MBSE, PLM and the Digital Thread: Where do we go from here?

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Digitalization: Transforming Enterprises
Digitalization requires rethinking the business, product, and data

- Radical advances in digitalization are underway all around us

- Digitalization itself as been defined in many ways, but the most succinct is the business strategy best geared to extract real-world value from digital data (e.g., Airbnb, Amazon, etc.)

- The Internet of Things (IoT) with its billions of connected devices is and will play a major role

  - A source of "big data" and enabling closed loop lifecycle management

  - Making the digital thread and digital twin more achievable

PLM: The Required End-to-End Connectivity

PLM touches all phases of a product's life—digitalization demands it

Portfolio Management

Planning

Conceptual Design

Product Engineering

Manufacturing Engineering

Requirements

Simulation & Validation

Knowledge

Re-use
Re-purpose
Re-mfg.
Re-cover
Re-cycle
Re-tire
Disposal & Recycling

Build and Produce

Test & Quality

Sales & Distribution

In-service Operation

Maintenance & Repair

PLM Solutions—Information Management across Media, Process, Time, Geography, & Enterprise

Digitalization is Driving Major PLM Market Trends
Simulation-Driven Systems Development

- Product Innovation Platforms

  ⇨ *Simulation increasingly relevant throughout the product lifecycle to enable innovation, quality and profitability*

- Modeling & Simulation Platforms

  ⇨ *Open Platform with 'best of breed' solutions is critical for delivering simulation value across the product lifecycle*

- Model-Based Systems Engineering

  ⇨ *Connecting VOC/requirements with systems level design, modeling and simulation across all engineering domains*

- Digital Thread & Digital Twins

  ⇨ *IoT & data analytics technology creating new insights and use cases for simulation models in operations*

- Democratization of Simulation

  ⇨ *Technological advances enabling simulation use by more engineers earlier and throughout the product lifecycle*

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"Sewing the Digital Thread"

The Digital Thread
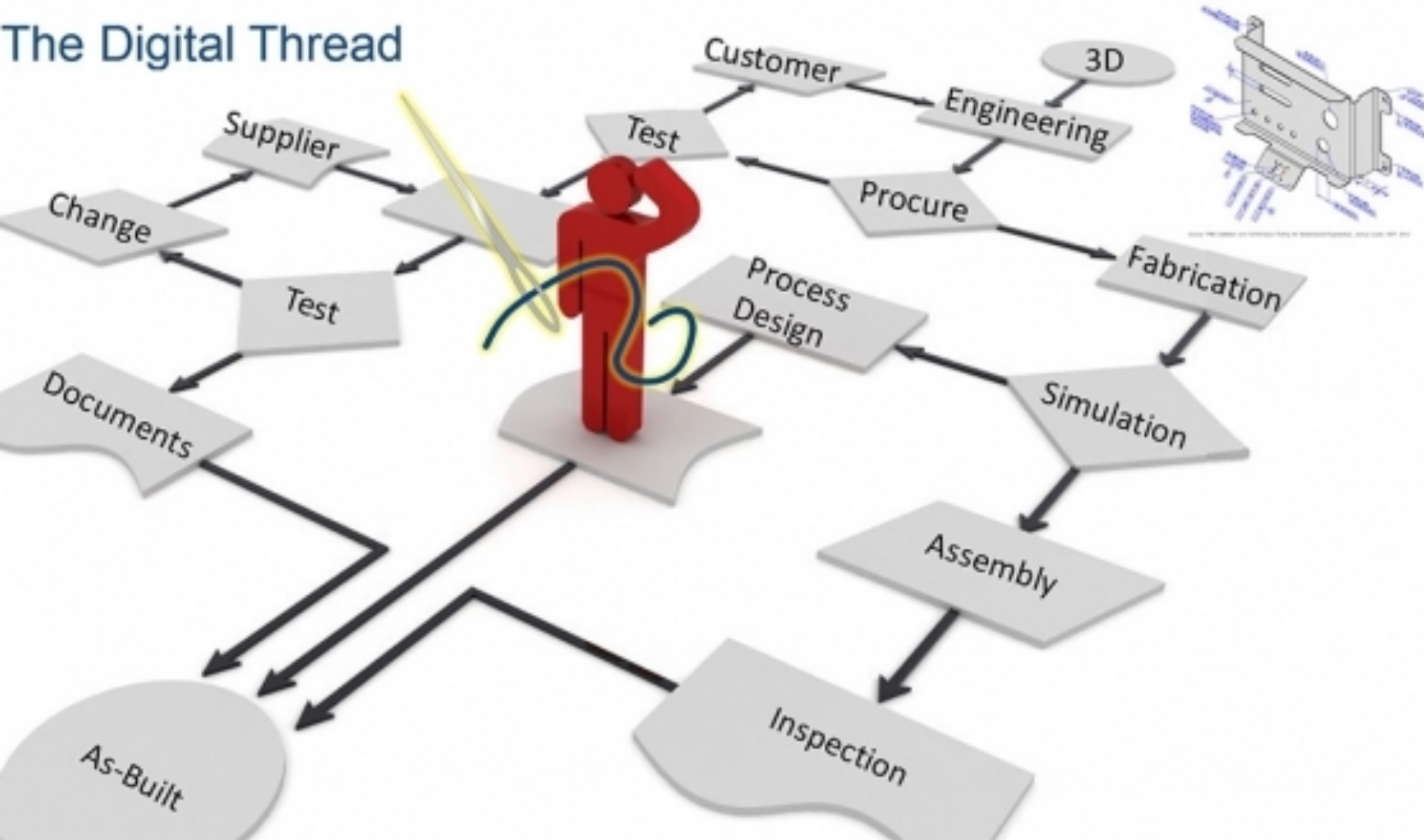
Connecting the Lifecycle Digital Thread

Building out all of these threads will enable the desired closed loop lifecycle process

Virtual

System Architecture & Design (RFLP)

Test/V&V

Product Reqs.

Modeling & Simulation
SPDM

IoT/ Digital Twins

In Service (SLM)

Mechanical Design

PDM

Model Based Design

Costing

Electronics Design

Design For Mfg

Digital Factory

Tech Docs

Inventory

Physical

ALM

Software Engineering

Supply Chain Mgmt.

Procurement

BOMs, Reqs, Configurations, Portfolio, Change Mgmt…
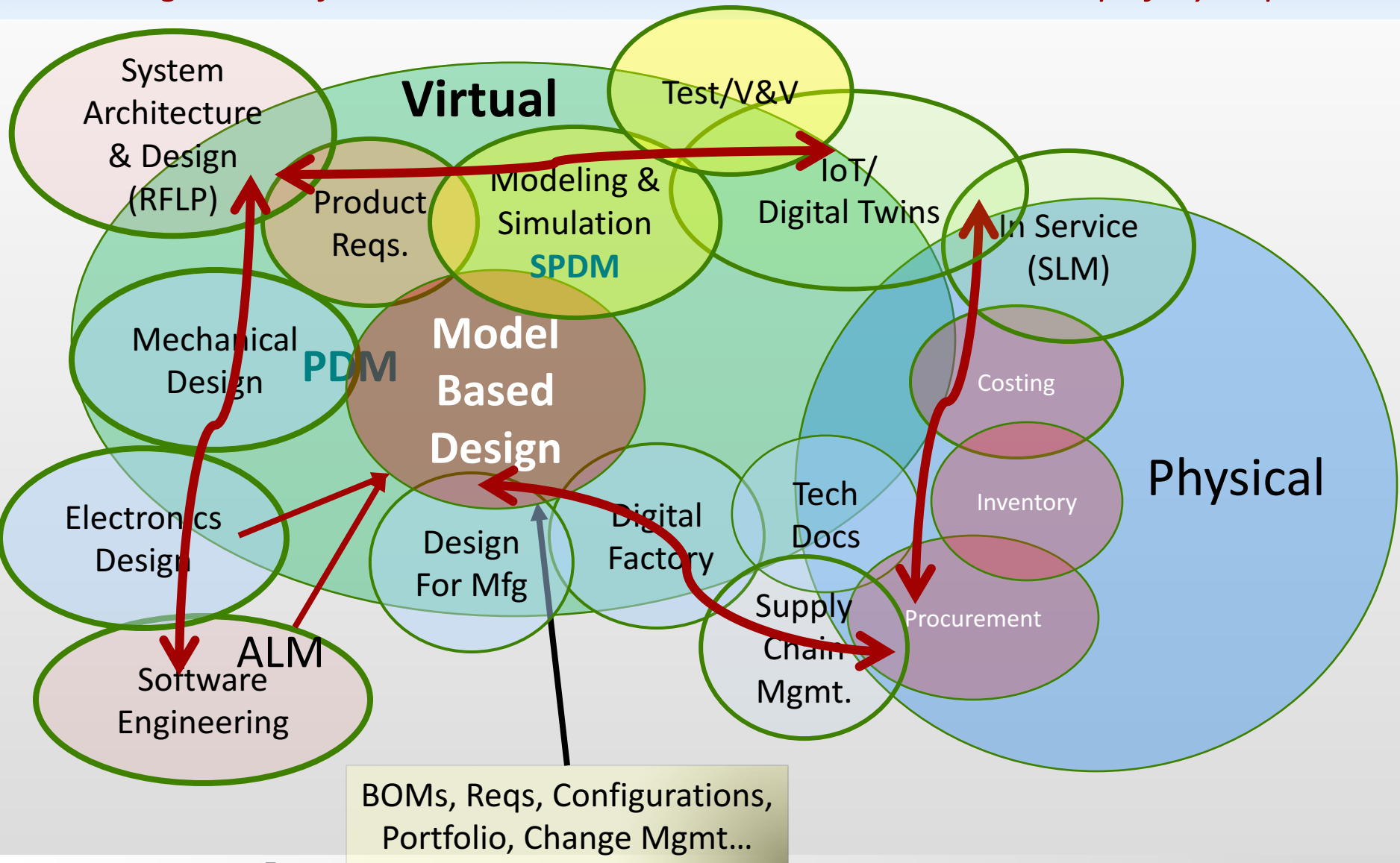
Platforms are now consolidating across domains

PLM vendors are acquiring MBSE, M&S, ALM & EDA technologies

Requirements Definition & System Architecture Design

Behavior Modeling & Simulation (Physics-based)

Systems Engineering (RFLP)

Software Development (Embedded, Controls)

Physical Development (Mechanical, Electrical, Chemical, Biological ..)
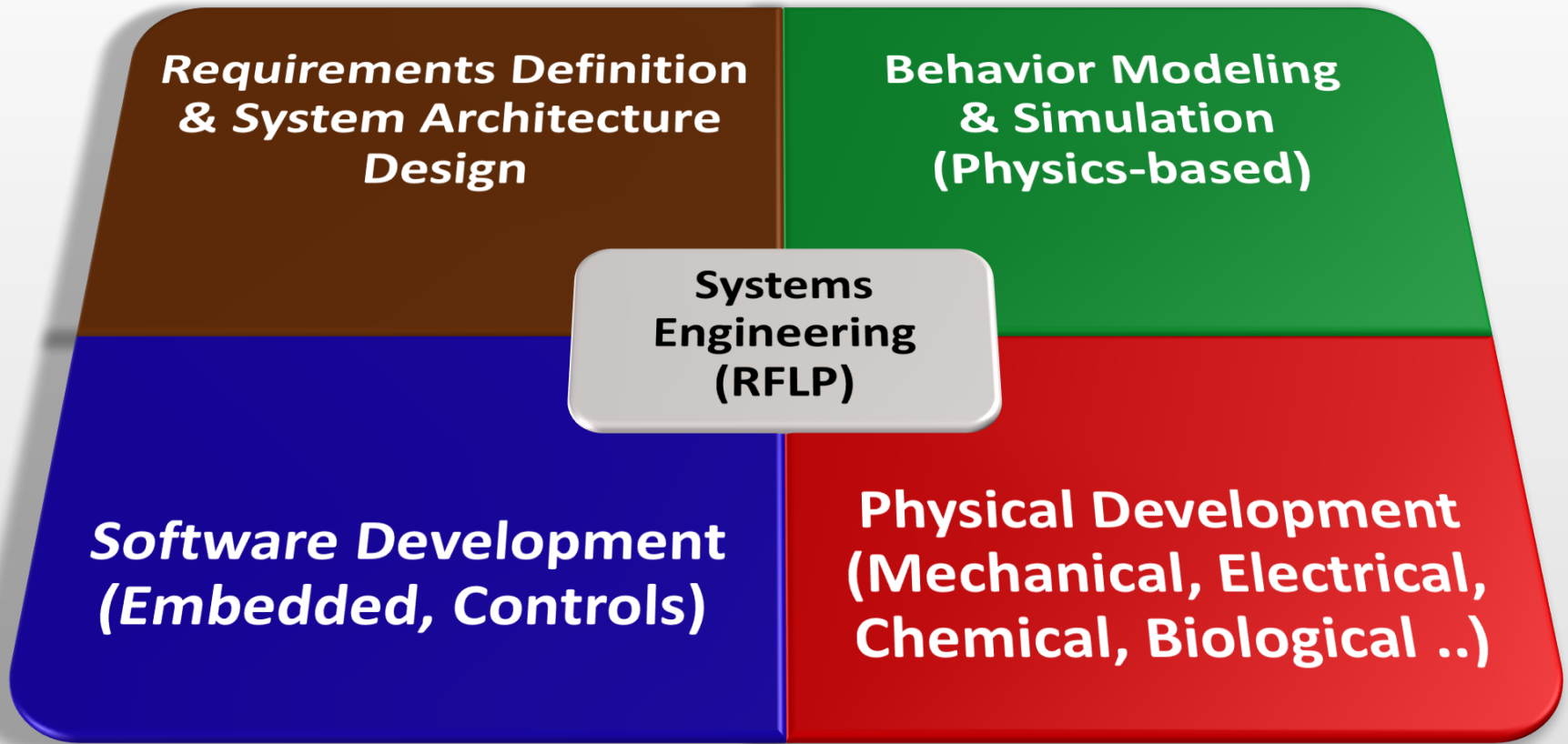
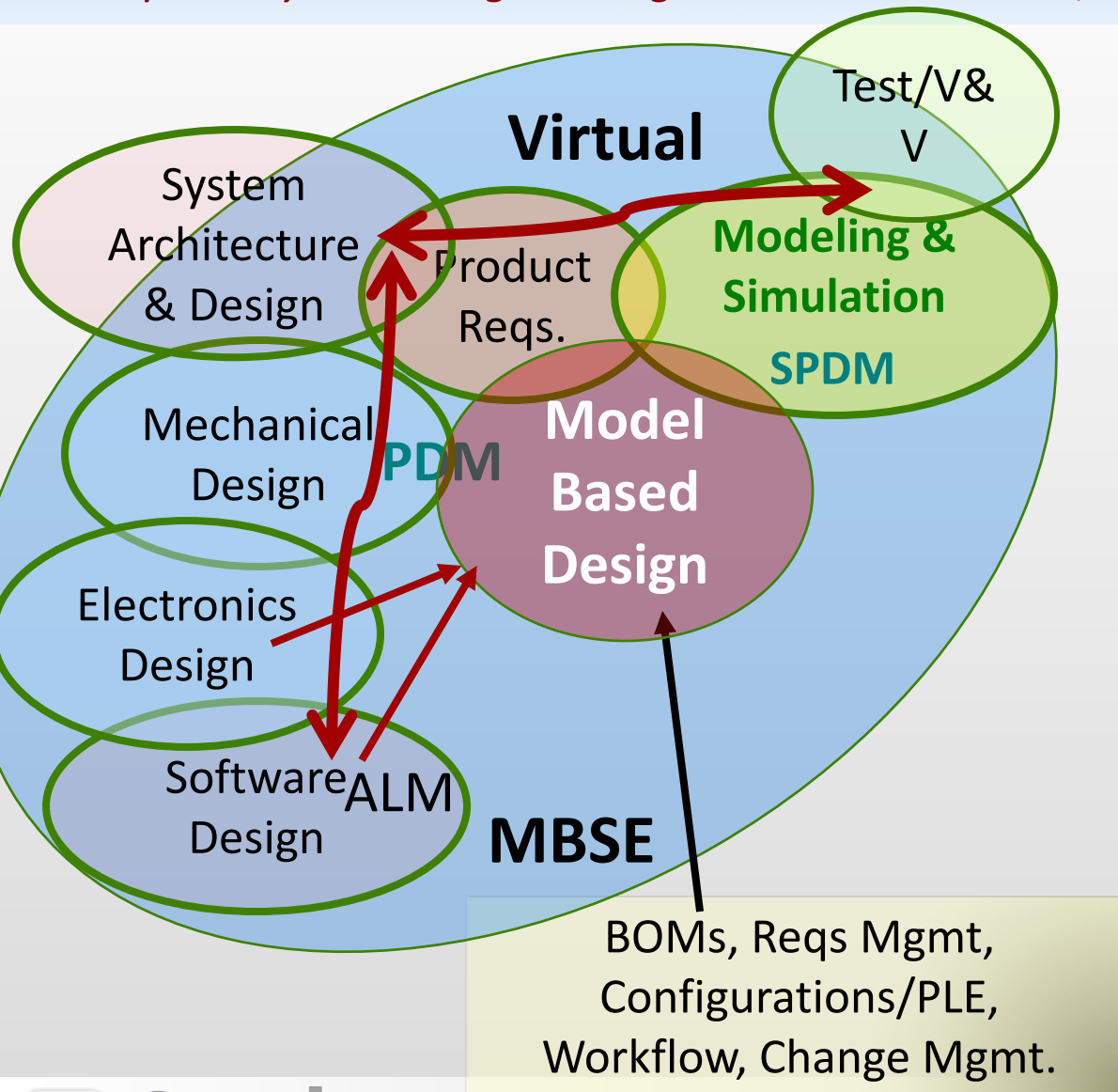*But still too many tools in use to cover all the disciplines*

Status of Digitalization Initiatives ("As Is")

Key domains in model-based are typically managed partially or totally in silos today

System Architecture & Requirements

Virtual

Test/V&V

IoT/ Digital Twins

In Service (SLM)

Product Reqs.

Modeling & Simulation

SPDM

Customers (CRM)

Mechanical Design

PDM

Model Based Design

Costing

Human Res.

Tech Docs

Inventory

Electronics Design

Design For Mfg

Digital Factory

Procurement

Finance

ALM

Supply Chain Mgmt.

Physical

Software Design

BOMs, Reqs, Configurations, Portfolio, Change Mgmt…

Sewing the MBSE Digital Thread ("To Be")

Conceptual Systems Engineering across domain silos; Iterative & agile processes

Virtual

Test/V&V

System Architecture & Design

Product Reqs.

Modeling & Simulation

SPDM

Mechanical Design

PDM

Model Based Design

Electronics Design

Software Design

ALM

MBSE

BOMs, Reqs Mgmt, Configurations/PLE, Workflow, Change Mgmt.

MBSE Use Case:
Conceptual Design, Optimization and Validation Of Cyber-Physical Systems

The MBSE thread needs to connect information across:
* Systems Architecture & Requirements
* Software/ALM
* EDA/ECAD/EBOM
* MDA/MCAD/PDM
* M&S/CAE/SPDM
* Test/V&V/TDM

Enabling the Digital Thread Vision for MBSE

What is needed to address the industry's business needs?

MBSE solutions will ultimately require a blend of:

1) ***Common ontology & languages*** for systems architecture design
   - *AP 2xx Unified Architecture, UPDM/UAF, UML/SysML, AADL, OWL, others?*

2) ***Process change*** leveraging MBSE best practices across industry leaders
   - This element of success is vastly underrated and may as important as any

3) ***Innovation platforms & software tools*** for PLM/MBSE integration
   - Across engineering domains- mechanical, electrical, software, etc.
   - Across the product lifecycle- Requirements, System architecture design, detailed 3D design and validation, manufacturing, IoT/in-service operations
   - Across the global enterprise including OEM/Design Chain collaboration

4) ***Model management*** across the engineering domain data silos
   - Key business metrics- Requirements Traceability, Change Management, Configuration Management, Long-term Archiving and Retrieval (LOTAR)

5) ***Robust standards*** for PLM/MBSE data interoperability
   - XML/XMI, OSLC/RDF, ReqIF, FMI/FMU, FMI/SSP, MoSSEC (AP 234), etc.

Final Thoughts

It's not about what we call it; It's about delivering value to customers and all other stakeholders of the enterprise

- MBSE needs to be defined and implemented based on specific application use cases and quantifiable ROI metrics
  - *Must account for cultural change, training & MBSE maturity growth over time*

- OEMs need to understand that they are asking suppliers to make a paradigm shift; Issues and benefits of using MBSE?
  - *Industry & DoD need to support new contractual concepts AND accept electronic project deliverables/TDPs/signoffs vs paper/documents*

- Open standards will be critical to achieving Digital Thread(s)
  - *Industry specific solutions will be based on a "platform of platforms" approach*

MBSE, PLM and the Digital Thread

Where do we go from here?

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