SoSECIE: Systems of Systems Architecture Approach for Lifecycle Digital Environments

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Abstract
NDIA SE Conference, Oct. 29, 2015

Government mandates to control costs throughout the life cycle of a product necessitate a comprehensive architecture and methodology from design through operations and sustainment that is enabled by a planned digital environment. The Systems Design for Operational Effectiveness (SDOE) model developed by Stevens Institute has become the basis of the Office of the Secretary of Defense (OSD) guidance with a focus on increasing reliability and reducing logistics footprint. The complexity of the digital environment needed to support systems of systems approaches and model based systems development increases when both on-board and off-board enabling systems are considered. Models for both should be included in any comprehensive digital tapestry. There are multiple digital threads for life cycle data for the enabling systems to represent the necessary causal relationships between primary and enabling systems that determine operational effectiveness. To address this challenge, a reusable architecture and methodology is the first step. This framework can support definition and advanced application of data analytics and big data approaches to the digital threads that define the interaction between primary and enabling system, the industrial enterprise, and the deployed environment, providing the variables which contribute to operational outcomes, and effectiveness. This includes analysis of feedback from actual operations compared with planned suitability analysis during the design phase.

Agenda

- **Context for Lifecycle Systems of Systems Architecture**
- **Systems Design for Operational Effectiveness (SDOE) Model**
- **Enabling Digital Environment History and Evolution**
- **Reusable Architecture Framework and Methodology**
- **Industry and Operational Data Integration Considerations**

Government Mandates

2. Achieve Dominant Capabilities While Controlling Lifecycle Costs

System of Systems Approach: Primary and Enabling Systems

Apply Systems Design for Operational Effectiveness (SDOE) comprehensive model

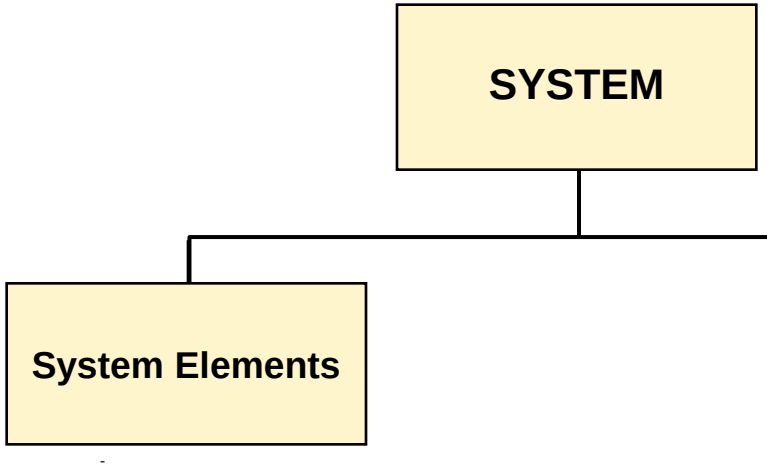
Manage efficient digital tapestry / environment that supports innovation

Assure model based approach supports the lifecycle

Develop data analytics to address system of systems and context complexity

Gaska M, Bobinis J, and Galluzzo V, Application of System Design for Operational Effectiveness for Architectural Modeling of the SoS Relationship Between Primary and Enabling Systems, Complex Adaptive Systems Conference, San Jose, CA, Publication 5, November 3, 2015

System of System Definitions



System: An aggregation of system elements and enabling system elements to achieve a given purpose or to provide a capability.

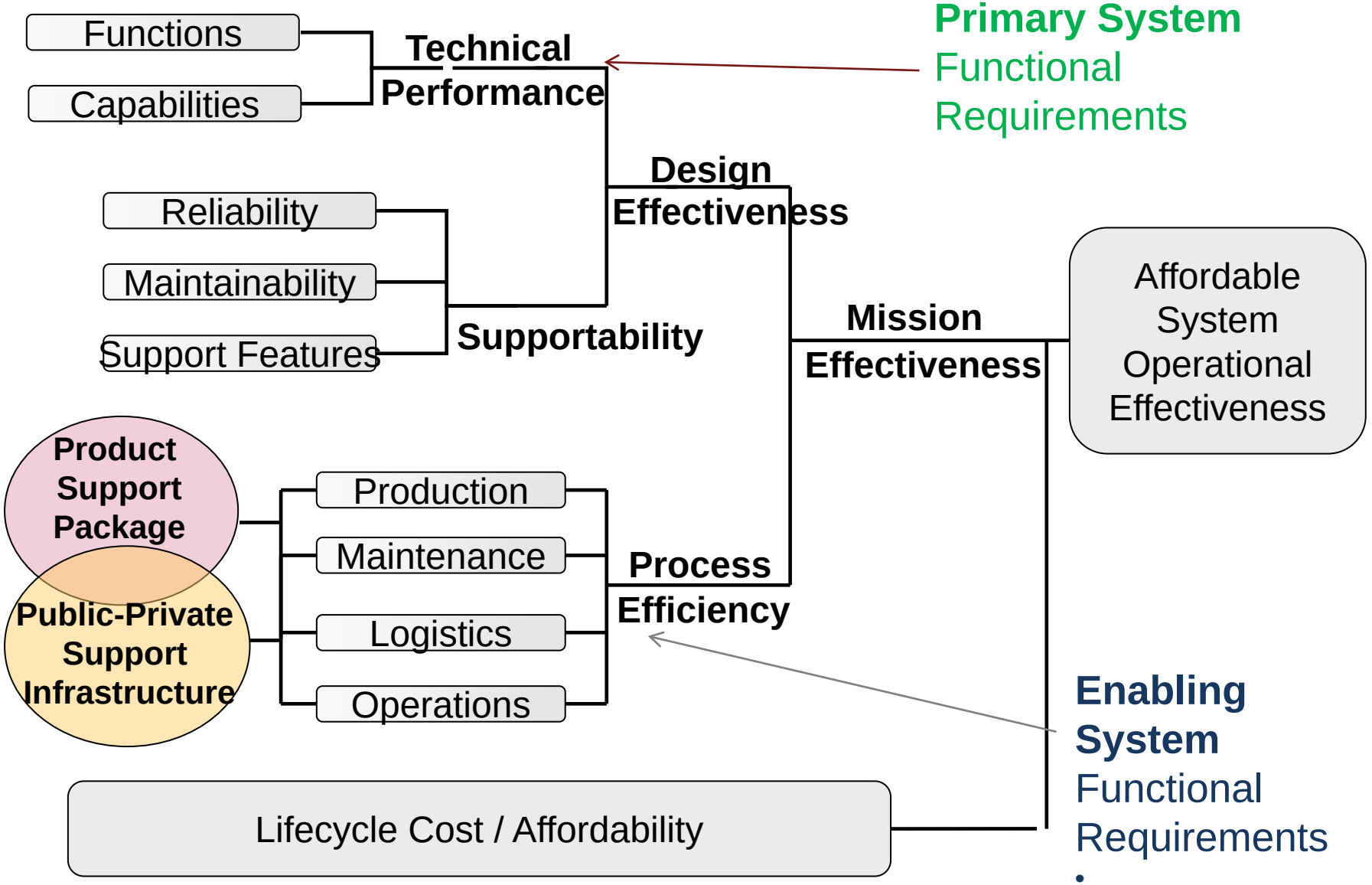
System Elements: Also referred to as configuration items, subsystems, segments, components, assemblies, or parts.

Enabling System Elements: Provide the means for putting a capability into service, keeping it in service, or ending its service, e.g., processes or products used to enable system development, test, production, training, deployment, support, and disposal.

Each system element or enabling system element may include but is not limited to hardware, software, people, data, processes, facilities, and tools.

- **Defense Acquisition Guidebook. Chapter 4.2.1.2. System of Systems. Figure 4.2.1.2 as of June 1, 2015.**

System Design for Operational Effectiveness (SDOE) Model



Defense Acquisition Guidebook. Chapter 5.2. Applying Systems Engineering to Life-Cycle Sustainment. Fig. 5.2.F.2 as of June 1, 2015.

Enabling System Elements

INTEGRATED PRODUCT SUPPORT

Design Interface

- Sustaining Engineering
- Supply Support
- Maintenance Planning & Management
- Packaging, Handling, Storage & Transportation (PHS&T)
- Technical Data
- Support Equipment
- Training & Training Support
- Manpower & Personnel
- Facilities & Infrastructure
- Computer Resources

Product Support Management

Product Support is enabled by a package of 12 Integrated Product Support (IPS) elements designed to deliver system readiness and availability while optimizing system life cycle cost.

Department of Defense (DoD). Integrated Product Support (IPS) Element Guidebook. Nov. 2011.

Enabling Digital Environment History: Concurrent Engineering

Shared product, process and organization information as 1990s enabler focus of DARPA Initiative in Concurrent Engineering (DICE)

Douglas R. SNEAKERS: A Concurrent Engineering Demonstration System Concurrent Engineering. Thesis, Worchester Polytechnic Institute, 1994.

WETICE. *24th IEEE International Conference on Enabling Technologies: Infrastructure for Collaborative Enterprises.* Larnaca (Cyprus), Greece. June 15-17, 2015.

NDIA Model Based Engineering (MBE)

- **Final Report MBE Subcommittee published Feb, 2011**
- **Includes all functions across the lifecycle**
- **Collaborative foundation includes customers, teammates, and suppliers**
- **“To Be” state includes standards and model registry**

Lubell J, Frechette SP, Lipman RR, Proctor FM, Horst JA, Carlisle M, Huang PJ. Model-Based Enterprise Summit Report. *NIST Technical Note 1820.* November 2013.

Digital Manufacturing and Design Innovation Institute (DMDII)

- **Mission: Establish a state-of-the-art proving ground for digital manufacturing and design that links IT tools, standards, models, sensors, controls, practices and skills, and transition these tools to the U.S. design & manufacturing industrial base for full-scale application**

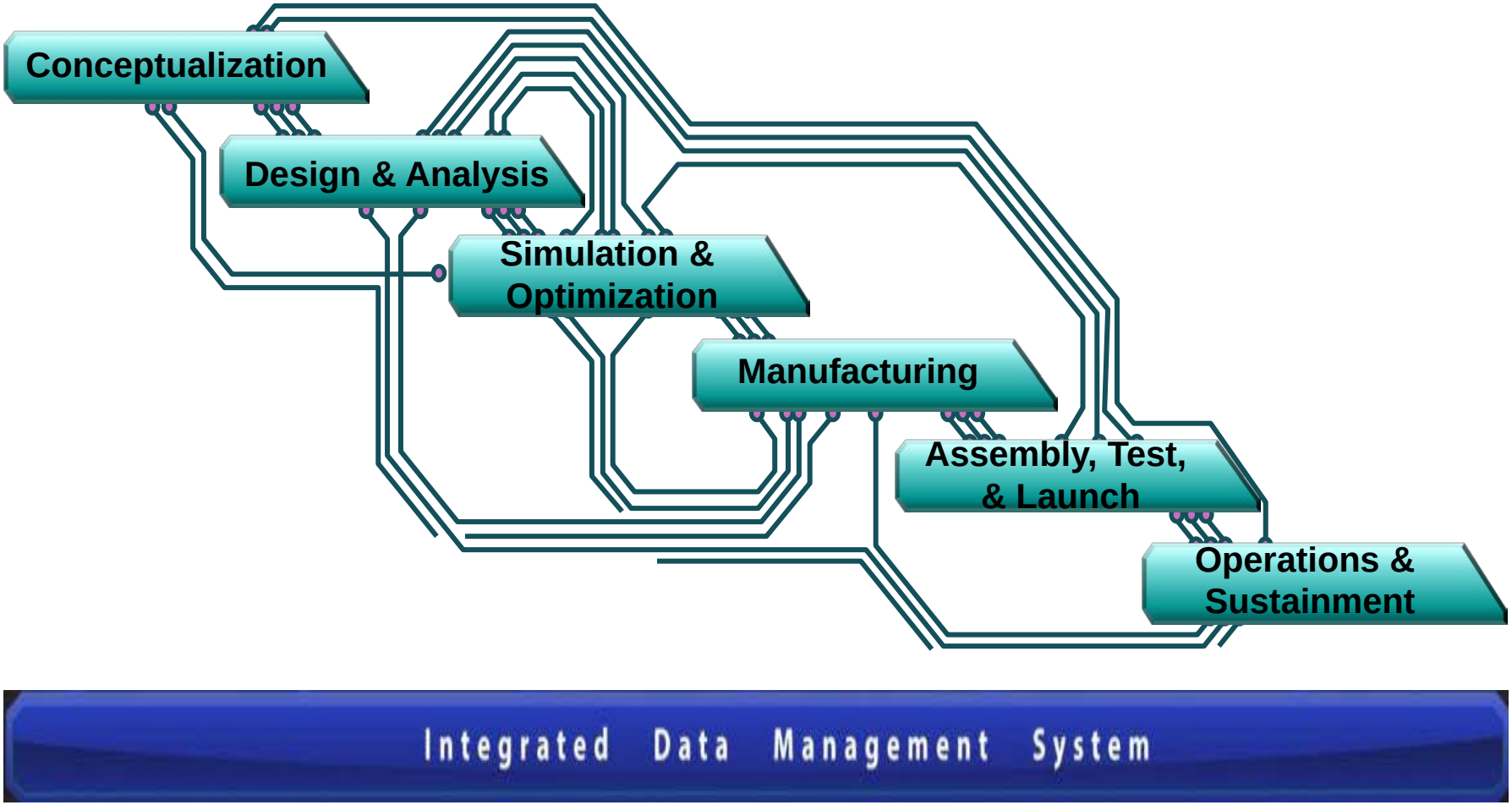
- **Announced in February 2014; UI Labs team selected in 2014**

- **Builds on digital thread focus at National Institute for Standards and Technology (NIST)**

Harris G. DMDII Institute Overview for The Lockheed Martin Mechanical Engineering and Advanced Manufacturing Workshop , 7 May, 2014. Approved for Public Release.

National Institute for Standards and Technology (NIST). Enabling the Digital Thread for Smart Manufacturing Project. Internet. June 1, 2015.

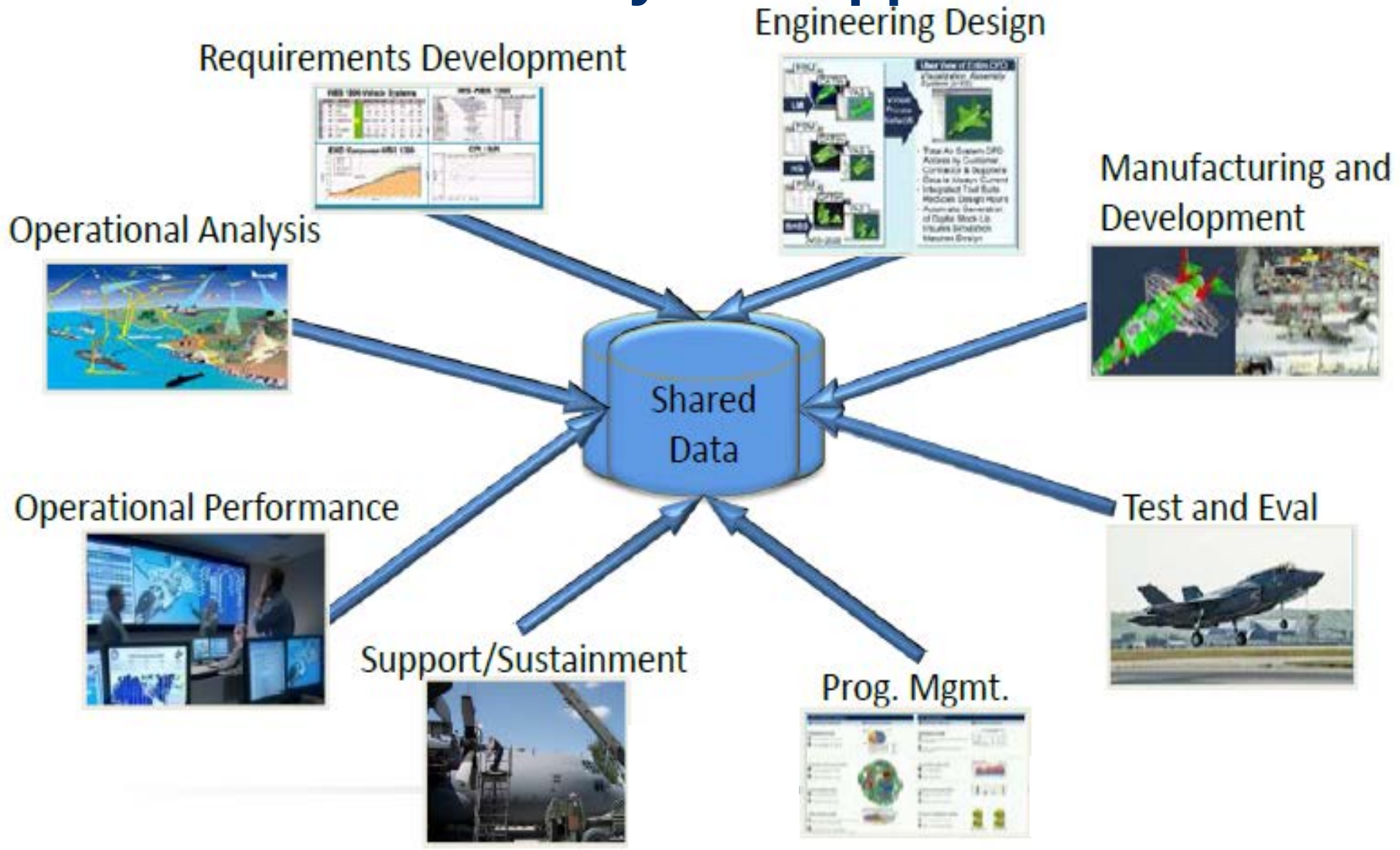
Integrated Data Management:
Supporting Digital Tapestry and MBE



Oster C. Digital Tapestry. *Model Based Systems Engineering Workshop at INCOSE International Workshop.* Jacksonville, Florida. January 21, 2012.

Gaska M. Importance of CM/DM in the Current and Emerging DoD Product Support Environment. *Association for Configuration and Data Management Conference.* Savannah, Georgia. March 3-5, 2014.

Share Data for Lifecycle Support



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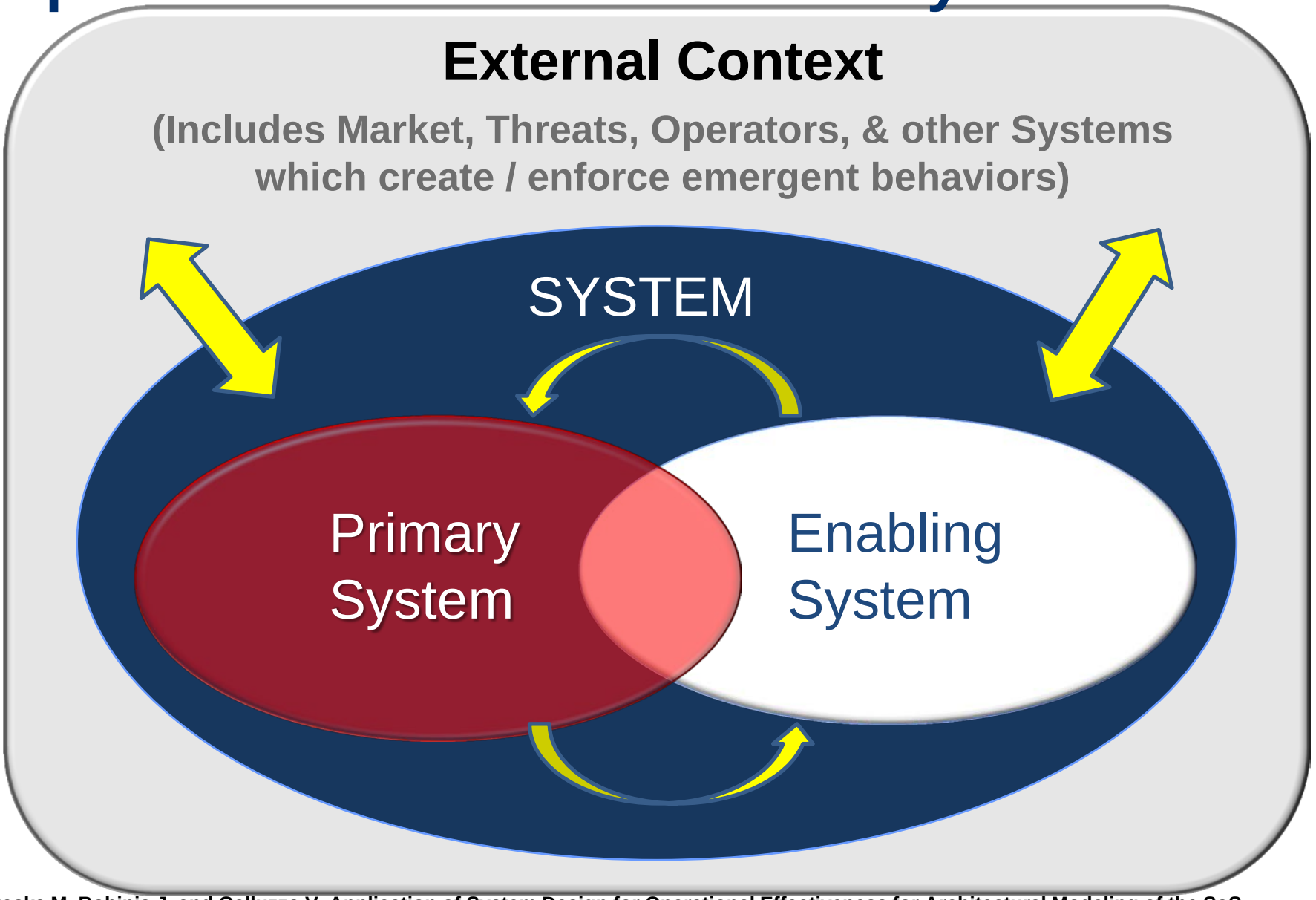
Framework for System of System and Operational Context Data Analytics



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Summary

- **Comprehensive lifecycle system of systems architecture planning**
- **Shared digital environment to support primary and enabling**
- **Digital data for additive manufacturing and sustainment**
- **Framework with system context for data management/analytics**
- **Open architecture for global business and customer feedback**

References

- **Bobinis J, Herald Jr T, An Enterprise Framework for Operationally Effective System of Systems Design. *Journal of Enterprise Architecture*, May. 2012.**
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- **Defense Acquisition Guidebook. Chapter 5.2. Applying Systems Engineering to Life-Cycle Sustainment. Fig. 5.2.F.2 as of June 1, 2015.**
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- **Undersecretary of Defense Acquisition, Technology, and Logistics. Implementation Directive for Better Buying Power 3.0 – Achieving Dominant Capabilities Through Technical Excellence and Innovation. April 9, 2015.**
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