

INNOVATION
WITHOUT LIMITATION

MBSE and the Business of Engineering

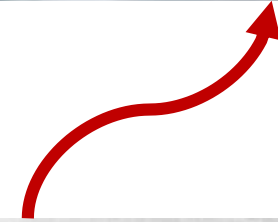
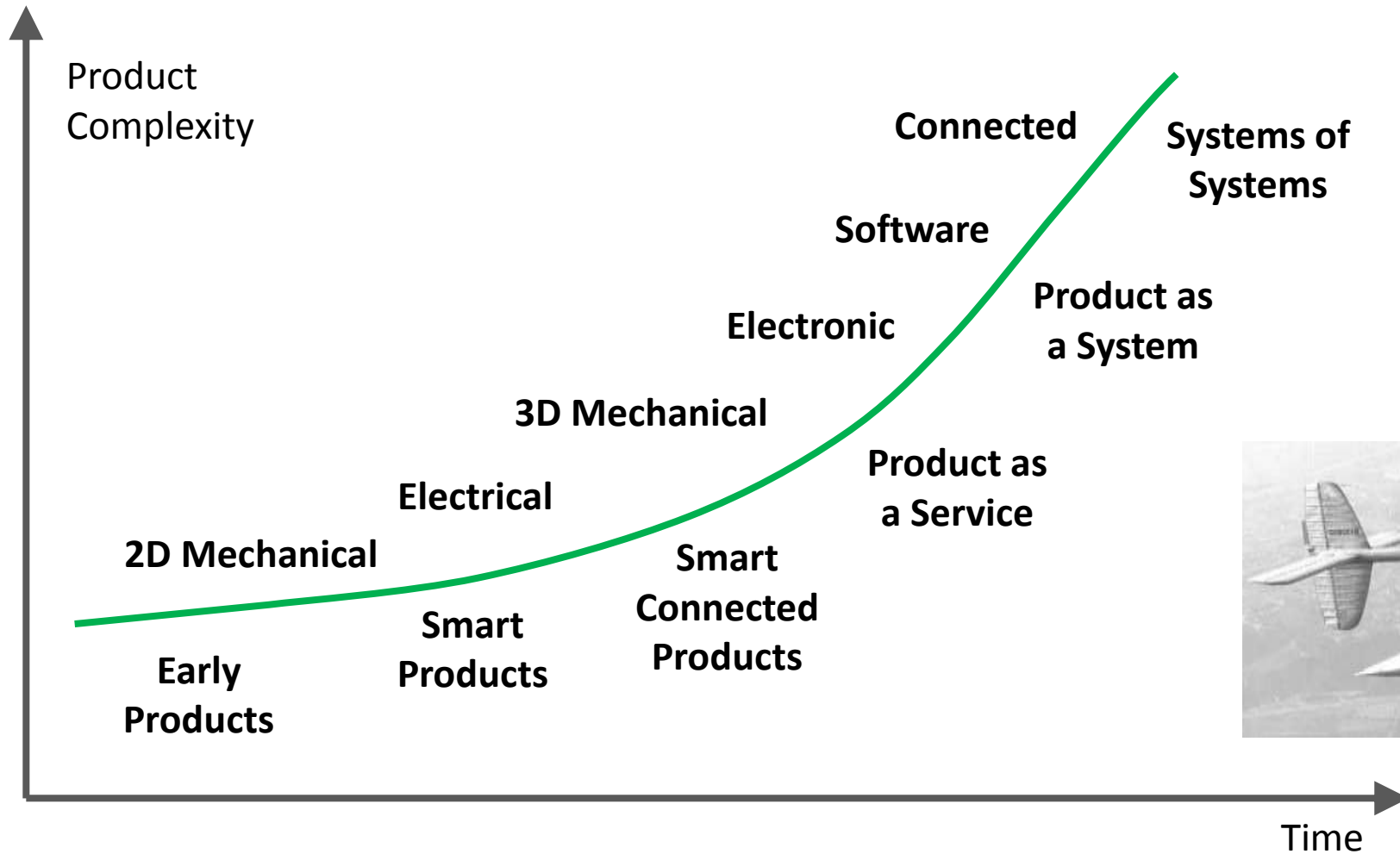
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Product complexity is increasing

And creating system design challenges



Product vs. Behavior

- Are these cars products with lots of parts?
- Or is it a system with behavior working with lots of other systems with behaviors?



Product vs. Behavior

- Are these cars products with lots of parts?
- Or is it a system with behavior working with lots of other systems with behaviors?

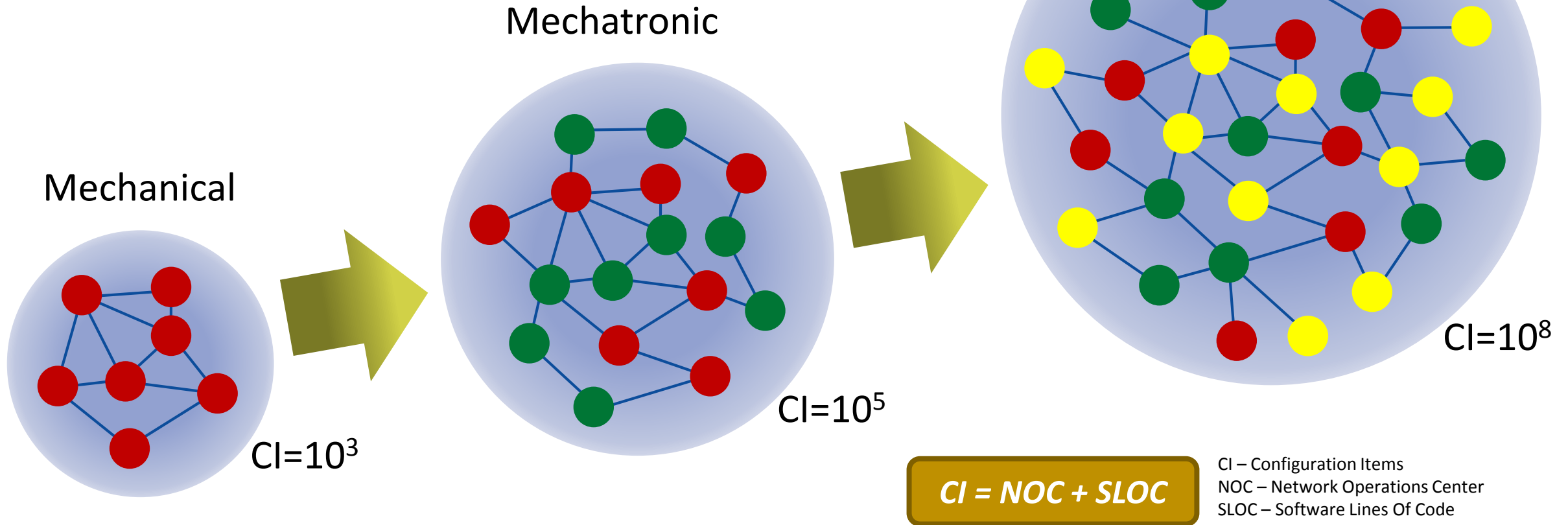
Hints and Tips



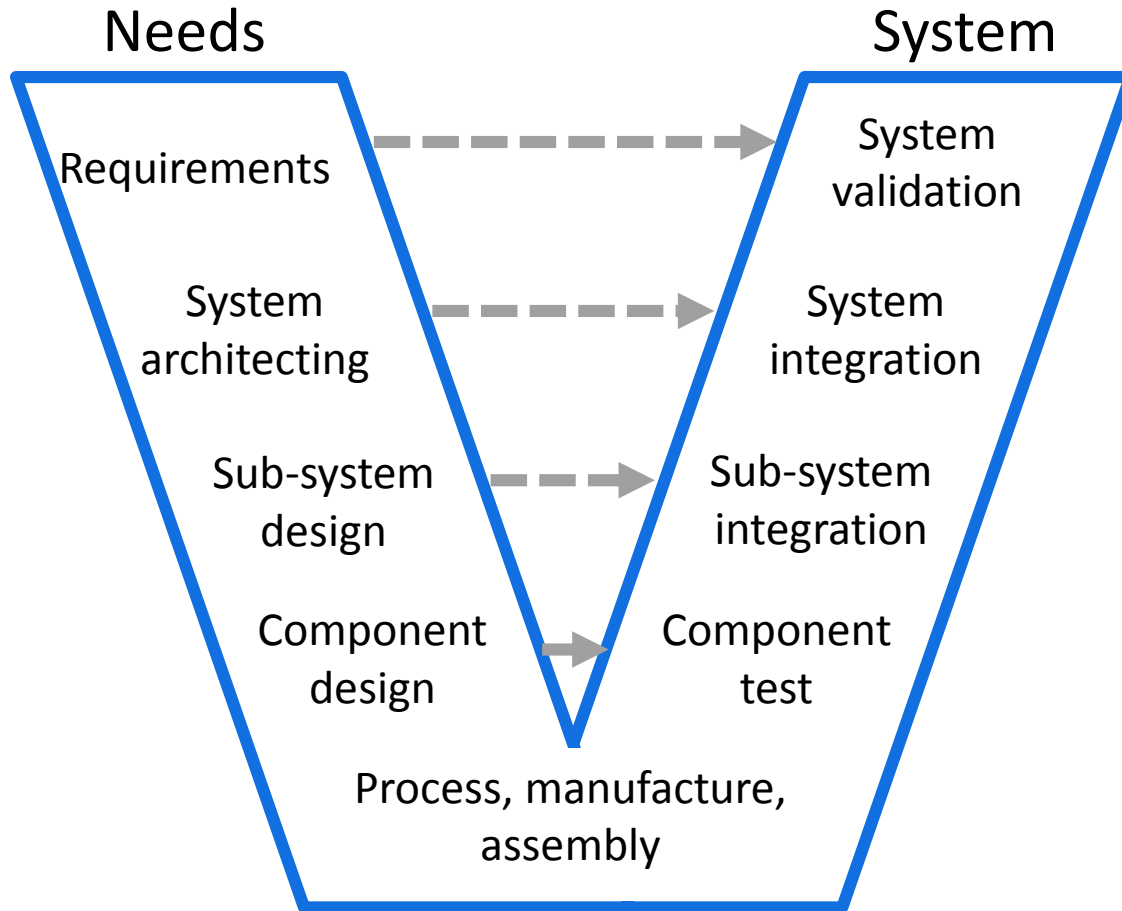
***Forces new
organizational thinking***

Evolution of system complexity

- *Behavior and network connectivity*
- *Continuous replacement and evolution*
- *Traceability and re-evaluation*

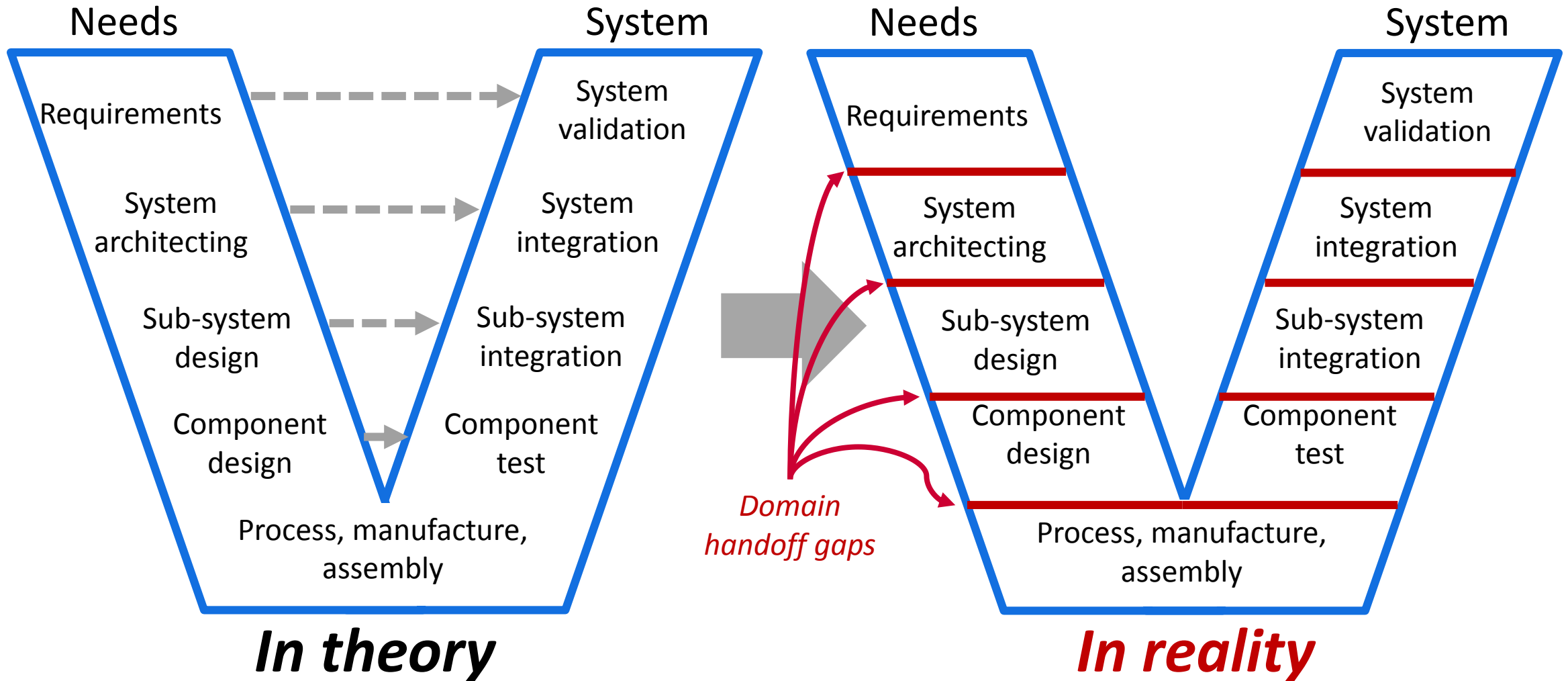


V-Process supports Systems Engineering

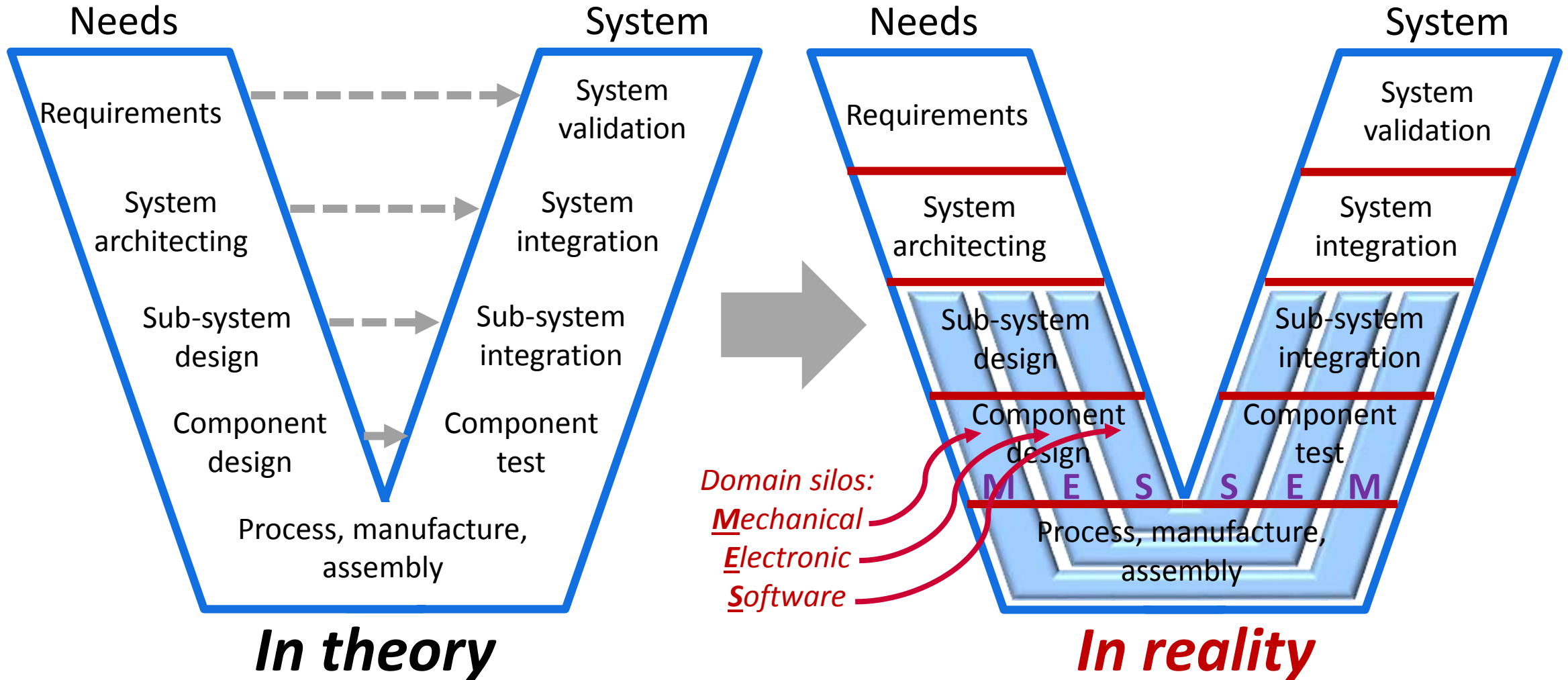


In theory

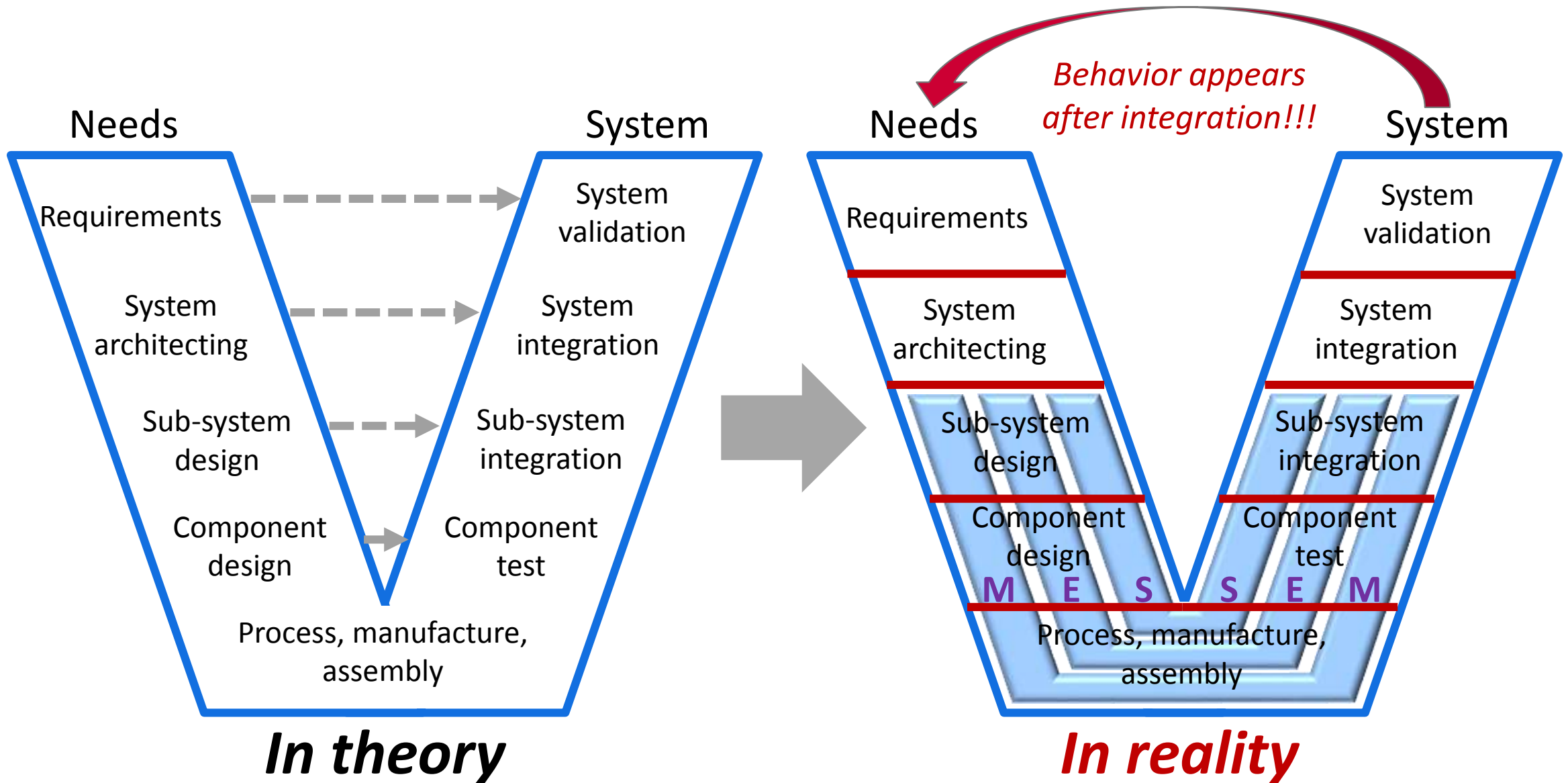
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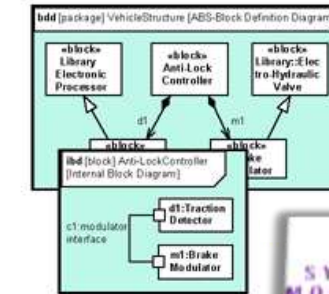


From SE to MBSE

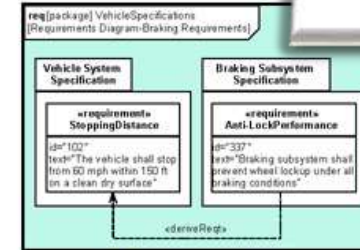
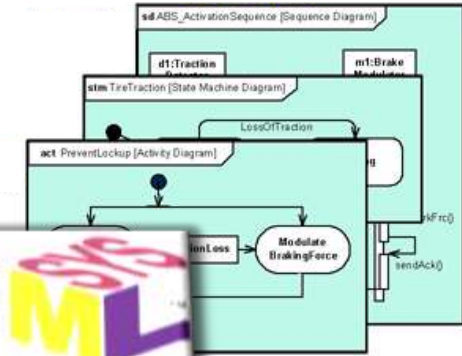


- Specifications
- Interface requirements
- System design
- Analysis and trade-off
- Test plans

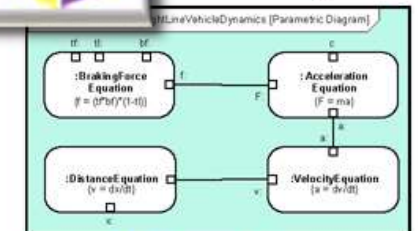
1. Structure



2. Behavior



3. Requirements



4. Parametrics

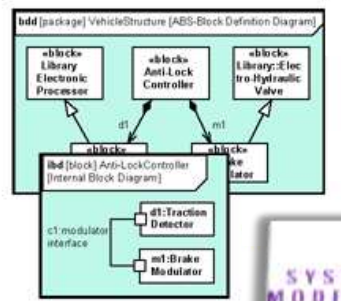
Replacing documents with models, behaviors, and interfaces

MBSE is not MBD/3D Mockup

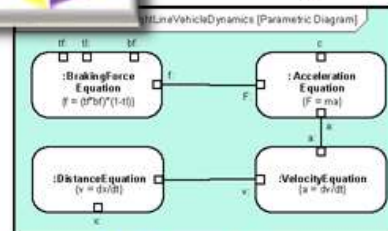
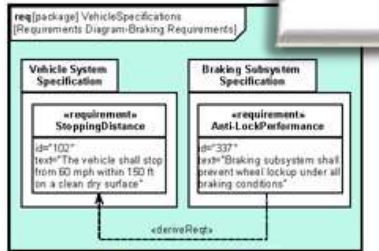
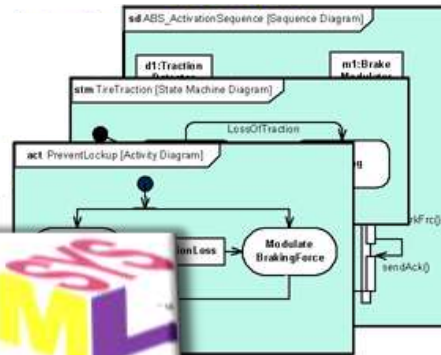
MBSE – Model-Based Systems Engineering

MBD – Model Based Drawing/Design

1. Structure



2. Behavior



3. Requirements

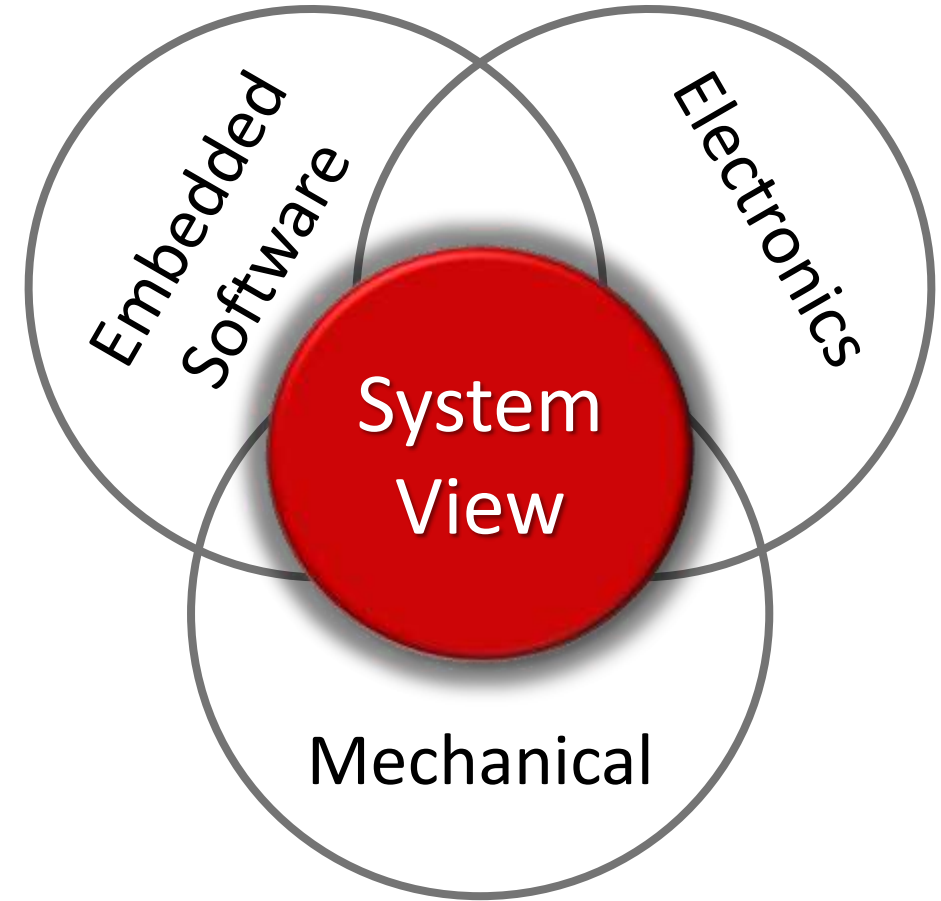
4. Parametrics



Both eliminate paper documents/drawings but only MBSE captures system behavior

MBSE thrives on cross-discipline collaboration

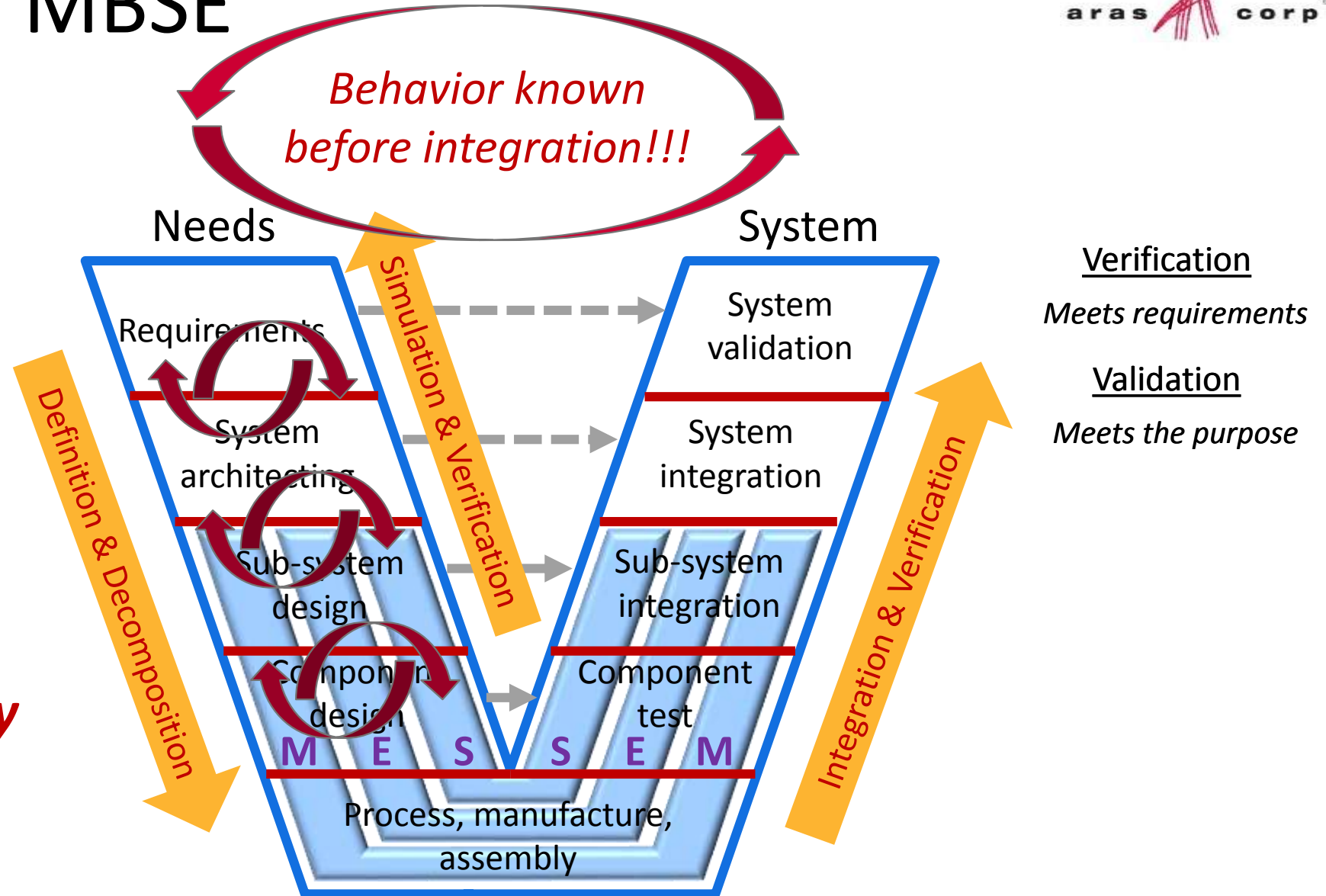
“Model-Based Systems Engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.” - INCOSE



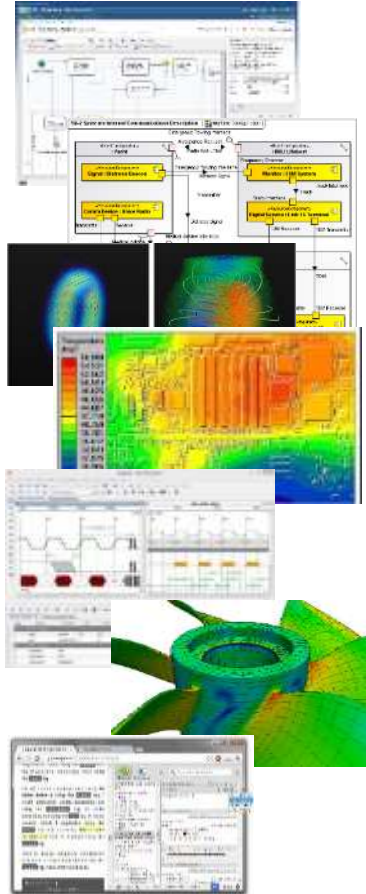
V-Process with MBSE

- Moves creative design work to the left
- Repeats in each domain
- Repeats cross-domains
- Requires new tools

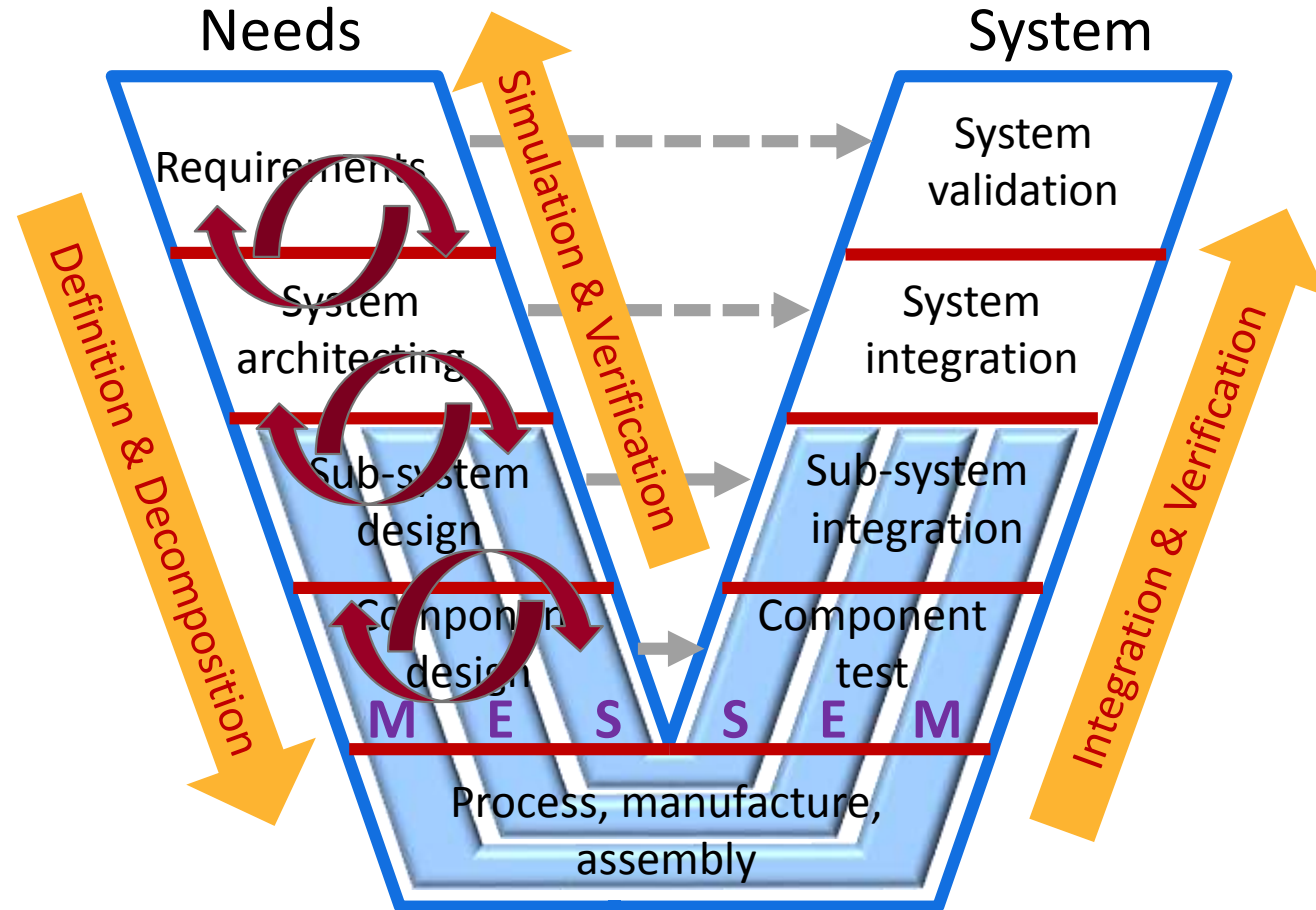
Behavior part of every design step



MBSE relies on multiple tools

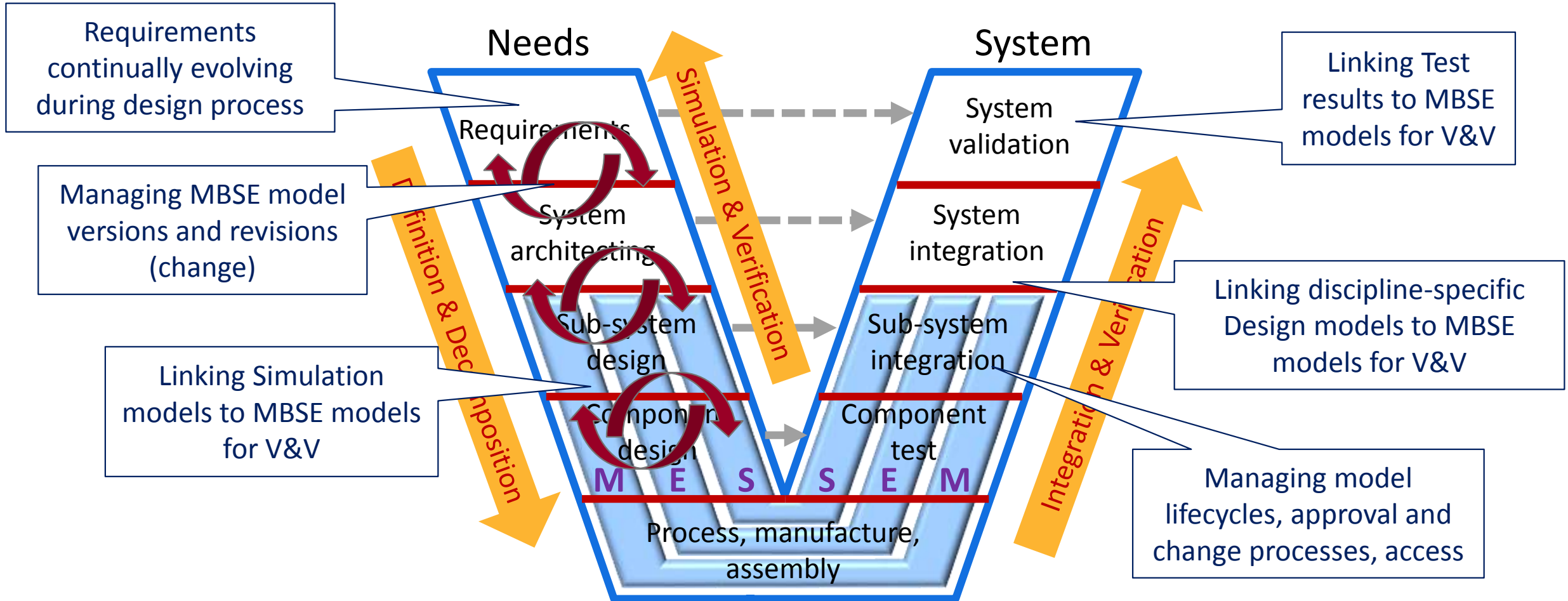


REQ model
 SysML model
 Simulation
 AML/Software
 MCAD
 ECAD
 Timing
 Thermal
 Stress
 etc.



Physical test
 Hybrid test
 QPP
 3D Mockup
 ERP/MRP
 E-M BOM
 Change process
 Documentation
 etc.

MBSE implementation challenges



It took Thales 10 years from first consideration to company-wide deployment of MBSE

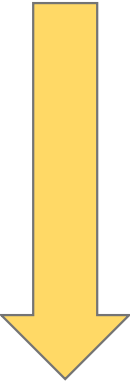
Source: 25th Annual INCOSE International Symposium, 7/2015

MBSE Digital Twin

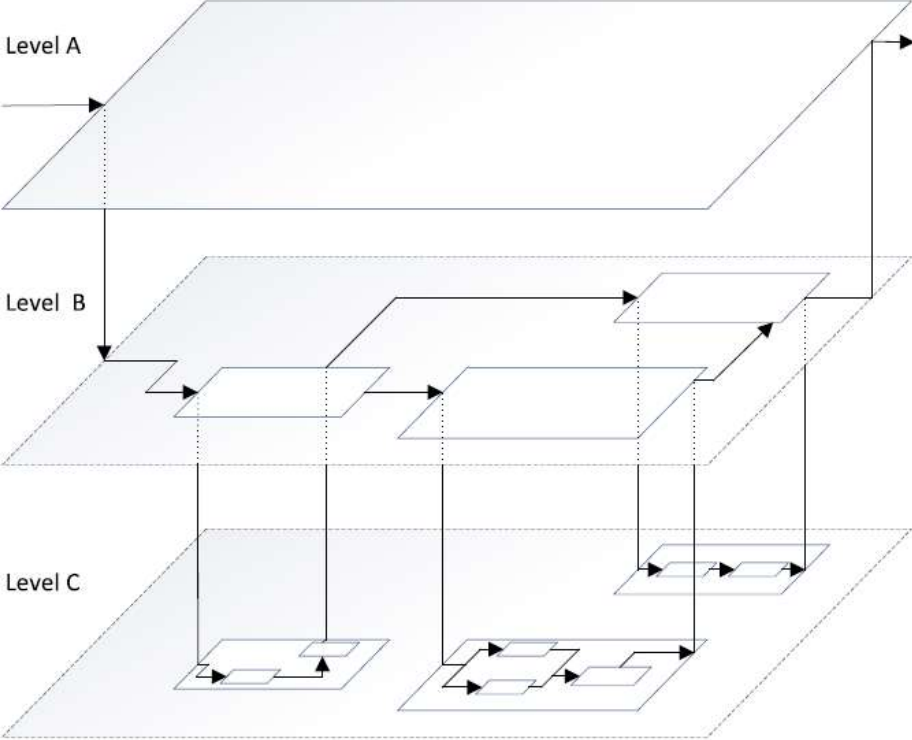


Closing traceability gaps & preventing them from occurring

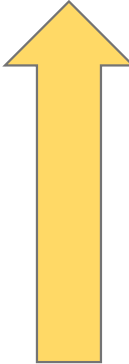
Systems Engineering decomposition



Links to a domain structure



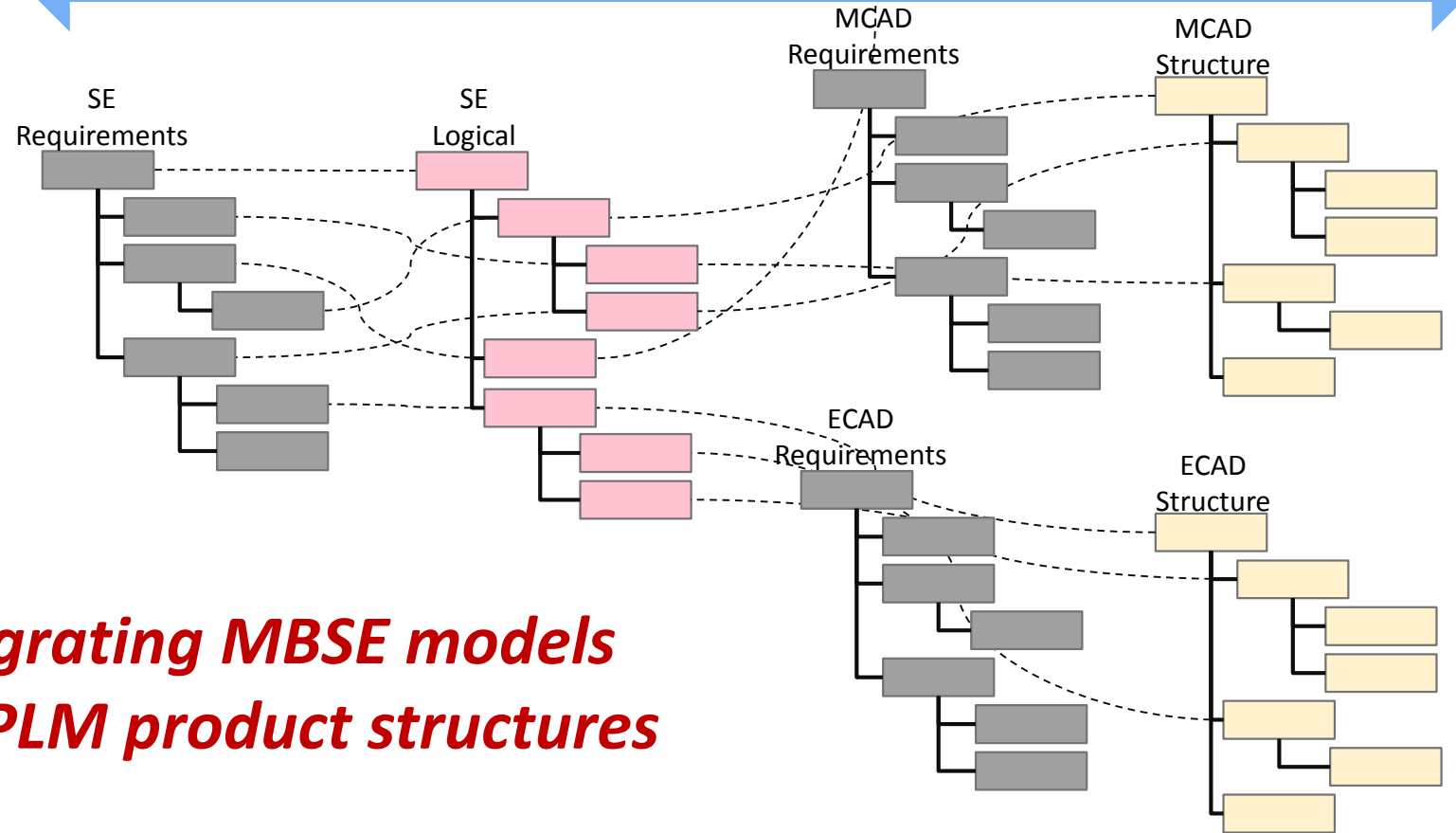
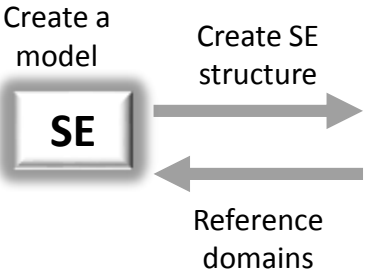
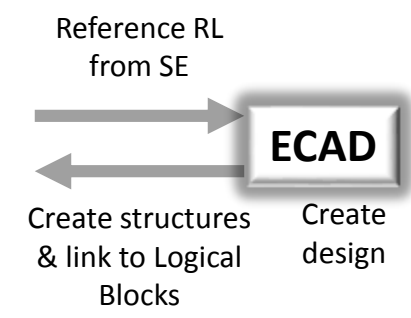
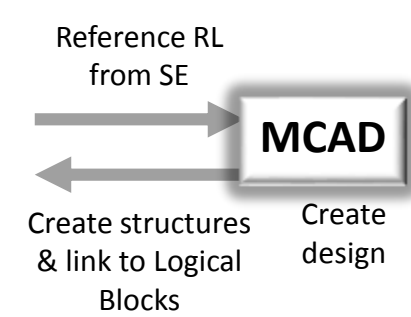
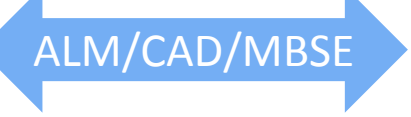
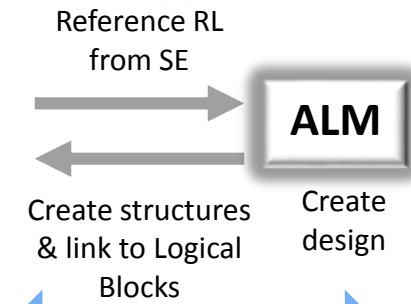
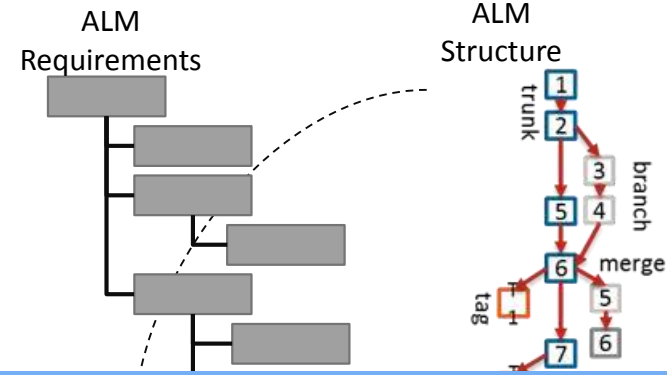
Links to the Systems Engineering decomposition



Domain structure

Pic.1 – Systems Engineering Abstraction levels (SE Grundlagen und Anwendung / Haberfellner et. Al.)

MBSE Logical to Physical



Integrating MBSE models with PLM product structures

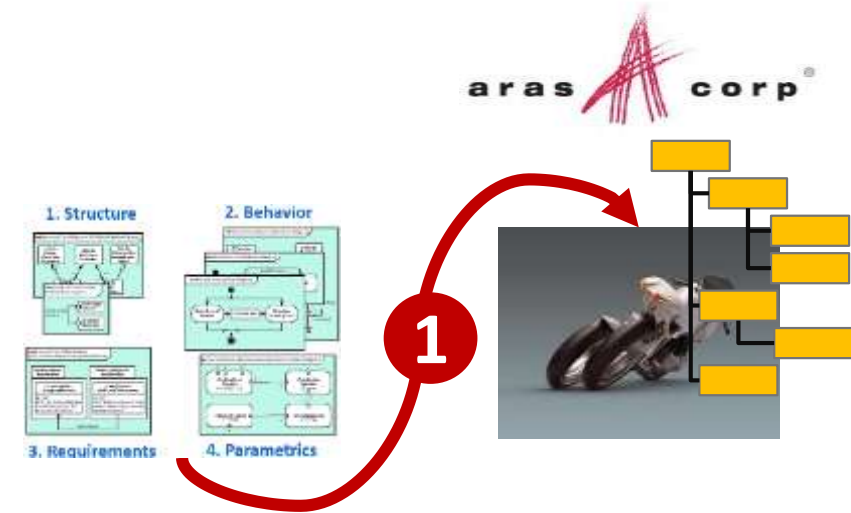
MBSE/PLM use cases

- The goal is a connected model and product with full traceability

MBSE/PLM use cases

➤ The goal is a connected model and product with full traceability

1 Top/Down – System model first, then detailed Product design

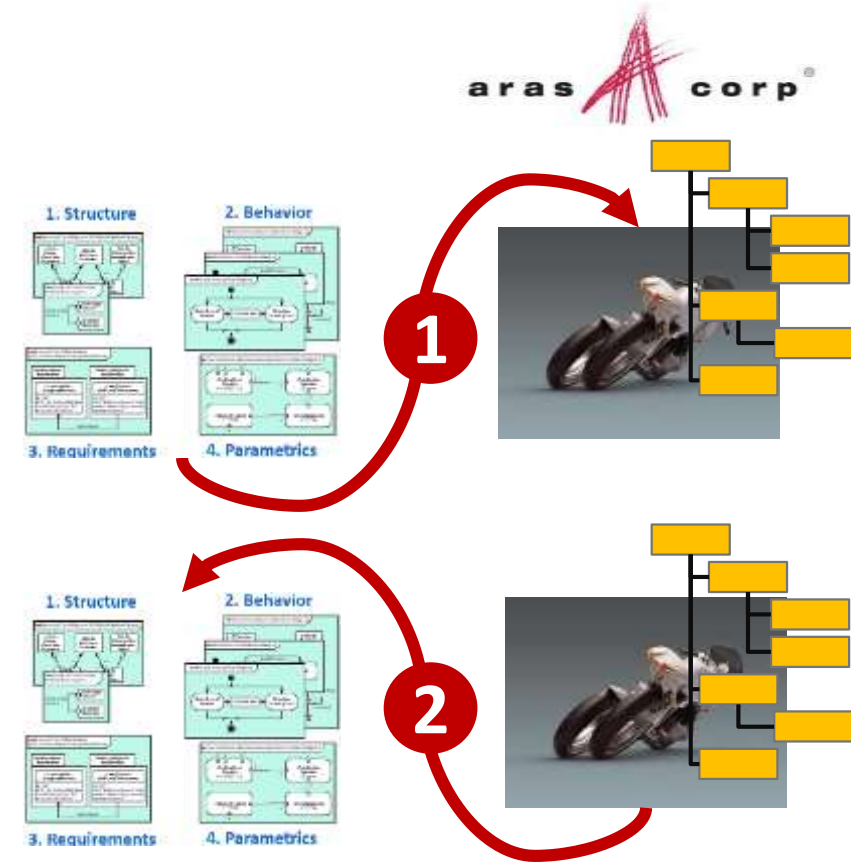


MBSE/PLM use cases

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2 Reverse modeling – System model from an existing Product design



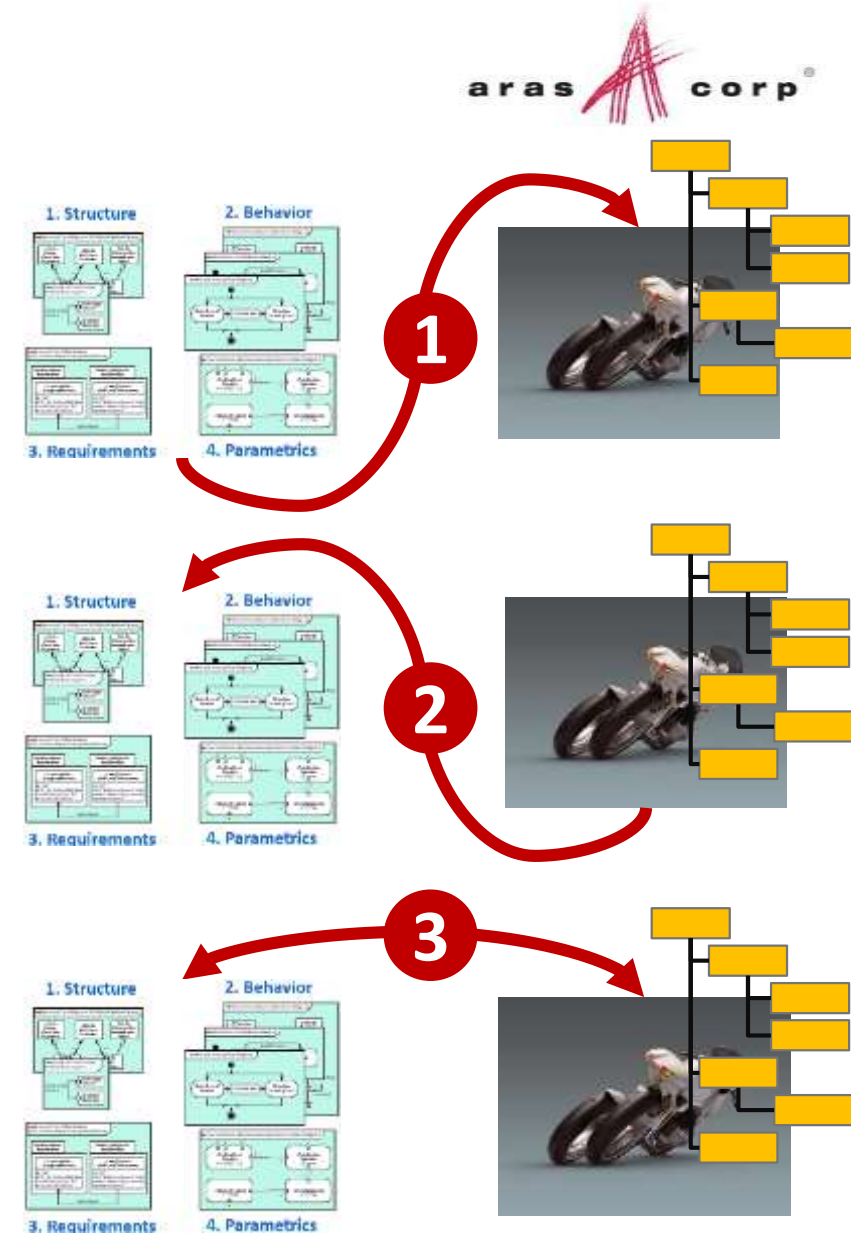
MBSE/PLM use cases

➤ The goal is a connected model and product with full traceability

1 Top/Down – System model first, then detailed Product design

2 Reverse modeling – System model from an existing Product design

3 Redesign – System model and Product design exist, requirements changed



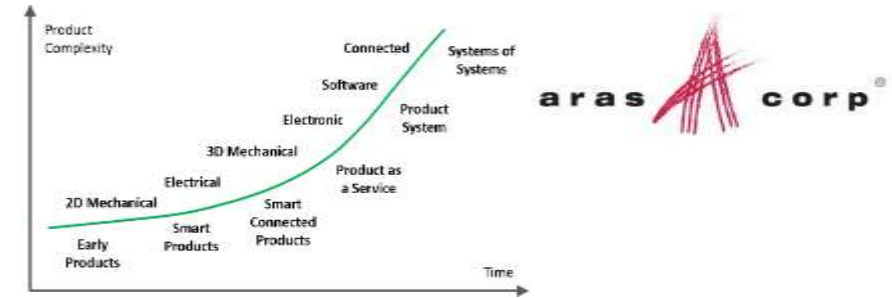
Benefits of MBSE/PLM integration



- Persistent administration in an extended PLM and/or ALM System for MBSE artifacts
- Integration of MBSE into the enterprise ECM (Engineering Change Management) and CM (Configuration Management) processes
- Managed access control
- Visualization of the MBSE artifacts
- Data exchange in the early phase based on standards

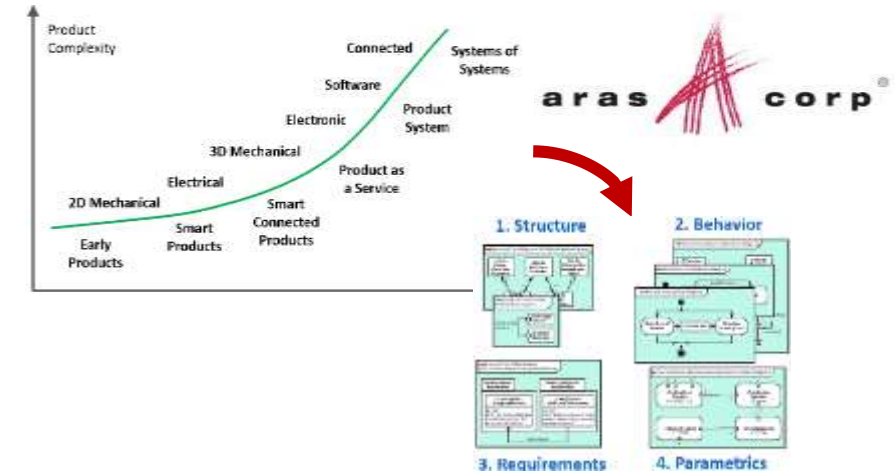
Business of Engineering

- Product complexity continues to rise



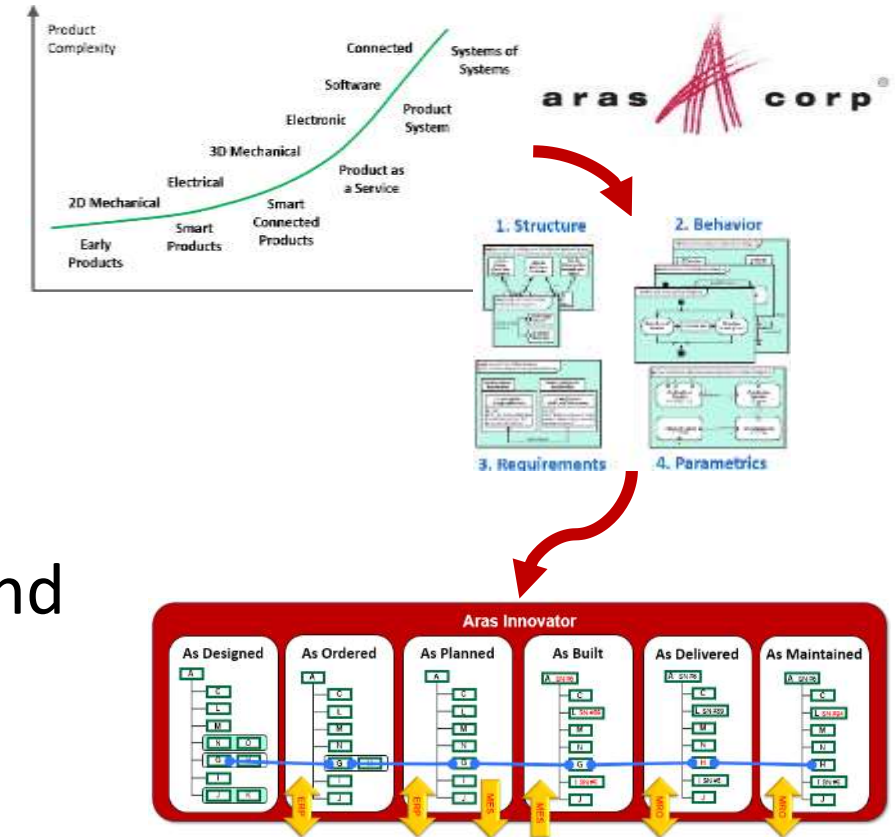
Business of Engineering

- Product complexity continues to rise
- MBSE provides powerful tools to synthesize the design of complex systems



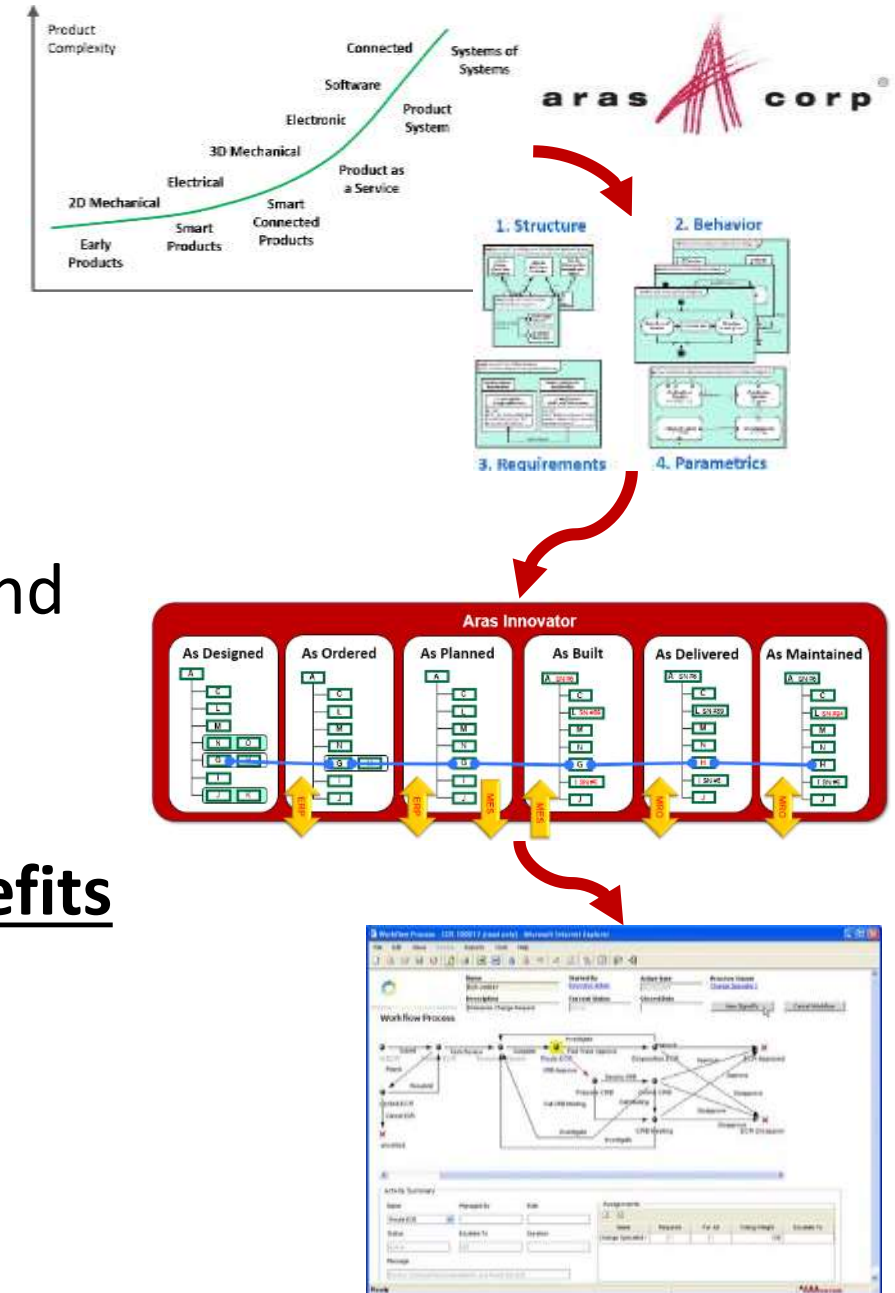
Business of Engineering

- Product complexity continues to rise
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- MBSE needs to be part of an overall traceability and configuration management philosophy



Business of Engineering

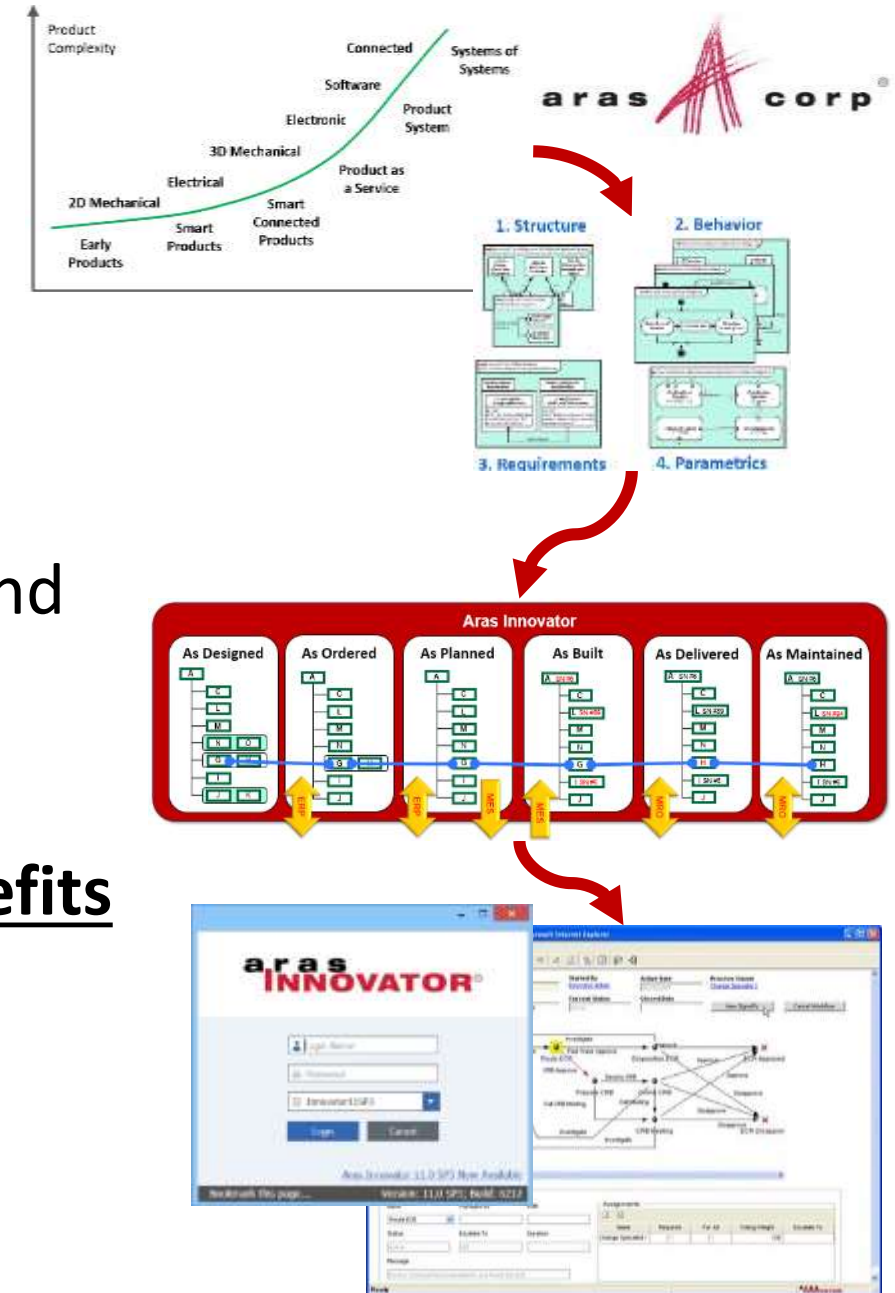
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- MBSE needs to be part of an overall traceability and configuration management philosophy
- **Strong, foundational CM throughout product lifecycle is a REQUIREMENT to realize MBSE benefits**



Business of Engineering

- Product complexity continues to rise
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- MBSE needs to be part of an overall traceability and configuration management philosophy
- **Strong, foundational CM throughout product lifecycle is a REQUIREMENT to realize MBSE benefits**

*Aras architecture provides
Future Proof Enterprise PLM
with industry leading CM capability*



Partnering with



- TU Kaiserslautern: Proof of Concept (MagicDraw)
- Airbus/IBM/Aras: OSLC-based ALM/PLM integration
- XPLM/No Magic: MagicDraw integration
- Aras/Altium: Bringing ECAD into MBSE



Acknowledgements

- Airbus
- IBM
- Dr. Eigner, TU Kaiserslautern
- Dr. Zhang, AVIC
- Altium
- No Magic
- ProSTEP
- INCOSE
- OMG
- OASIS
- XPLM



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