will be used by anyone performing activities related to the program as it evolves across the acquisition lifecycle, including but not limited to defining requirements, trading design aspects, designing, engineering, cost budgeting, staffing, manufacturing, fielding, training, sustaining, and disposing. The resultant system model will integrate program data into a complete description of the system.**

DAG Chapter 4 and Modeling, Simulation and Analysis Fundamentals

- **Section 4.1 Introduction**
- **Section 4.2 Systems Engineering Activities in the Life Cycle**
- **Section 4.3 Systems Engineering Processes**
- **Section 4.3.19 Tools, Techniques, and Lessons Learned**
  - 4.3.19.1 Modeling and Simulation - Models and simulations are SE tools used by multiple functional area disciplines during all life-cycle phases. Modeling is essential to aid in understanding complex systems and system interdependencies, and to communicate among team members and stakeholders. Simulation provides a means to explore concepts, system characteristics, and alternatives; open up the trade space; facilitate informed decisions and assess overall system performance.



MDA USA USN USAF USMC

DEPARTMENT OF DEFENSE
ACQUISITION MODELING AND SIMULATION WORKING GROUP

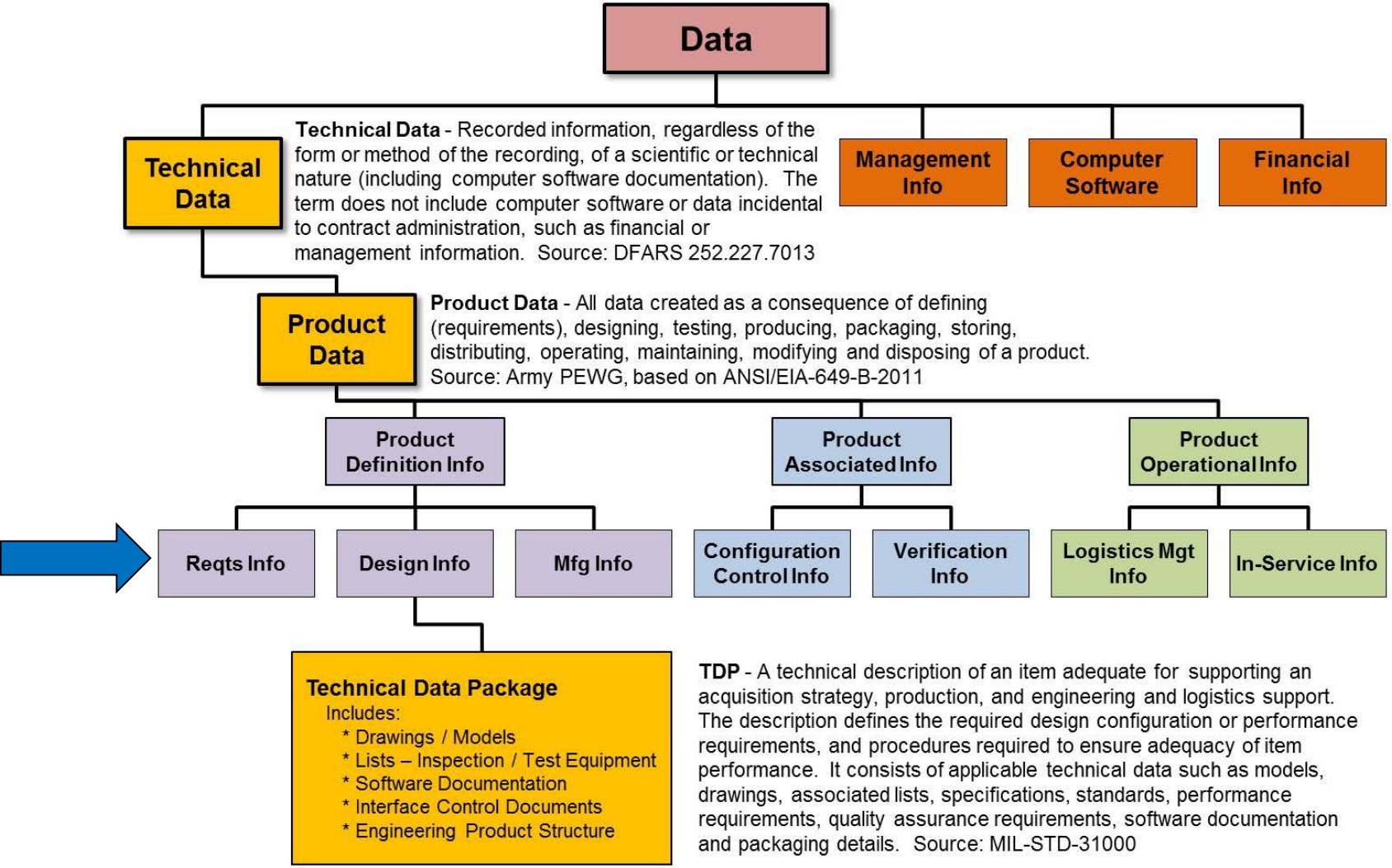
Systems Engineering Modeling, Simulation, and Analysis Fundamentals

1. The responsibility for planning and coordinating program modeling and simulation efforts belongs to the Program Manager and may be delegated to the Program Systems Engineer and other program staff as appropriate.
2. Modeling and simulation efforts are included in the systems engineering effort as part of program/project, analysis of alternatives, risk management and cost and schedule planning. Modeling and simulation efforts include identifying metrics that relate the use of modeling and simulation to cost savings and risk reduction.
3. Systems engineers use models to define, understand systems of systems interactions, communicate, assess, interpret, and accept the project scope; to produce technical documentation and other artifacts; and to maintain "ground truth" about the system(s).
4. Programs should identify, develop, and maintain a system model to support acquisition.
   a. The scope of the system model should support the program objectives.
   b. Unless impractical, the program should develop the system model using standard model representations, methods, and underlying data structures.
   c. The system model is a product of both system and design engineering efforts. The program should construct the model by integrating data consumed and produced by the modeling and simulation activities across and related to the program. The program should confirm the model baseline at appropriate technical milestones.
   d. The program should construct depictions of system concepts developed in support of technical reviews using the system model as source data.
   e. The system model should include, but should not be limited to, parametric descriptions, definitions of behaviors, internal and external Interfaces, cost inputs, and traces from operational capabilities to requirements and design constructs.
   f. The system model should be a part of, and should evolve with, the program development baseline. The system model should be integrated throughout the program life cycle and across domains within a program's various phases through disposal.
   g. The system model can provide source data for the program to use to construct executable models to support system trades; optimizations; design evaluations; system, subsystem, component, and subcomponent integration; and other analysis such as cost estimations.
   h. The program should update the system model throughout the program life cycle. This includes the feedback from empirical tests. Capturing these updates to the system model will provide continuity among the program modeling and simulation users and activities. During the development and construction of models and simulations, the program should ensure the models will be applicable to other program areas such as training and testing.
5. The development of models, construction of simulations, and use of these assets to perform program definition and development activities (to include pre-MDD, and pre-milestone A) requires collaboration among all project stakeholders.
6. Proper use of modeling and simulation throughout the acquisition life cycle is critical for program success. The program should provide sufficient training tailored to the user community to support the appropriate use of modeling and simulation. The program should identify metrics and track the metrics to support the linkage between the training and increased support to the program.
7. Modeling and simulation provides critical capabilities to effectively deal with issues including but not limited to interoperability, joint operations, coalition operations and systems of systems across the entire acquisition life cycle.
8. Models employed in acquisition activities should be credible, and the program should use the models while acknowledging a level of risk appropriate to the application (see DoD Instruction 5000.61, DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)).

Version 2.5, July 2013

www.acq.osd.mil/se/docs/SE-MSA-Fundamentals.pdf

DAG Ch 4: Technical Data Management Process



Who Are the Stakeholders?

Systems Engineering

Analysis

Sustaining

Training

Decision Making

Test and Evaluation

Program Management

Source Selection

Business Management

Systems Architecting

Senior Leadership

Program Protection

Life Cycle Logistics

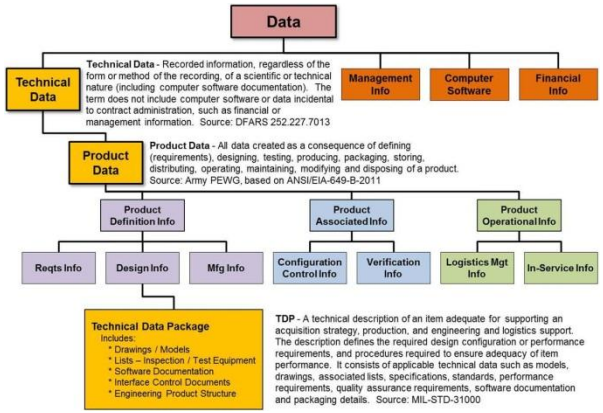
Affordability

Production

Human Systems Integration

Design

Documenting



Need to identify the value propositions to/from stakeholders and others that contribute to system model

- *Participants need tangible benefits for making contribution – carrot not stick*

What Is In Work?

- **Approaches to building the template; aka 'the structural view'**
  - Via Program Manager/Staff needs
    - Acquisition via system model vs. acquisition via documentation
  - Via activity performers
    - Identify the activities supported by model / simulation
  - Via acquisition decision maker information needs
    - Process, milestones, reviews (policy is back burner)
  - Via Tool vendors
    - What do they already support?
- **Identify stakeholders**
  - Identifies who, and what is important in the exchange

What Is In Work?

- **Socialize and educate**
  - Working on opportunity basis with Services, Agencies, Industry groups, etc.
  - Remember – modeling and simulating are tools within SE toolkit – so make the modeling and simulating education/training part of SE education/training
- **Find the example activities**
  - Engineered Resilient Systems
  - Service/Agency successes in Programs of Record, and support activities

For Additional Information

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Systems Engineering: Critical to Defense Acquisition





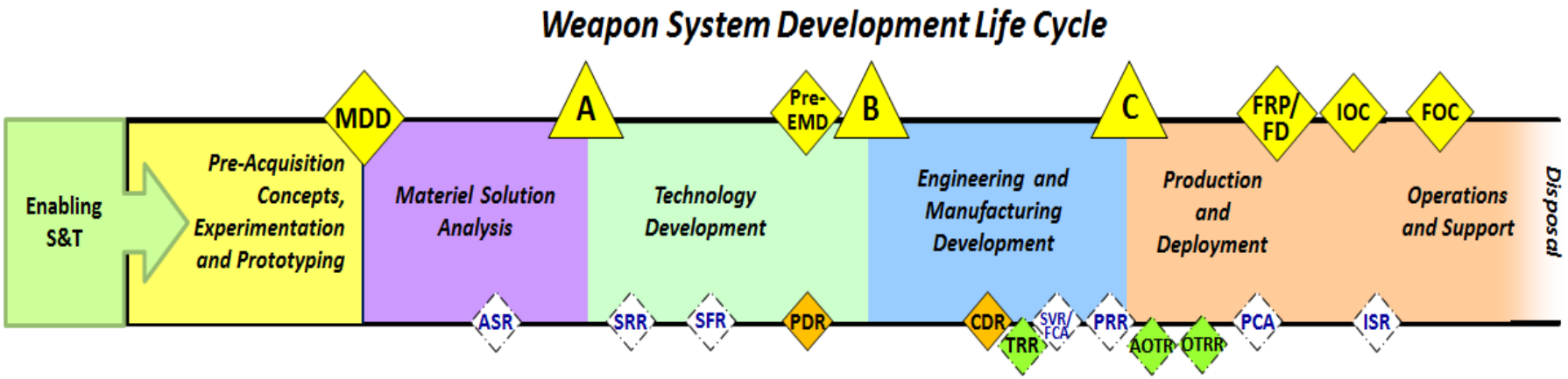





Innovation, Speed, Agility

http://www.acq.osd.mil/se

DAG Ch 4: Weapon System Development Life Cycle



AOTR - Assessment of Operational Test Readiness
ASR - Alternative Systems Review
CDR - Critical Design Review
EMD - Engineering and Manufacturing Development
FCA - Functional Configuration Audit
FD - Full Deployment
FOC - Full Operational Capability
FRP - Full Rate Production
IOC - Initial Operational Capability
ISR - In-Service Review
MDD - Materiel Development Decision
OTRR - Operational Test Readiness Review
PCA - Physical Configuration Audit
PDR - Preliminary Design Review
PRR - Production Readiness Review
S&T - Science and Technology
SRR - System Requirements Review
SFR - System Functional Review
SVR - System Verification Review
TRR - Test Readiness Review

◆ Mandatory technical reviews

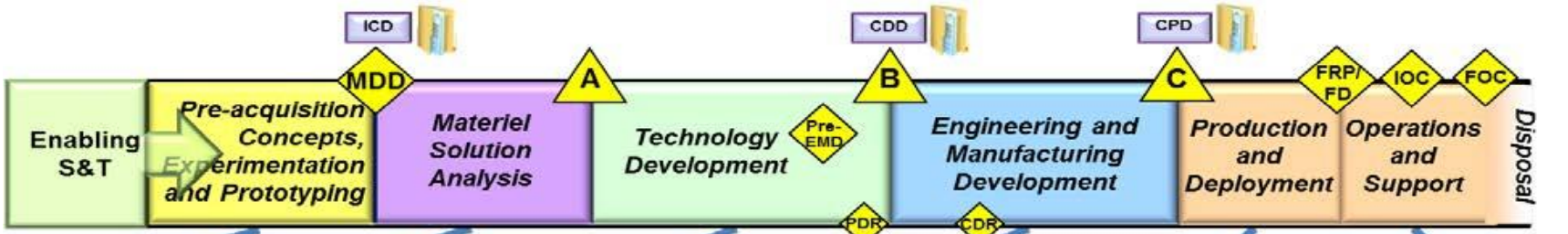
◇ Best practice technical reviews and audits

◆ Test reviews (see DAG Chapter 9)

DAG Ch 4: Various Applications of Modeling and Simulation

Modeling and Simulation in the DoD Acquisition Life Cycle

"Weapon System Development"



Analysis of Alternatives

- Concept of Operations (CONOPS) modeling
- Cost / schedule / performance trades
- System interoperability discoveries
- Portfolio coverage analysis

Analysis of Alternatives

- Assess materiel solutions
- Estimate life cycle costs
- Model CONOPS and mission context
- Interoperability and warfighter integration analysis
- Industrial / manufacturing capability analysis
- Supportability and sustainment modeling

Technology Maturation and Risk Reduction

- Trade studies
- System threat integration
- Model environment and demonstrate technology
- Interoperability and supportability analysis
- Operational suitability and affordability
- Industrial / manufacturing capability and readiness assessment
- Estimate manpower/cost
- Model system to performance specifications
- T&E planning
- Human interface prototyping

Develop Affordable and Executable Manufacturing Process

- Ensure operational supportability
- Reduce logistics footprint
- Survivability analysis
- Human Systems Integration (HSI)
- Design for producibility
- Demonstrate system safety
- Verify functionality and performance to specifications/needs
- Manpower estimates

Manufacturing Development

- Industrial / manufacturing readiness assessment
- Environment, Safety, and Occupational Health (ESOH) models
- Military equipment valuation
- Corrosion prevention and control
- Refine LCSP
- Production qualification testing
- Verify and validate production configuration
- Economic analysis

Post-Production Support

- Supply chain management
- Monitor performance and adjust product support
- Training
- Supportability assessments
- Disposal planning
- Validate failures and determine root causes
- Determine system risk / hazard severity
- ECP impact analysis