

# **SoSECIE: Systems of Systems Architecture Approach for Lifecycle Digital Environments**

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**LOCKHEED MARTIN**



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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



## Better Buying Power 3.0

Achieving Dominant Capabilities through Technical Excellence and Innovation

### Achieve Affordable Programs

- Continue to set and enforce affordability caps

### Achieve Dominant Capabilities While Controlling Lifecycle Costs

- Strengthen and expand "should cost" based cost management

### Eliminate Unproductive Processes and Bureaucracy

- Emphasize acquisition chain of command responsibility, authority and accountability
- Reduce cycle times while ensuring sound investments
- Streamline documentation requirements and staff review

## 2. Achieve Dominant Capabilities While Controlling Lifecycle Costs

### Incentivize Productivity in Industry and Government

- Align profitability more tightly with Department of Defense
- Employ appropriate contract types, but increase use of incentive type contracts
- Expand the superior supplier incentive program
- Ensure effective use of Performance-Based Logistics
- Remove barriers to commercial technology utilization
- Improve the return on investment in DoD labor force
- Increase the productivity of corporate IRAD

### Incentivize Innovation in Industry and Government

- Increase the use of prototyping and experimentation
- Emphasize technology insertion and refresh in program planning
- Use Modular Open Systems Architecture to stimulate innovation
- Increase the return on and access to small business research and development
- Provide draft technical requirements to industry early and involve industry in funded concept definition
- Provide clear and objective "best value" definitions to industry

### Improve the Professionalism of the Total Acquisition

- Increase small business participation, including more effective use of small business set-aside
- Strengthen contract management outside the normal acquisition chain – installations, etc.
- Establish higher standards for key leadership
- Establish stronger professional qualification for all acquisition specialties
- Strengthen organic engineering capabilities
- Ensure development program leadership is qualified to manage R&D activities
- Improve our leaders' ability to understand technical risk
- Increase DoD support for STEM education

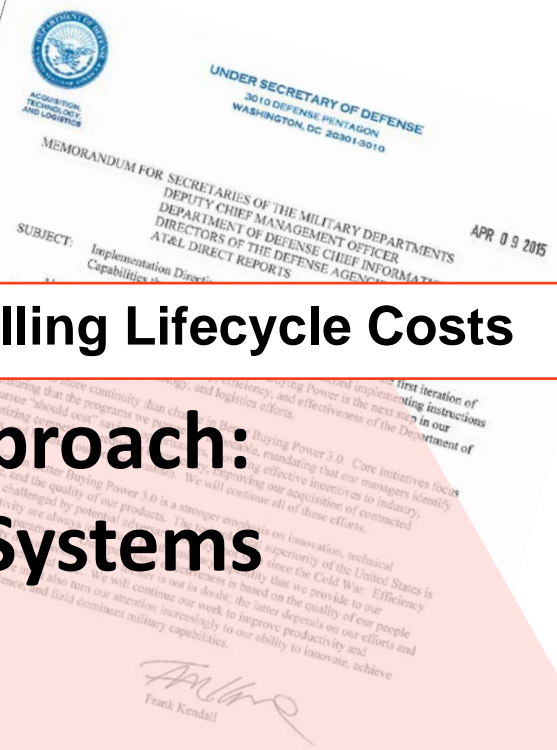
## System of Systems Approach: Primary and Enabling Systems

Apply Systems Design for Operational Effectiveness (SDOE) comprehensive model

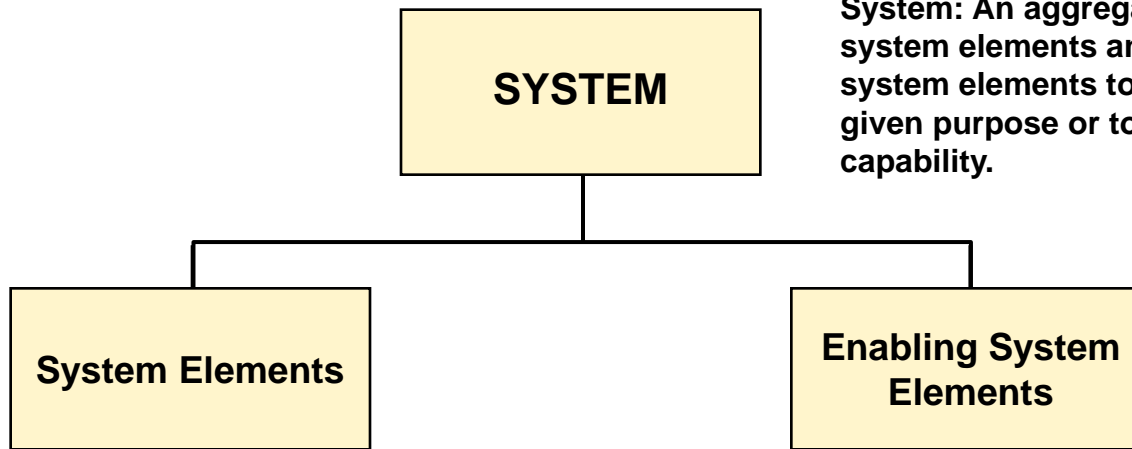
Manage efficient digital tapestry / environment that supports innovation

Assure model based approach supports the lifecycle

Develop data analytics to address system of systems and context complexity



# System of System Definitions



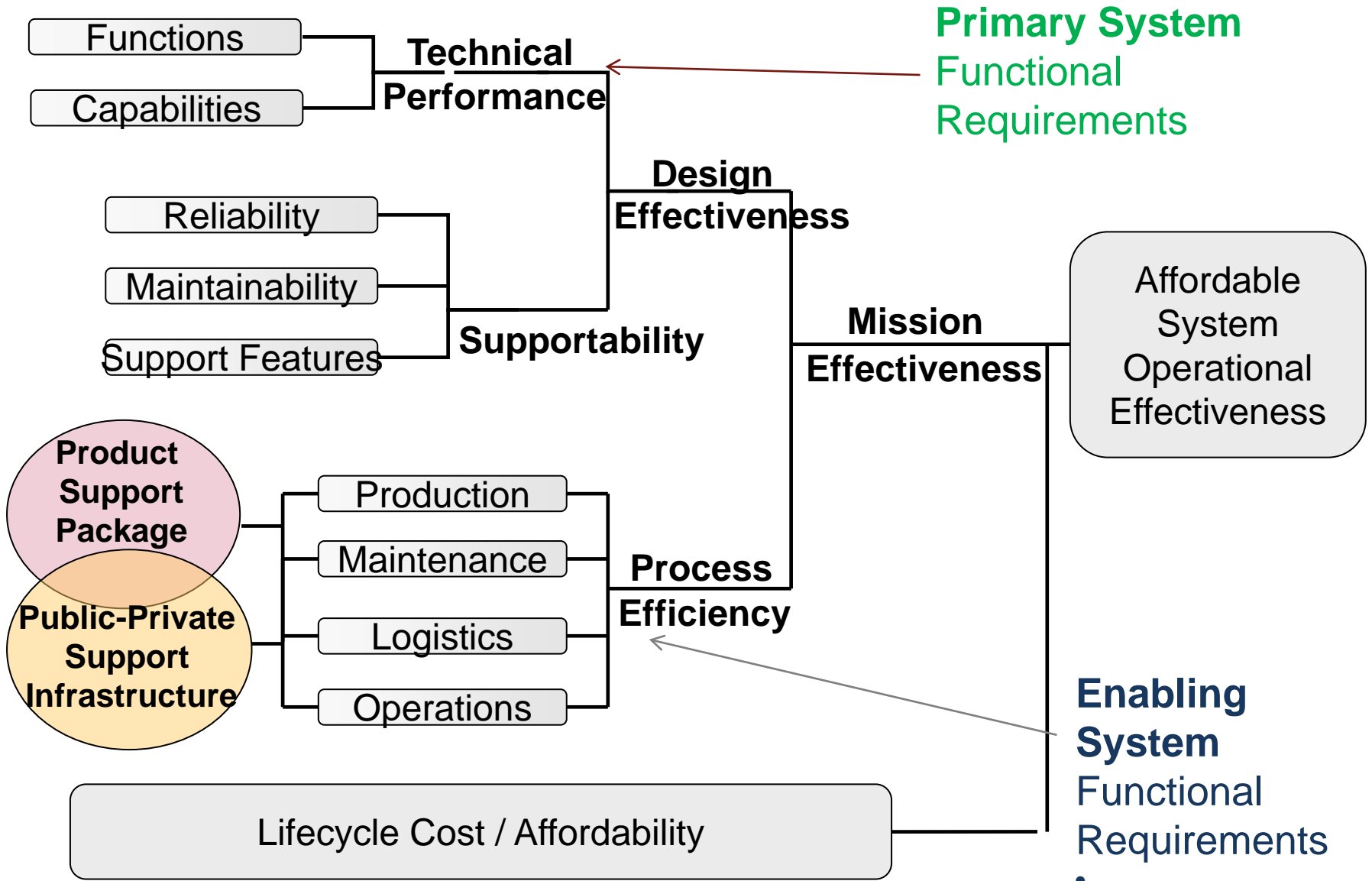
**System:** An aggregation of system elements and enabling system elements to achieve a given purpose or to provide a capability.

**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.

# System Design for Operational Effectiveness (SDOE) Model



# Enabling System Elements

## INTEGRATED PRODUCT SUPPORT

### Design Interface

Sustaining  
Engineering



Supply\_Support



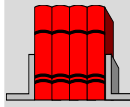
Maintenance Planning  
& Management



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.*

# 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](#), Worcester 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**

# Digital Manufacturing and Design Innovation Institute (DMDII)

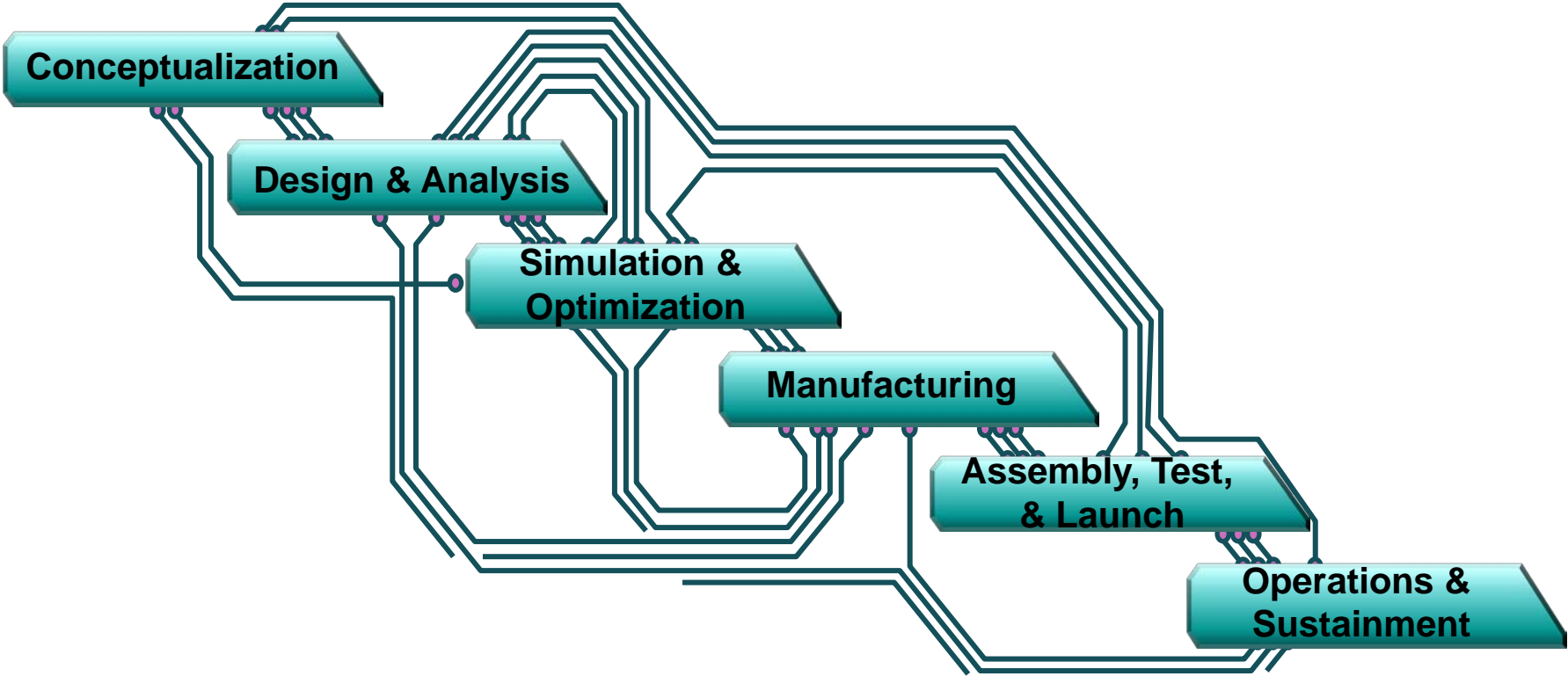


- **Mission: Establish a state-of-the-art proving ground for digital manufacturing and design that links IT tools, standards, models, sensors, controls, practices and skills, and transition these tools to the U.S. design & manufacturing industrial base for full-scale application**
- **Announced in February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



Integrated Data Management System

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.

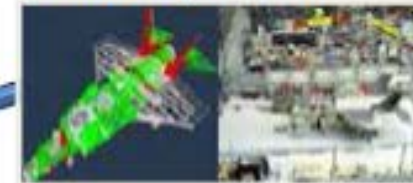
# Share Data for Lifecycle Support

Engineering Design

Requirements Development



Manufacturing and Development



Shared Data

Test and Eval



Prog. Mgmt.



Support/Sustainment



Operational Analysis



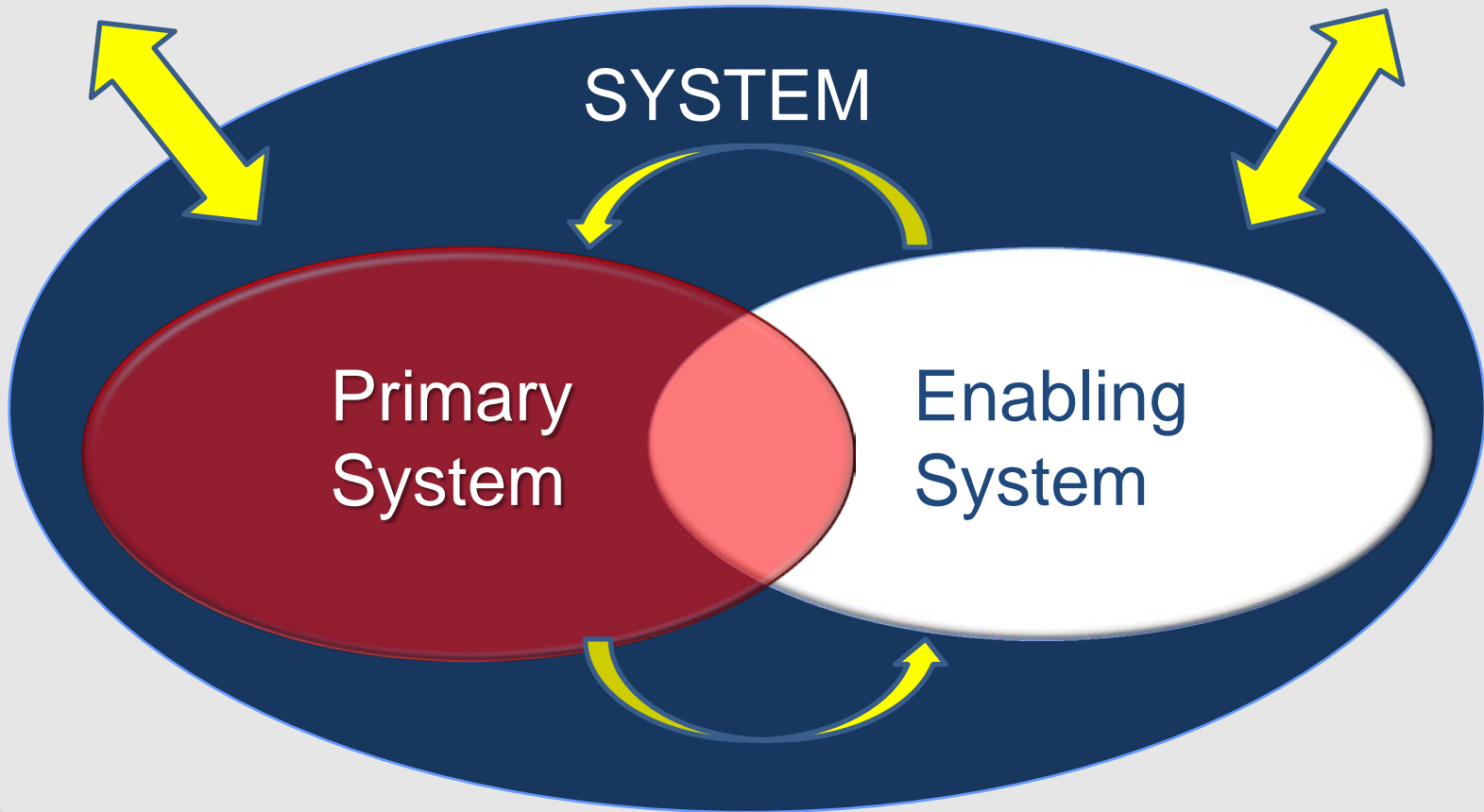
Operational Performance



# Framework for System of System and Operational Context Data Analytics

## External Context

(Includes Market, Threats, Operators, & other Systems which create / enforce emergent behaviors)



# 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



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