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Practical Implementation of Model Based Systems Development

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Biography

Thomas F. ‘Rick’ Landers

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- 35 Years SE and Systems Development experience , through all phases of Product Development Life Cycle.
- Certifications/Awards: LM SEDQP – Advanced Level, NASA Mission Success Honoree
- Key Programs: NASA Space Shuttle, X-33 Venture Star, UK MoD, F-35, MI5 & MI6
- Education: BS Aerospace Engineering
- Hobbies Interests; Tennis, Football

Biography

Dr. Yvonne Bijan

Systems Engineer Senior Staff
Systems Engineering Tech Ops

Lockheed Martin Aeronautics
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- 15 years at Lockheed Martin developing SysML models, UML models, and Interoperability Architectures on F-35, Harvest Hawk, and SBIRS
- Certified Enterprise Architect, Certified Systems Engineering Professional, Certified SysML Model Builder Advanced, and QFD Greenbelt
- LM Aero MBSE POC
- PhD Systems Engineering
- MS Computer Science
- BS Physics

Model Based System Design – Thoughts/Perspectives

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In theory, there is no difference between theory and practice. In practice, there is.
- Yogi Berra

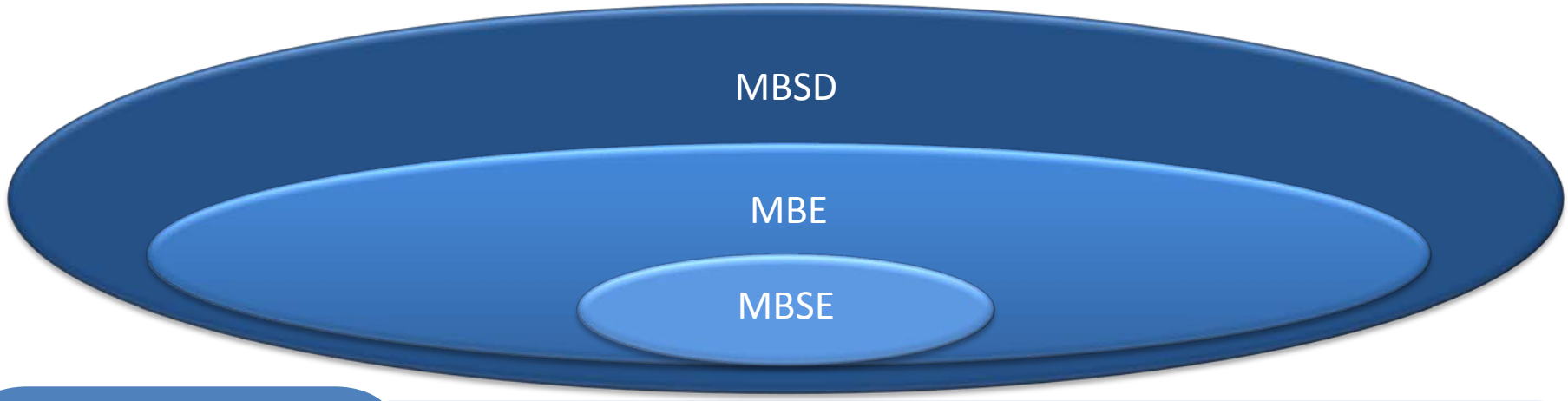
Systems Thinking

Approach to problem solving

Peter Michael Senge
(social scientist)
1947-

"Problems" are part of a system
View systems in a holistic manner
Not a science, but a "frame of mind"

Terminology



Model Based Systems Development (MBSD)	• Model-based approach to develop products across the product life cycle. Includes model-based systems, software, hardware, test engineering, and supporting simulation and analysis.
Model Based Engineering (MBE)	• An approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle.
Model Based Systems Engineering (MBSE)	• Those aspects of MBSD associated with Systems Engineering. Includes analysis, system architecture, simulation, test, and other areas.

Why consider MBSD?

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Problem

- Long development time
- Integration issues
- Defects not found until downstream lifecycle phases. E.g. Flight Test, product support

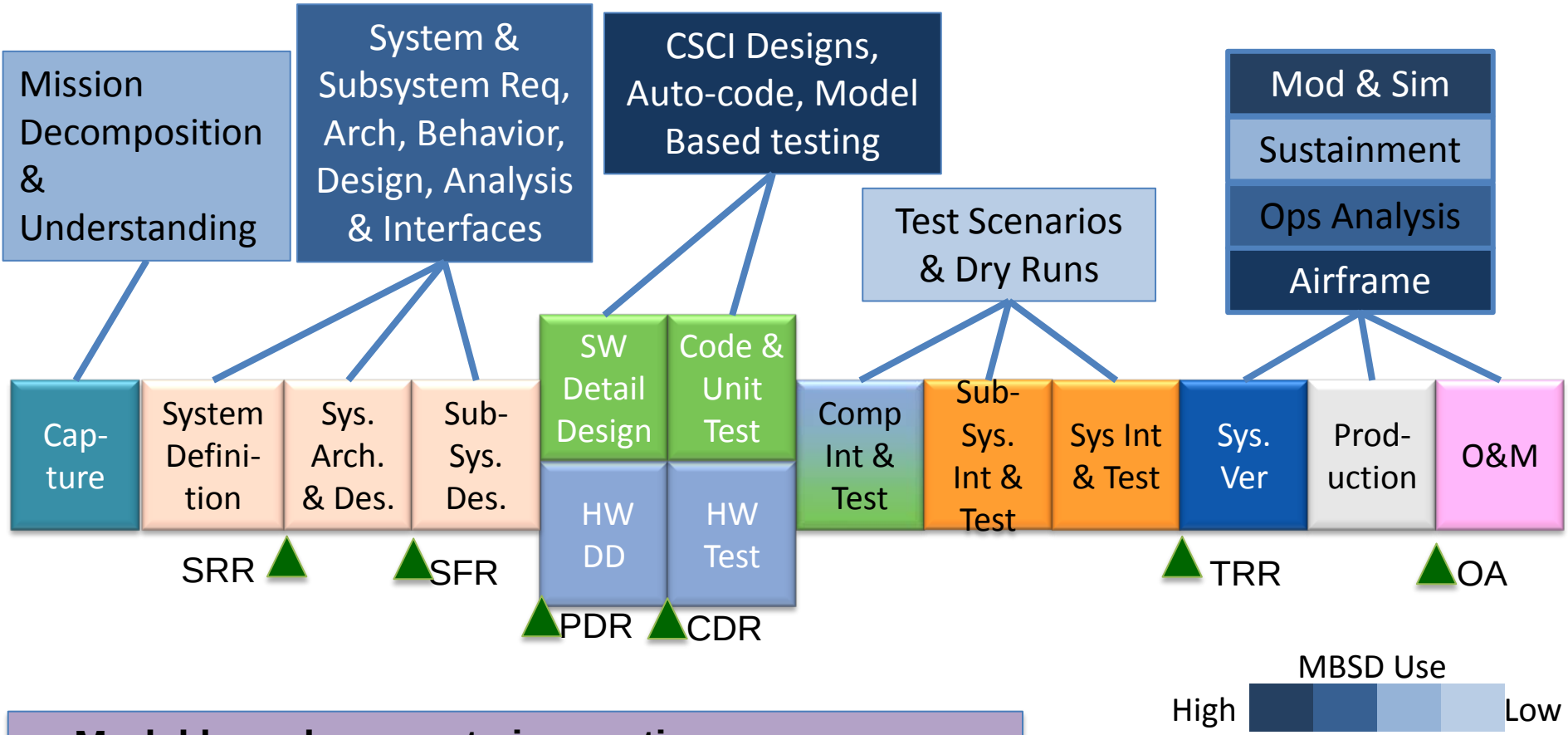
Current state

- Individual domain models – Systems Engineering, Software IPTs, Flight Controls, Wiring, and Loads, etc.
- **Framework for Product Development**

Future work

- Integrated set of models
- Digital Air Vehicle

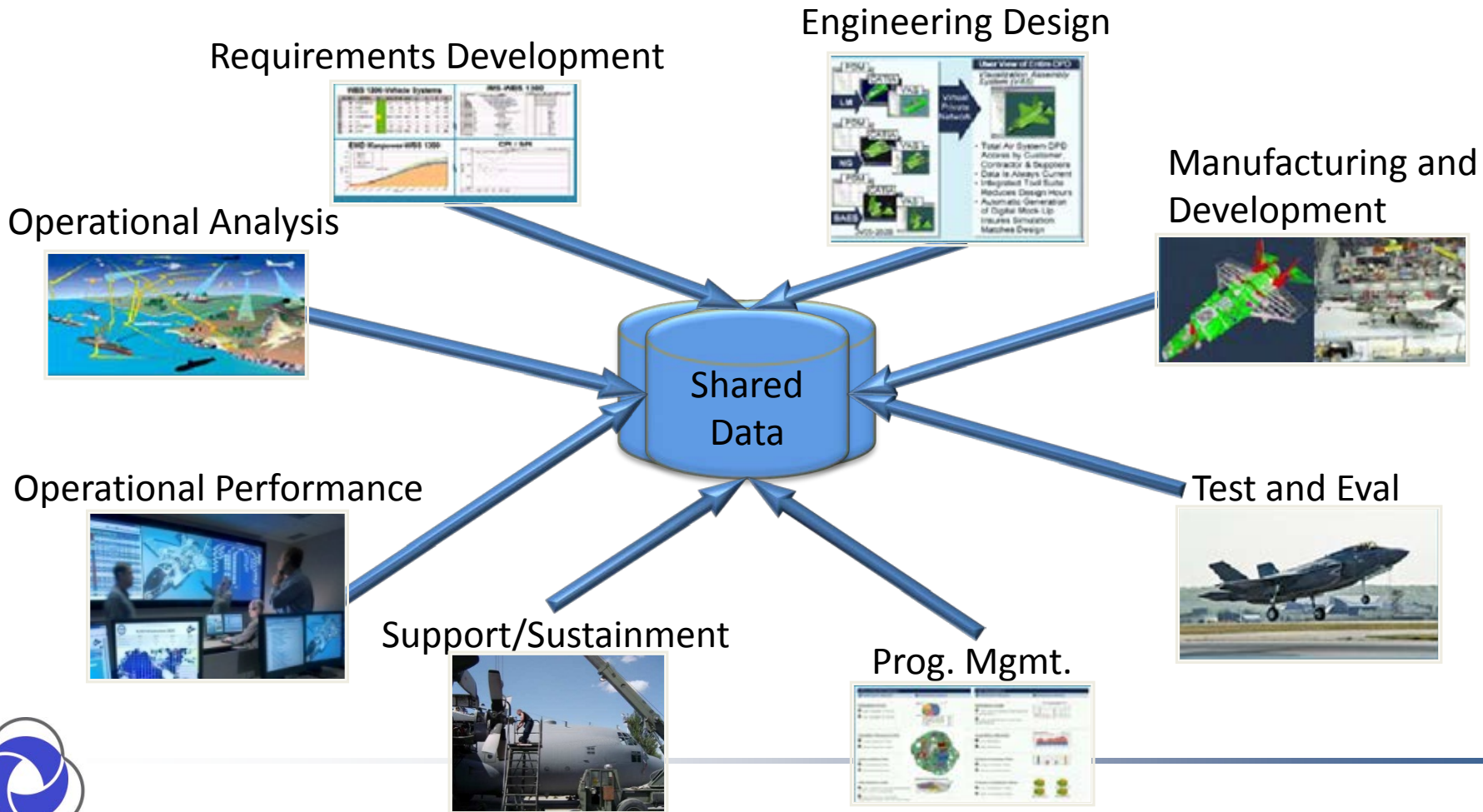
Current MBSD across the lifecycle



- **Model based concepts in practice**
- **Changes in one are not propagated to others**
- **Applied across various domains, i.e. Air System, Flight Controls, etc.**
- **Not integrated within or across domains**

Vision/Needs – MBSD Requirements across lifecycle

- Increase customer value through a Model Based Systems Design (MBSD) approach
- Provide engineering expertise needed throughout an aircraft's lifecycle, beginning with the design phase, ensuring production success and sustainment of the aircraft.



Challenge

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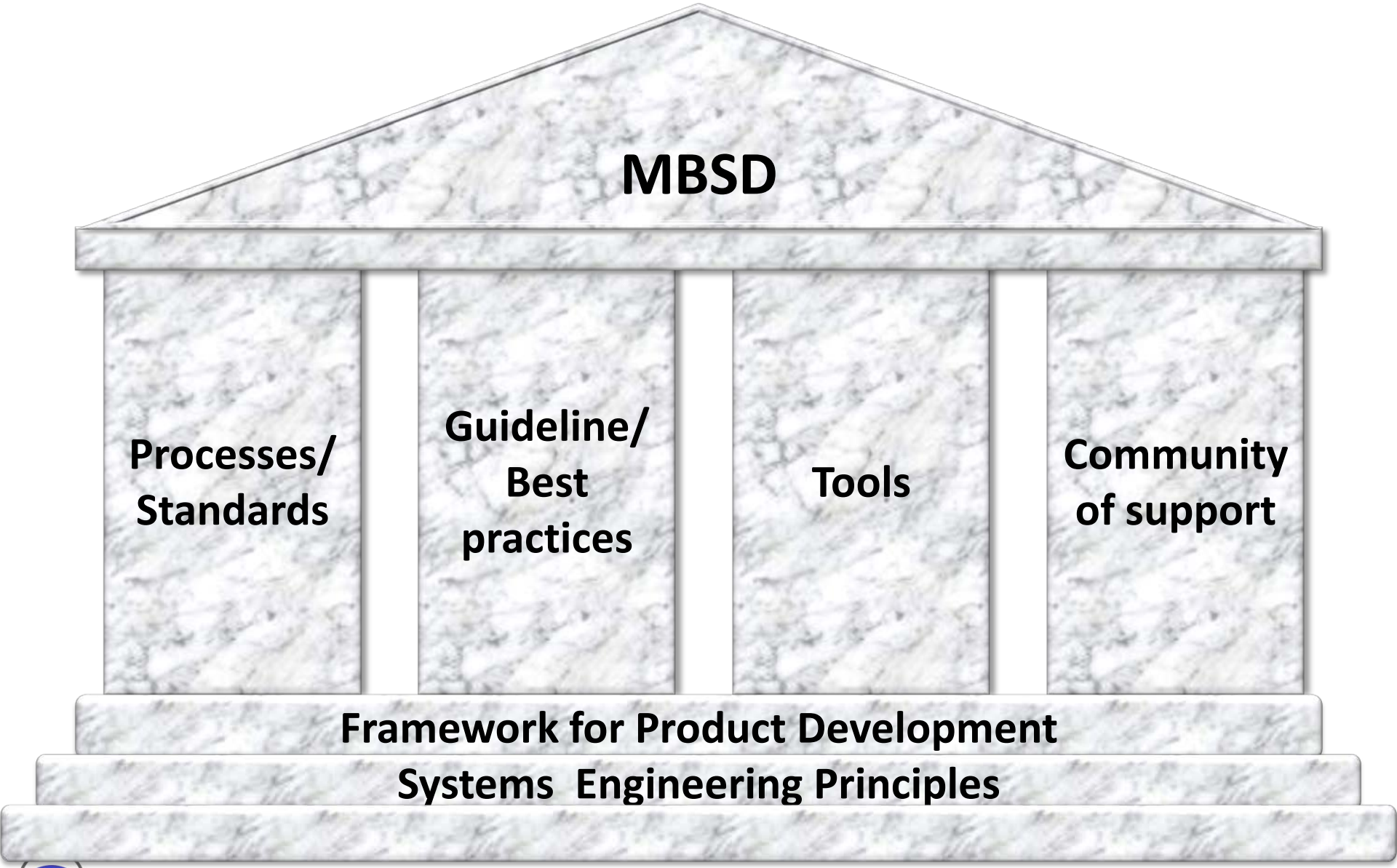
Develop highly integrated model-based environment in which the model and associated data set is the technical baseline

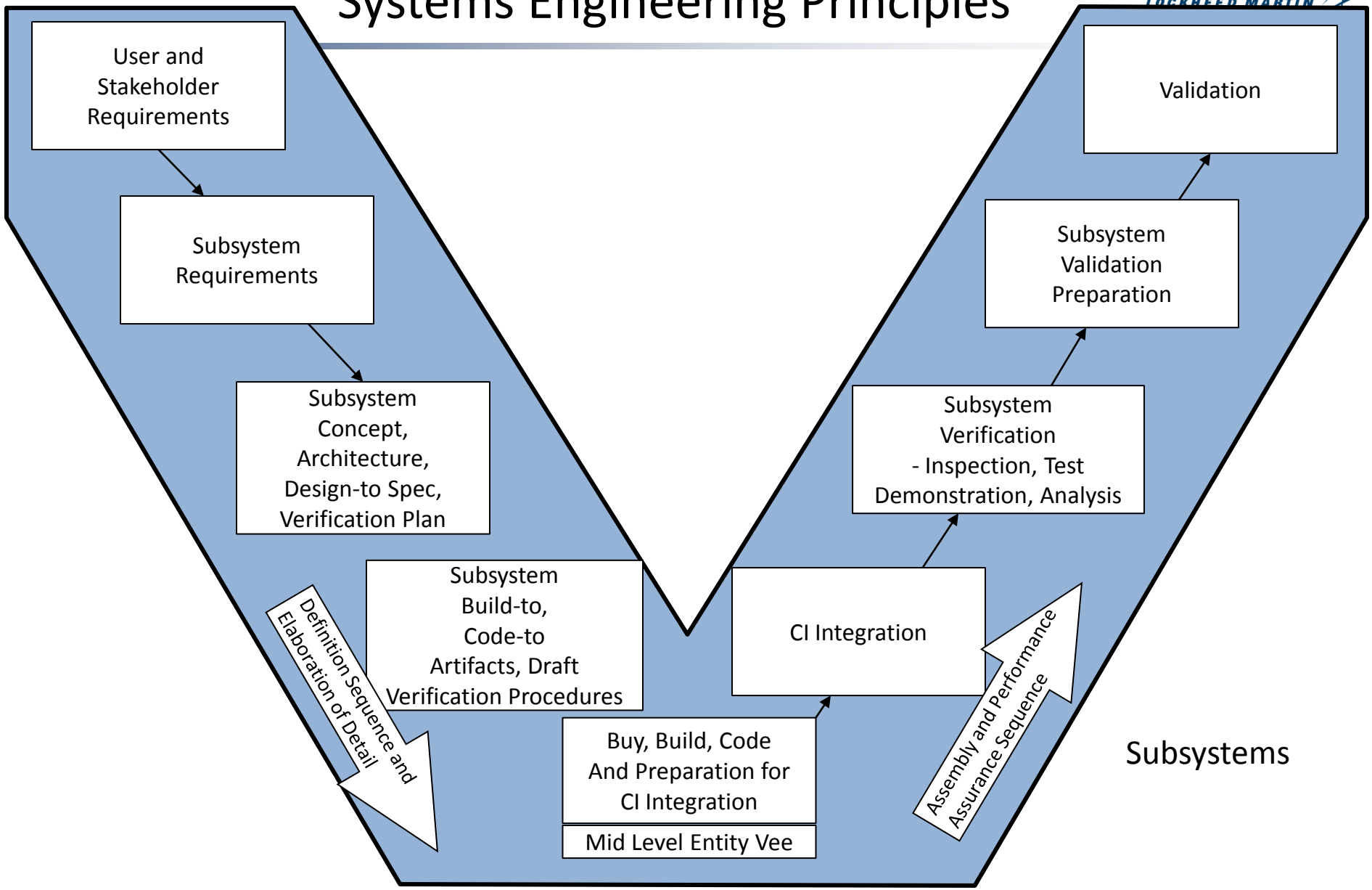
Institutionalize advanced technologies and methods

Increase relevancy to our customer through superior product development, production and deployment

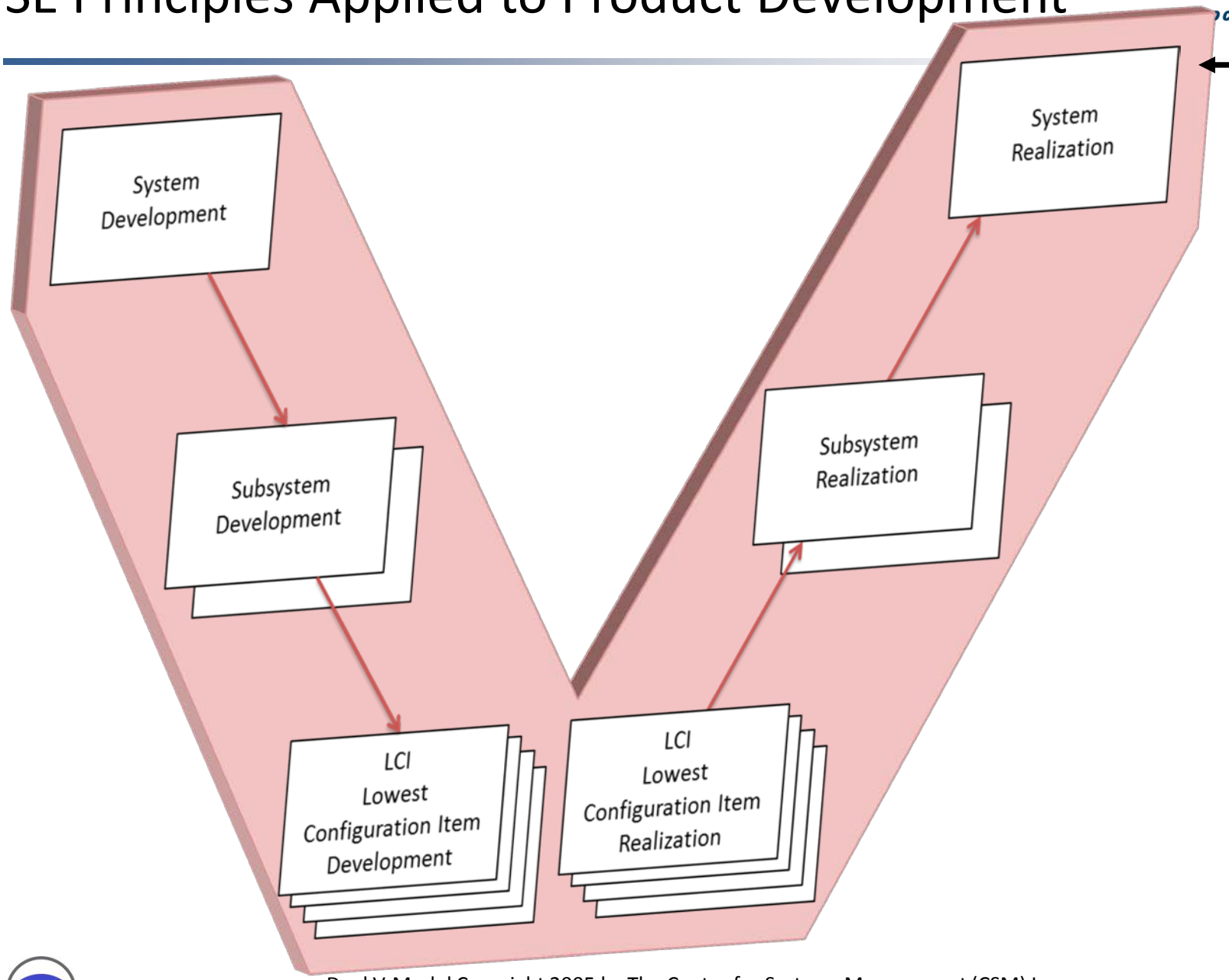
Foundation & Pillars for MBSD Implementation



Systems Engineering Principles

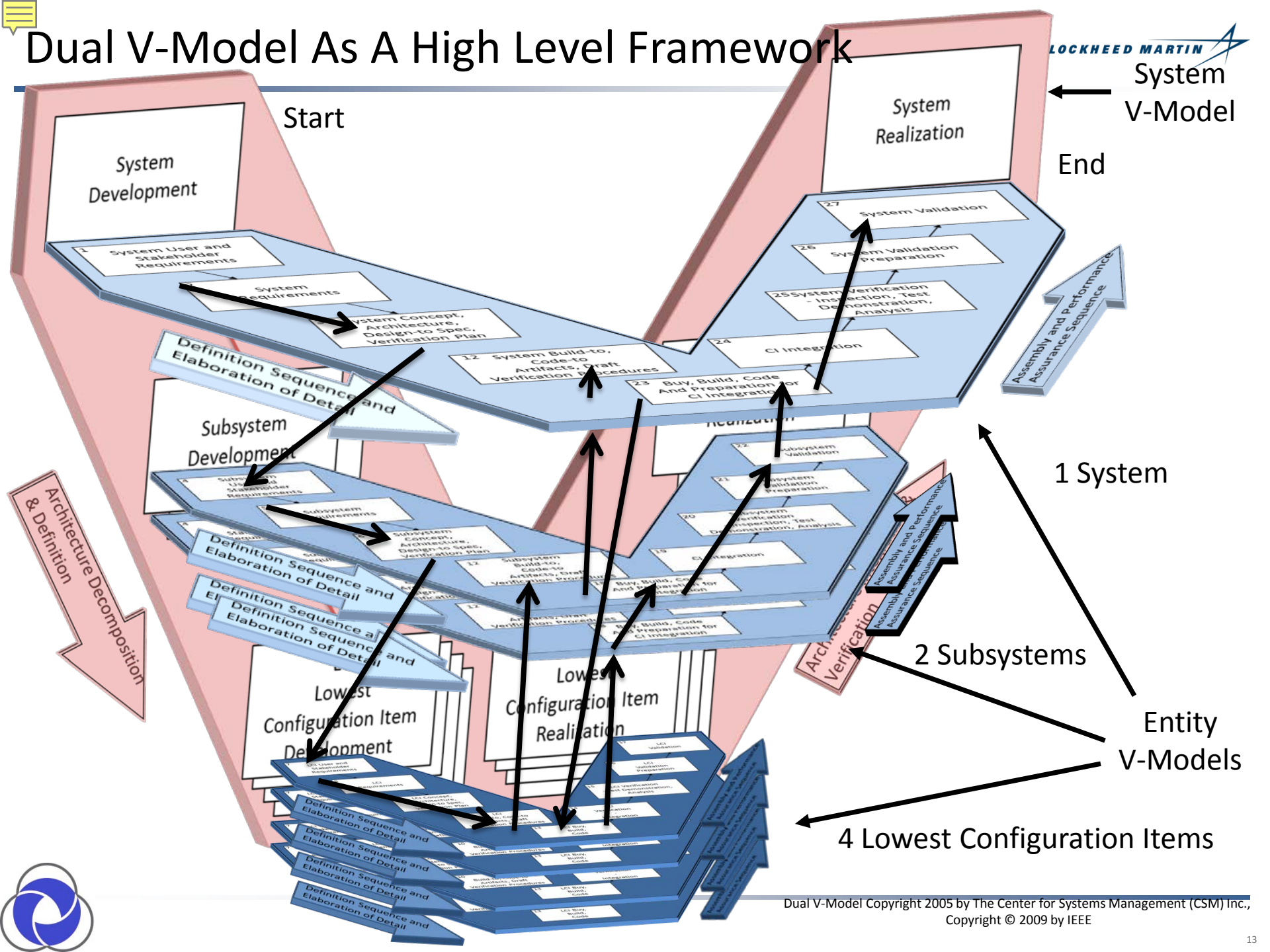


SE Principles Applied to Product Development

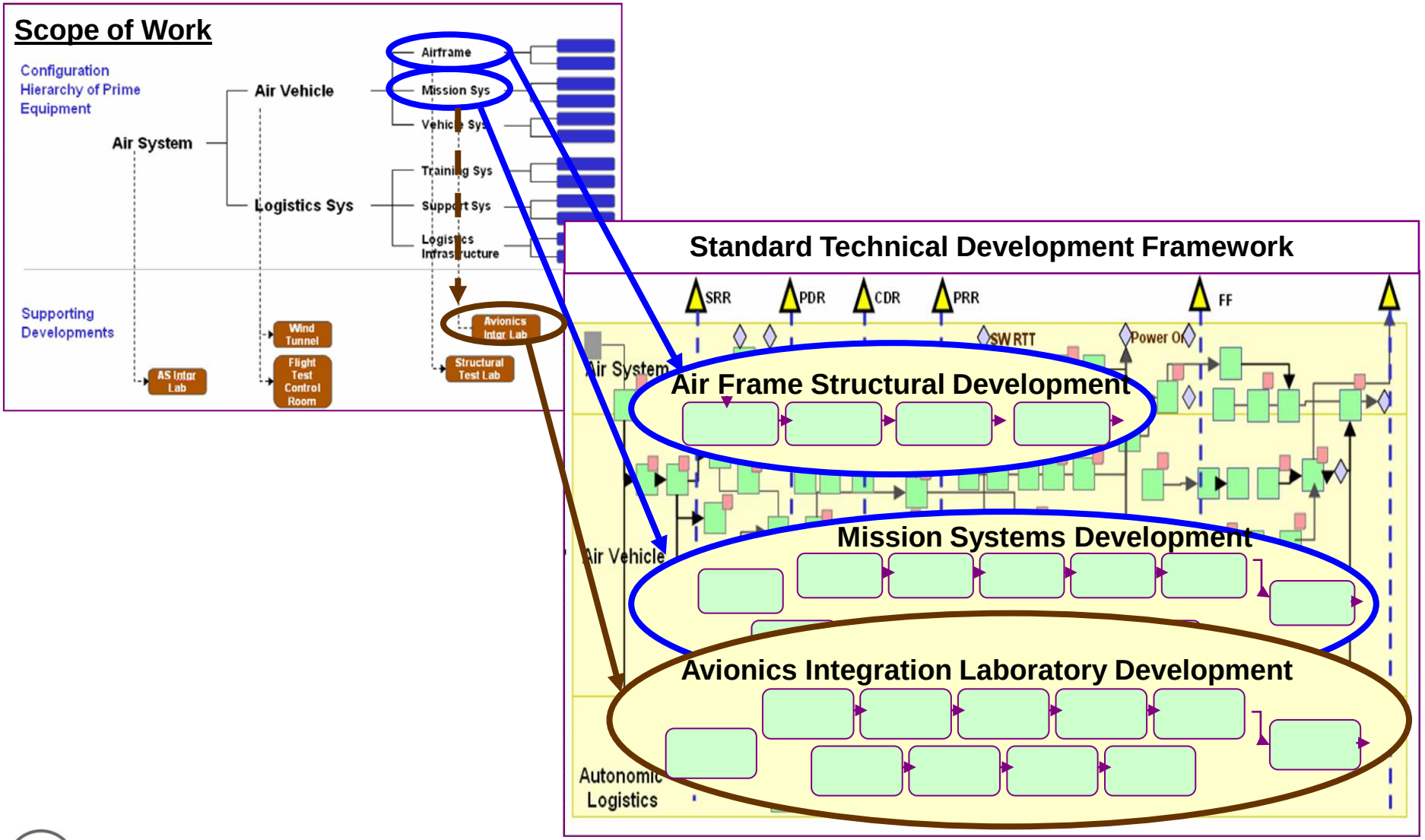


System V-Model

Dual V-Model As A High Level Framework



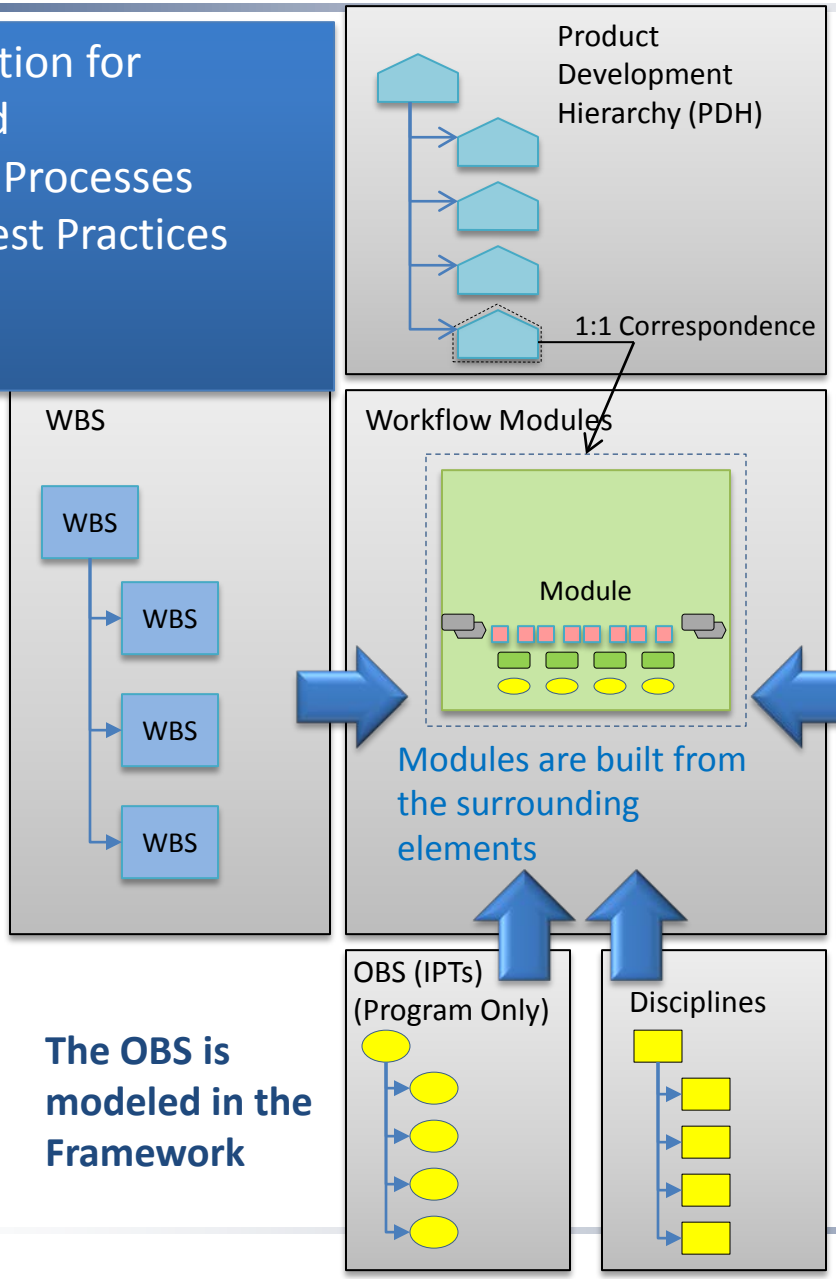
Product Development Hierarchy



Attributes of Framework for Product Development

This is the foundation for identifying related

- Standards and Processes
- Guidelines / Best Practices
- Tools
- SMEs / POCs



System components are modeled in the Product Development Hierarchy (PDH)

The WBS is modeled in the Framework

Work Products are contained in the Framework in an "Object Data Library (ODL) synchronized with the Work Product Standard (WPS)

The OBS is modeled in the Framework

Core Competencies and their technical disciplines are modeled in the Framework

Example: Workflow – Requirements to Verification

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Development Work Flow For Each Component
(e.g. Air Vehicle, Landing Gear, Wing, Antenna, Integration Lab)

Supplier Sourcing *If Development Is To Be Procured*

Requirements Development

Architectural Design

Preliminary Design

Detailed Design

Implementation

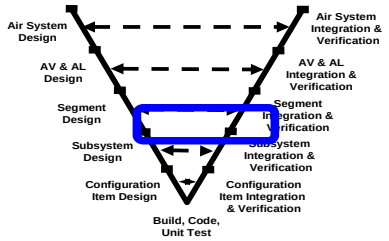
Integration & Test

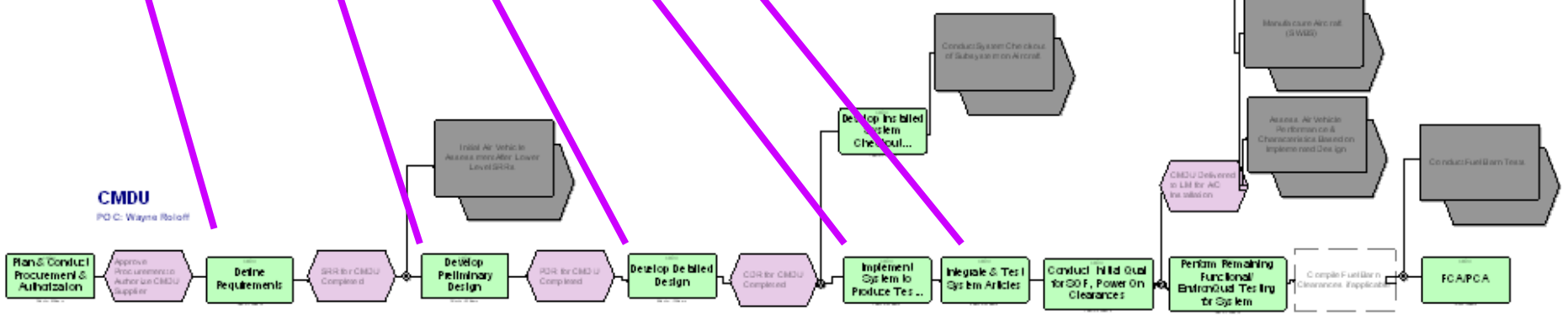
Verification

Handoff to Next Level of Integration

** Each Component Development Flow May Reflect Specific Terminology Associated With The Best Practice Development For That Component; However, They Must All Follow The Systems Engineering Process *(See Examples On The Following Slide)*

Development Program Life-Cycle "V"





Work Products are key Handoffs

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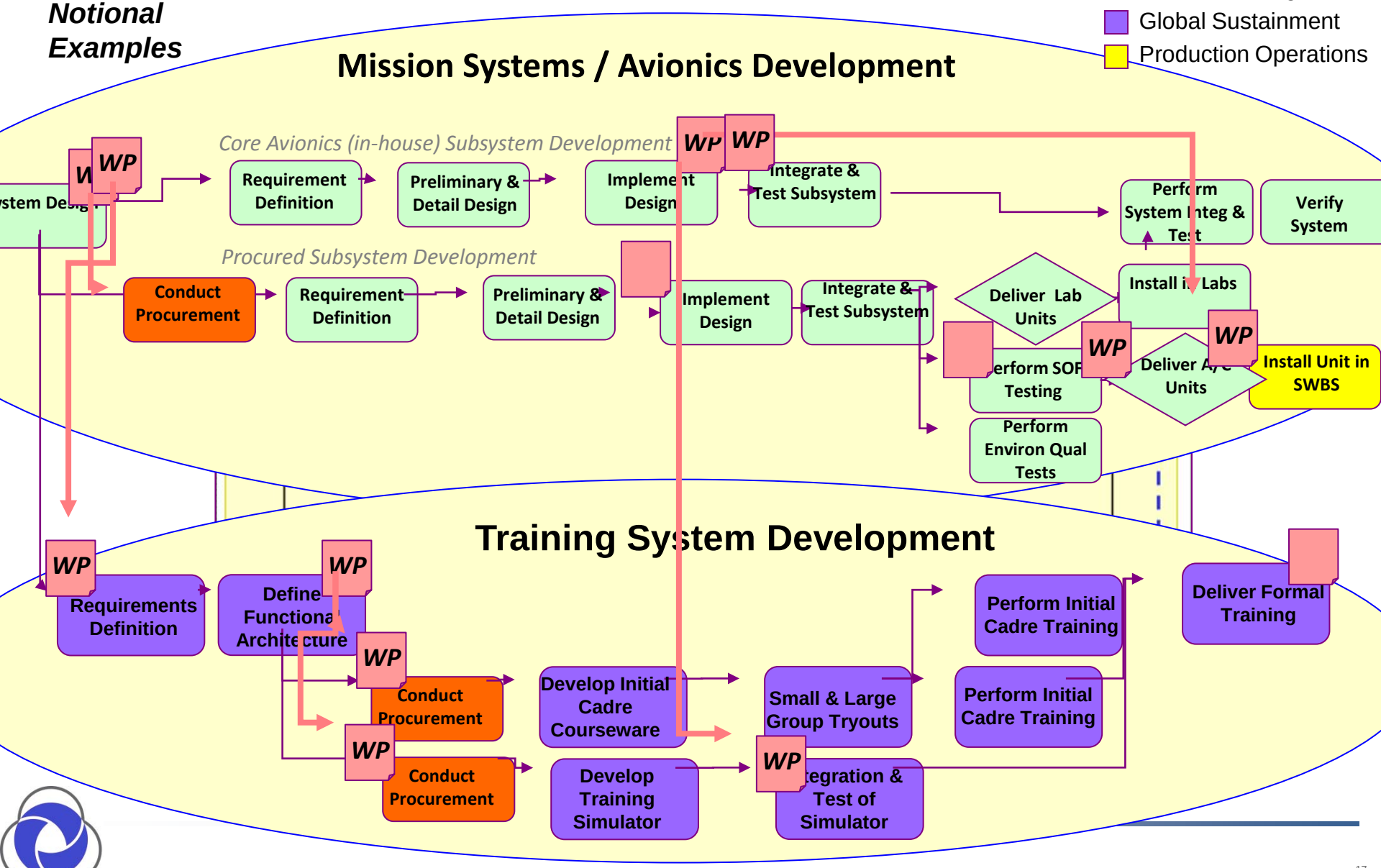
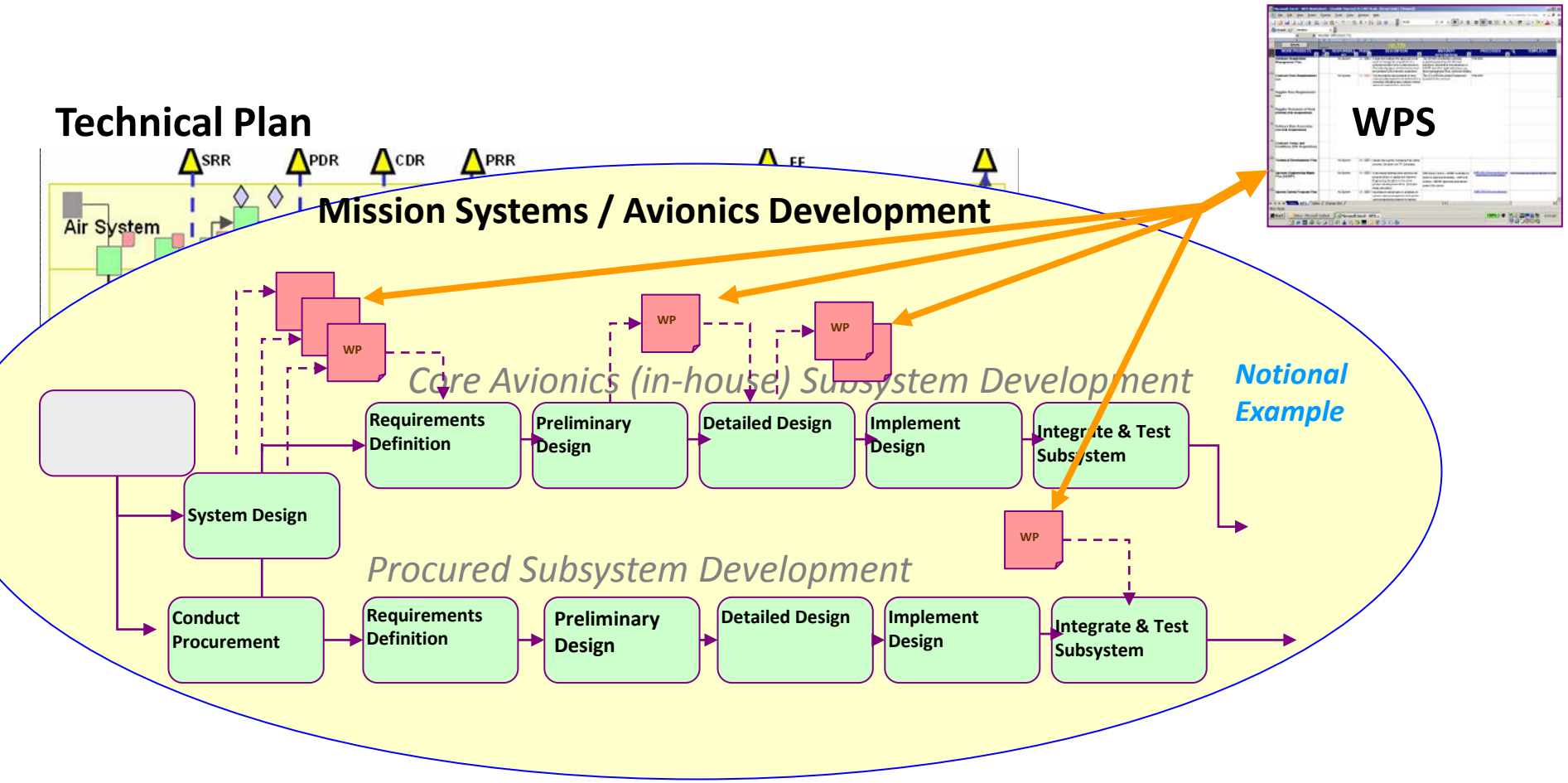
- Engineering
- Material Management
- Global Sustainment
- Production Operations

Notional Examples

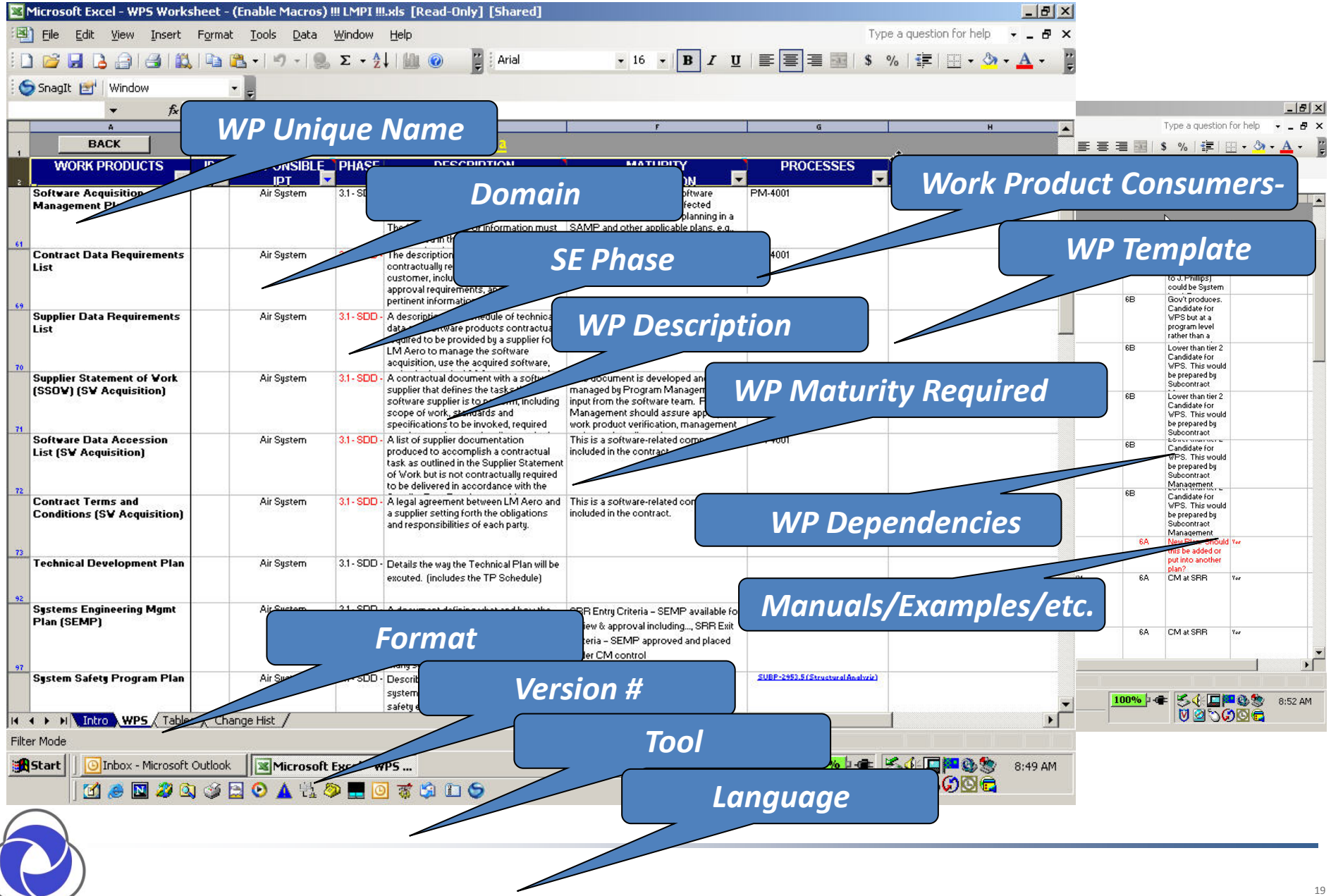


Technical Plan Integrates Work Product Standard

- Work products are defined from the work product standard

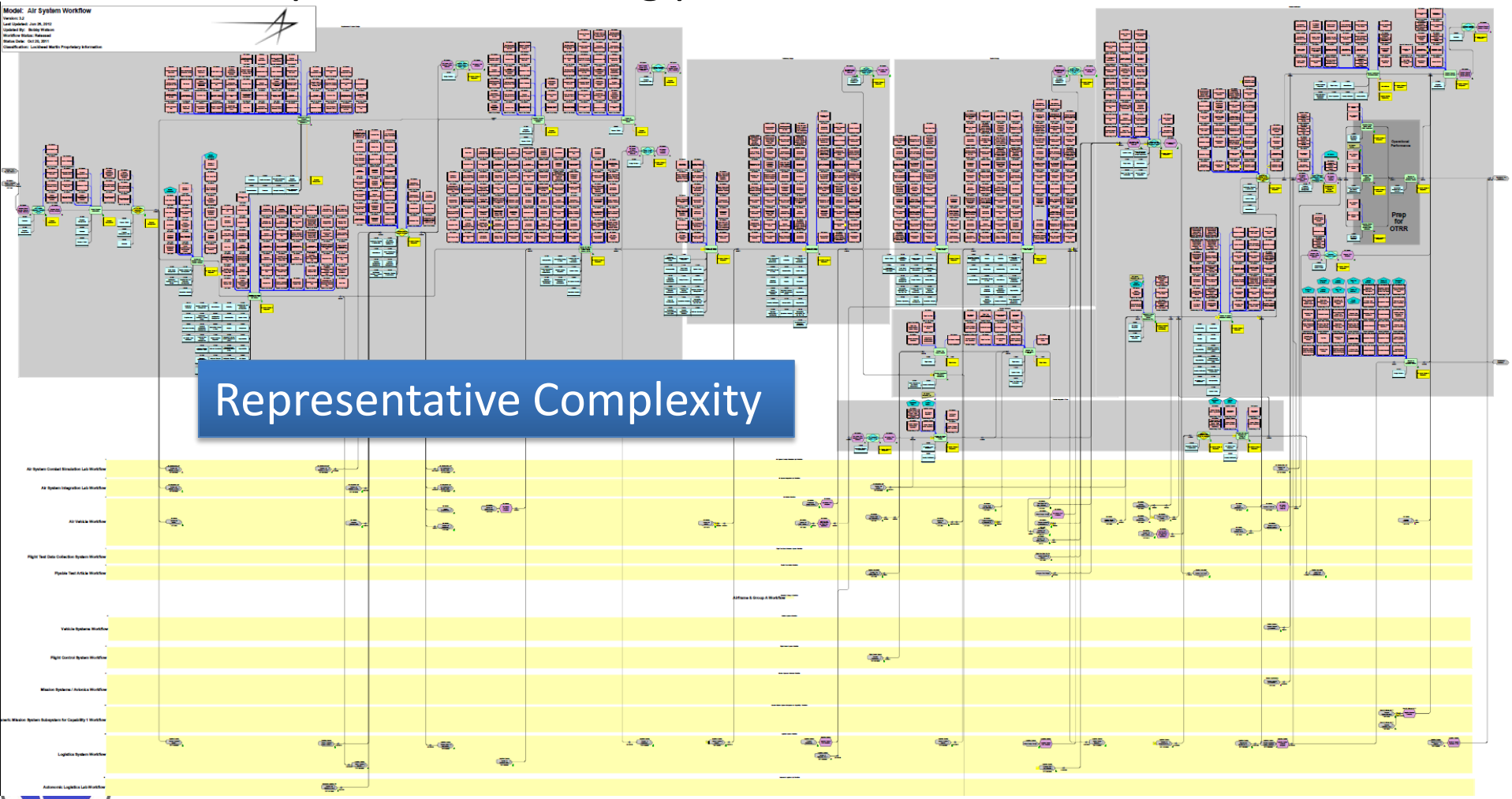


Work Product Standard -- Attributes

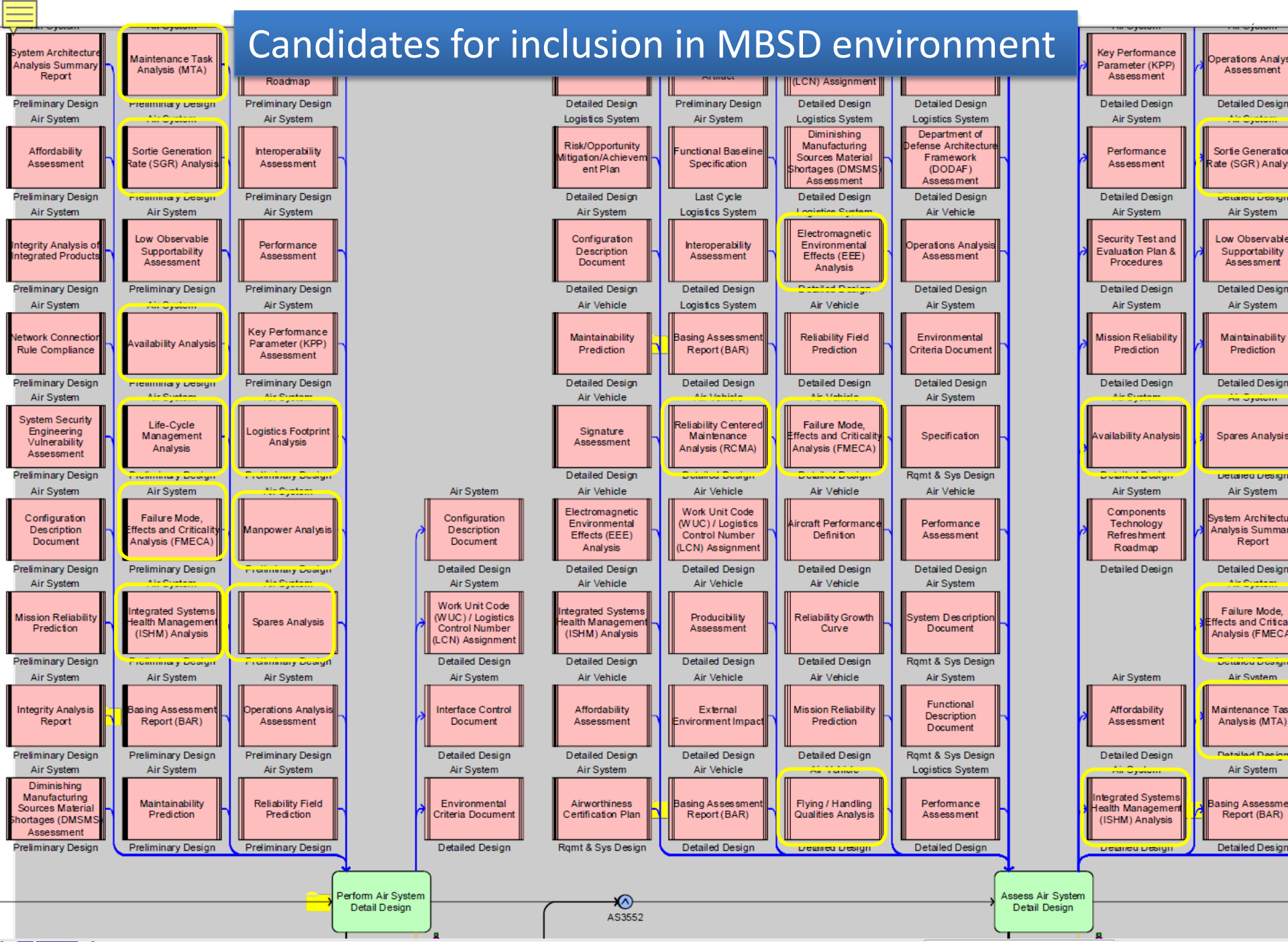


Product Development Standard

- Incorporate MBSD into PDS
- Identify products that should use MBSD approach
- Develop interface among products



Candidates for inclusion in MBSD environment



Candidate products for Modeling

Selection Guidelines

- Analysis required
- Trade space investigation
- Highly integrated work products
- Traceability is needed
- High complexity

Candidates (Subset)

- Maintenance Task Analysis
- Sortie Generation Rate Analysis
- Availability Analysis
- Life-Cycle Management Analysis
- Logistics Footprint Analysis
- Electromagnetic Environmental Effects Analysis
- Reliability Centered Maintenance Analysis
- Failure Mode, Effects and Criticality Analysis (FMECA)
- Spares Analysis
- Integrated Systems Health Management Analysis

Benefits of MBSD

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Formalizes the practice of systems development

- Includes industry accepted standards
- Includes tools
- Includes command media
- Provides single source of truth

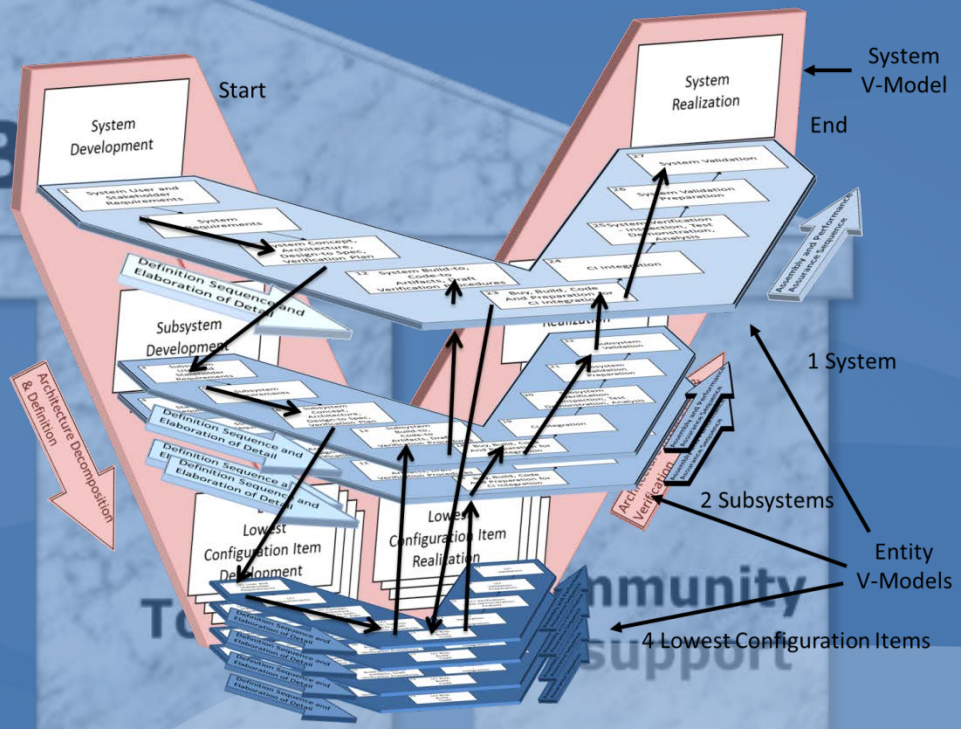
Increases integration

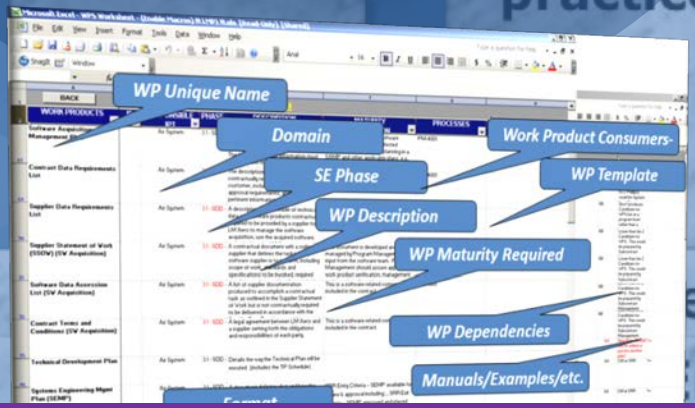
- Includes multiple domains
- Supports handoffs in the product hierarchy from SoS to component
- Defines data needs

Improves quality & productivity, Reduces schedule & risk

- Increases rigor and precision of definition
- Communicates to stakeholders
- Manages complexity
- Automates labor intensive activities (document generation)

Practical Implementation of **MBSD**





It's NOT Scientific, it's a 'FRAME of Mind'

https://aero-sp1.external.lmco.com/sites/AeroSE/Site%20Documents/MBE/MBE_Survey.docx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