

# MBSE and the Business of Engineering

John Sperling  
VP Product Management  
Aras Corporation

## GLOBAL PRODUCT DATA INTEROPERABILITY **SUMMIT** 2016



 **ELYSIUM**

 **Parker** Aerospace

**NORTHROP GRUMMAN**

 **BOEING**

 **ELYSIUM**

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 **BOEING**

# My Background

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Y2K



Autonetics  
Strategic  
Systems  
Division



Space  
Systems  
Division



Integrated  
Defense  
Systems



ORACLE®



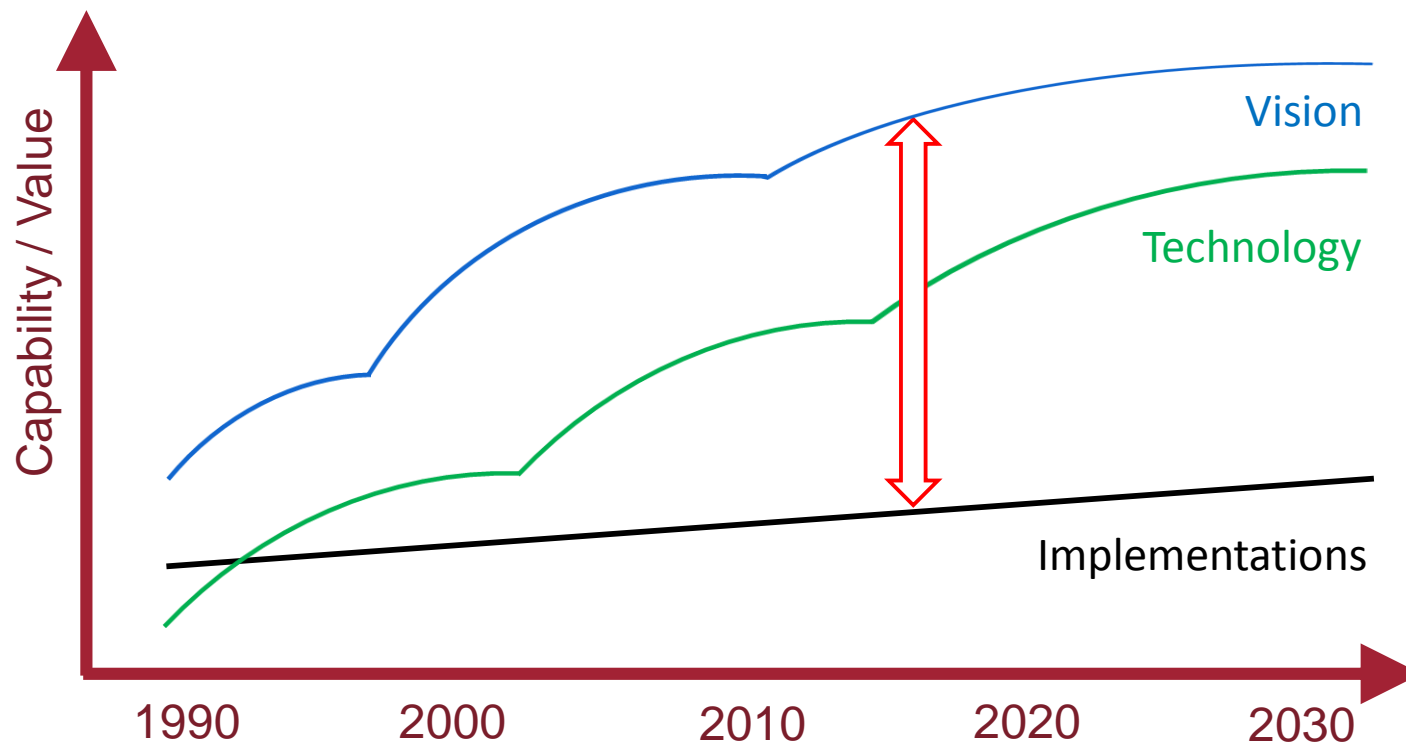
# Agenda

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- **The Business of Engineering**
- **Challenges of product complexity**
- **The Return of Systems Engineering**
- **Aras MBSE-PLM Reference Architecture**
- **Aras/XPLM Prototype**

# Legacy PDM has failed to meet the vision

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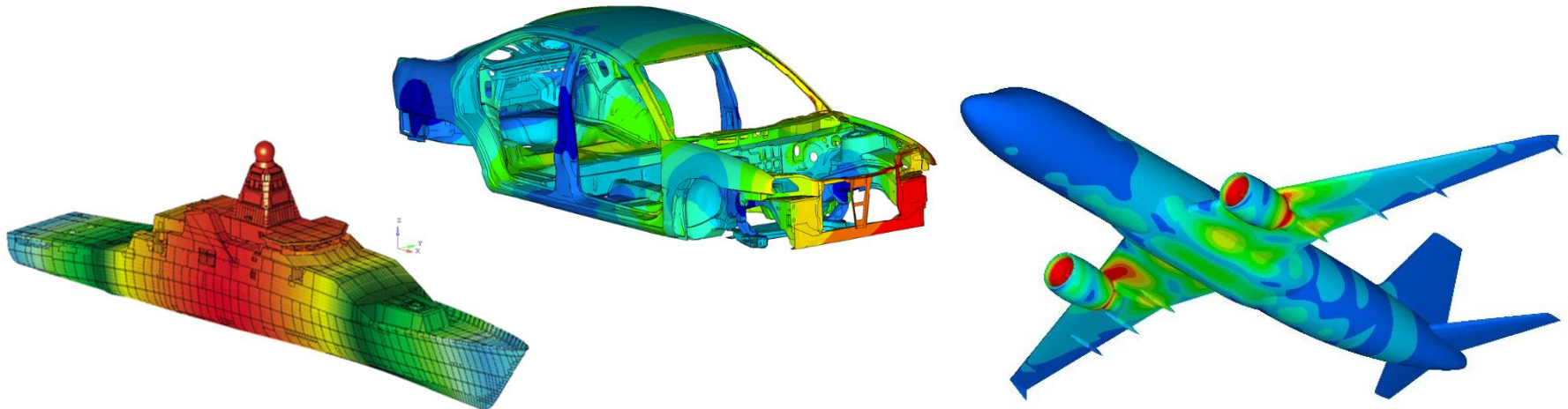


CIMdata

Adapted from: Aerospace & Defense Industry PLM Value Gap Survey, CIMdata, March 2013

# The Science of Engineering

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MCAX PDM

# Investment is not balanced with new reality

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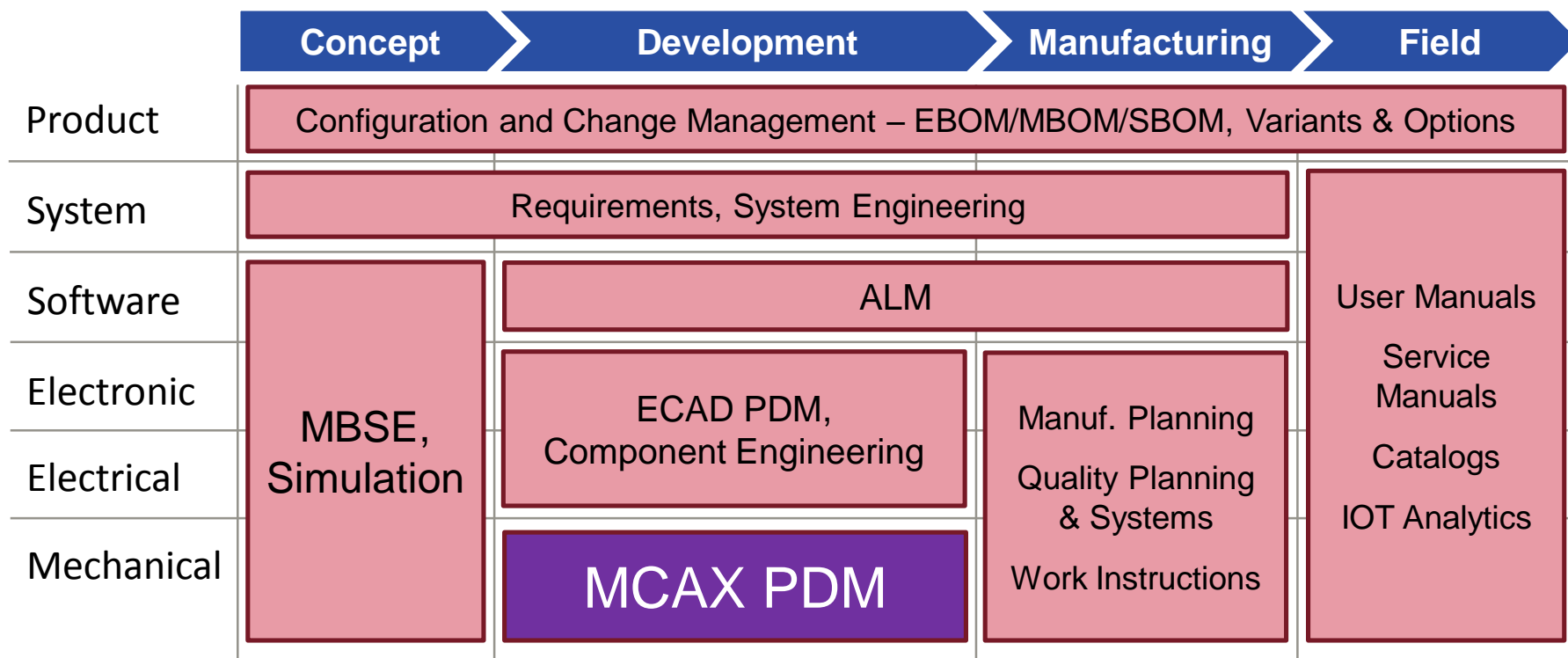
- **Mechanical**



- **Electronics**
- **Electrical**
- **Software**
- **Manuals**
- **Packaging**
- **Services**
- **IoT**
- **Manufacturing**
- **Phase-Gate**
- **Cost**
- **BOM**
- **Quality**
- **Supply Chain**
- **Compliance**
- **Variants-Options**

# The Business of Engineering

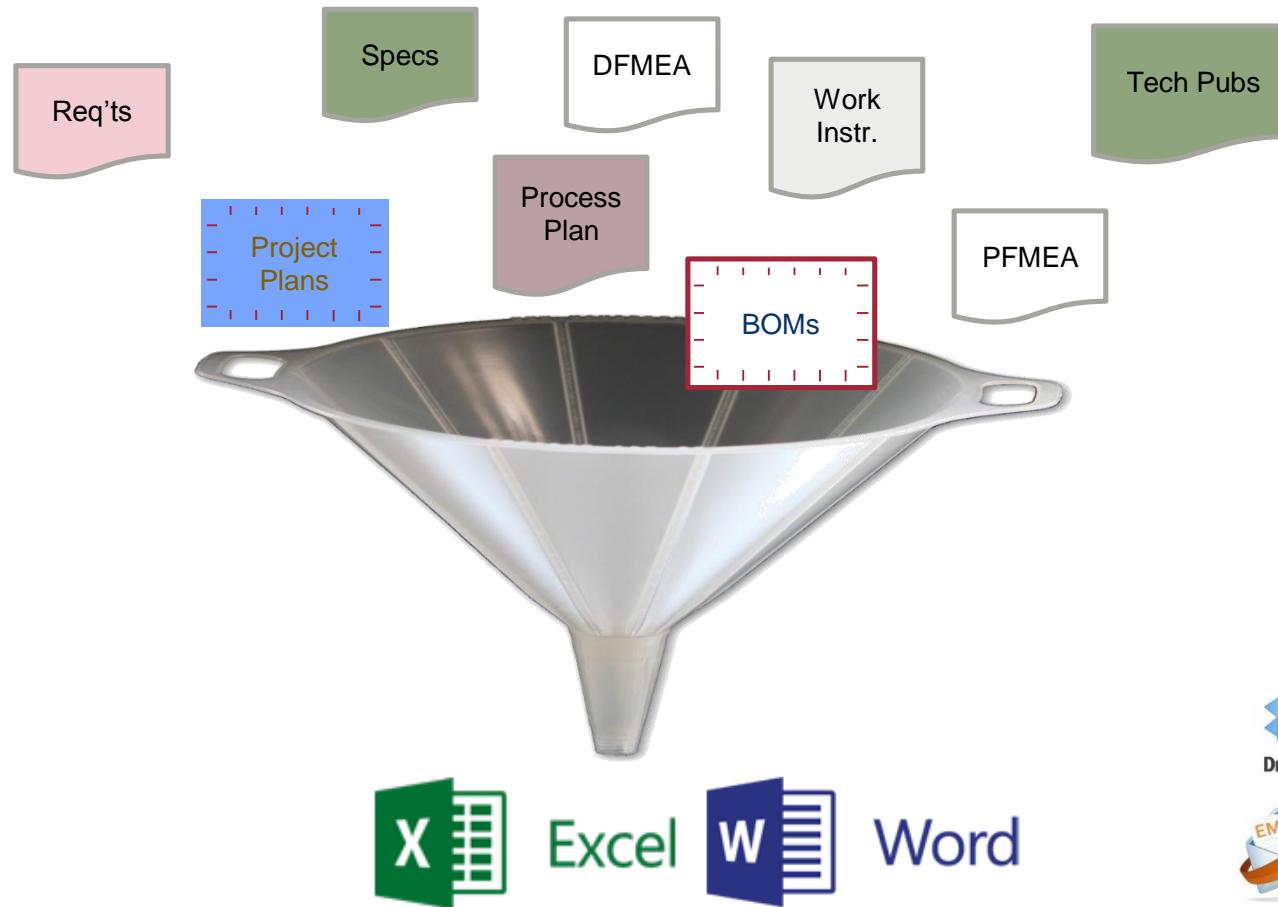
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# “The PLM Underground”

*Where the work actually gets done*

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# Agenda

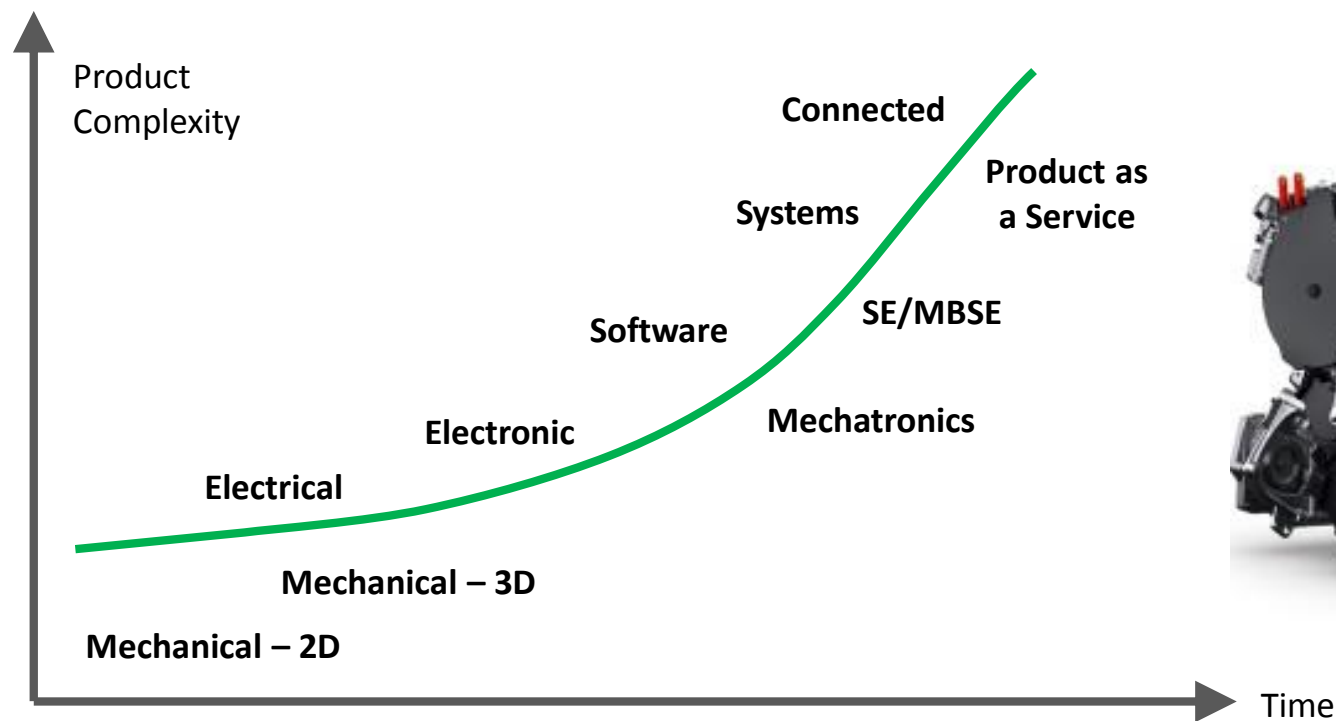
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# Product complexity is increasing

*And creating challenges*

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# Managing design integrity

*As role of software increases*

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## Toyota's killer firmware: Bad design and its consequences



Honda recalling 142K cars over software issues

**One software problem could cause the front wheels to lock up on certain Civics and Fits**



## US military finds F-35 software is a buggy mess

Tests jettisoned to protect schedule



## Airbus confirms software configuration error caused plane crash

Airbus A400M flight recorder data confirms "quality issue" in setup caused failure.



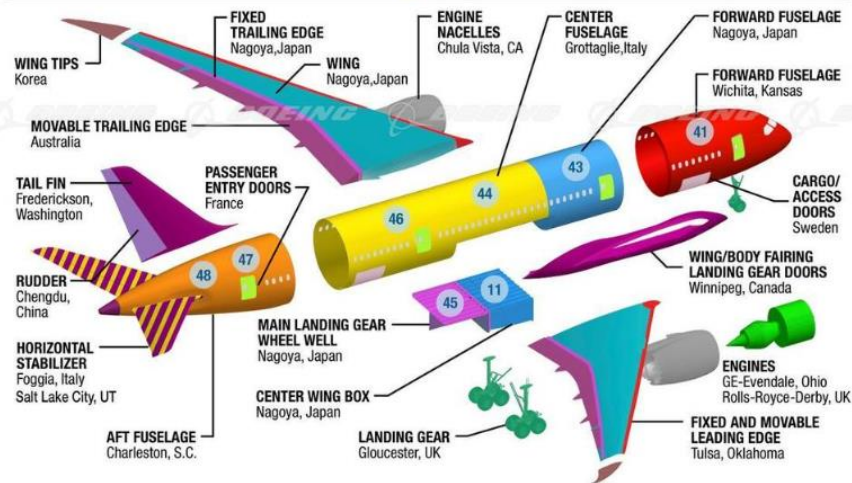
# Coordinating outsourced activities

## Avoiding conflicts in design/manufacture/support

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### THE COMPANIES

U.S.	CANADA	AUSTRALIA	ASIA	EUROPE
Boeing	Boeing	Boeing	Kawasaki	Messier-Dowty
Spirit	Messier-Dowty		Mitsubishi	Rolls-Royce
Vought			Fuji	Latecoere
GE			KAL-ASD	Alenia
Goodrich			Chengdu Aircraft Industrial	Saab



### Global Suppliers to 2013 Ford Fusion

Suppliers to the all-new Fusion play a critical role in Ford's strategy to increase parts commonality across global platforms. Below is a profile of Fusion's global supply base, as well as examples of suppliers that provide key components to the vehicle. Fusion is built off Ford's global CD4 platform and will be sold as the Mondeo in Europe and China.

234  
SUPPLIERS

Built:  
FLAT ROCK ASSEMBLY PLANT  
Flat Rock, Michigan, USA

HERMOSILLO STAMPING  
AND ASSEMBLY  
Hermosillo, Sonora, Mexico



32  
COUNTRIES



70%

ALIGNED  
BUSINESS  
FRAMEWORK  
SOURCING

80%

GLOBAL PARTS  
COMMONALITY

<ul style="list-style-type: none"> <li>AUTOLIV: Airbags (front, rear, curtain, passenger)</li> <li>AUTONEUM: Floor carpet, trunk trim, insulation</li> <li>BOSCH: Powertrain control unit, restraint control module</li> <li>BREMO: Rotors</li> <li>BROSE: Window regulator</li> <li>CONTINENTAL: Brake components, ABS, body control module, powertrain control unit, instrument clusters</li> <li>DELPHI: EDS, evaporative emission canister</li> </ul>	<ul style="list-style-type: none"> <li>DENSO: A/C compressor, HVAC unit, fuel delivery module, instrument clusters, alternators</li> <li>DMI: Knuckles, rear lower control arm</li> <li>FAURECIA: Exhaust system</li> <li>FLEX-N-GATE: Body molding, hinges, door check arms, stampings</li> <li>GKN: Power transfer unit, halfshafts</li> <li>GRUPO ANTOLIN: Headliner</li> <li>IAC-INTERNATIONAL: AUTOMOTIVE COMPONENTS: Instrument panel, floor console, door trim, hard trim</li> </ul>	<ul style="list-style-type: none"> <li>INALFA: Sunroof/moonroof</li> <li>JCI: Batteries</li> <li>KAUTEX: Fuel tank</li> <li>KEY SAFETY SYSTEMS: Seat belts</li> <li>LEAR: Seat modules</li> <li>MAGNA: Radiator support, exterior functional moldings (plastic), stampings, FEM</li> <li>MANN+HUMMEL: Air induction system</li> <li>MARTINREA: Subframes, suspension link, fuel lines, hoses, filler pipes</li> </ul>	<ul style="list-style-type: none"> <li>PANASONIC: Audio</li> <li>TAKATA: Steering wheel and driver airbag</li> <li>THYSENKRUPP: Steering column</li> <li>TOYODA GOSAI: Dynamic seating</li> <li>TRELLEBORG: Engine and transmission mounts</li> <li>TRW: Switches, knee airbags</li> <li>ZF: Electric power-assisted steering gear, control arm</li> </ul>
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# Ensuring operational safety

## *Maintaining context for IoT data and connected products*

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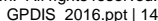
### Engine Health Management (EHM)

Rolls-Royce uses EHM to track the health of thousands of engines operating worldwide, using onboard sensors and live satellite feeds



### Over The Air Updates (OTA)

OTA software updates will not only affect your infotainment system but also power train and vehicle safety systems



# Innovation without Limitation

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## Not just about building a faster mousetrap

- Packaging, Labeling, Compliance?
- Limiting Liability?
- Serviceability, Manufacturability, and Profit!



## Innovation is not just about the Product!

**The Business of Engineering needs Systems Level Thinking**

# Agenda

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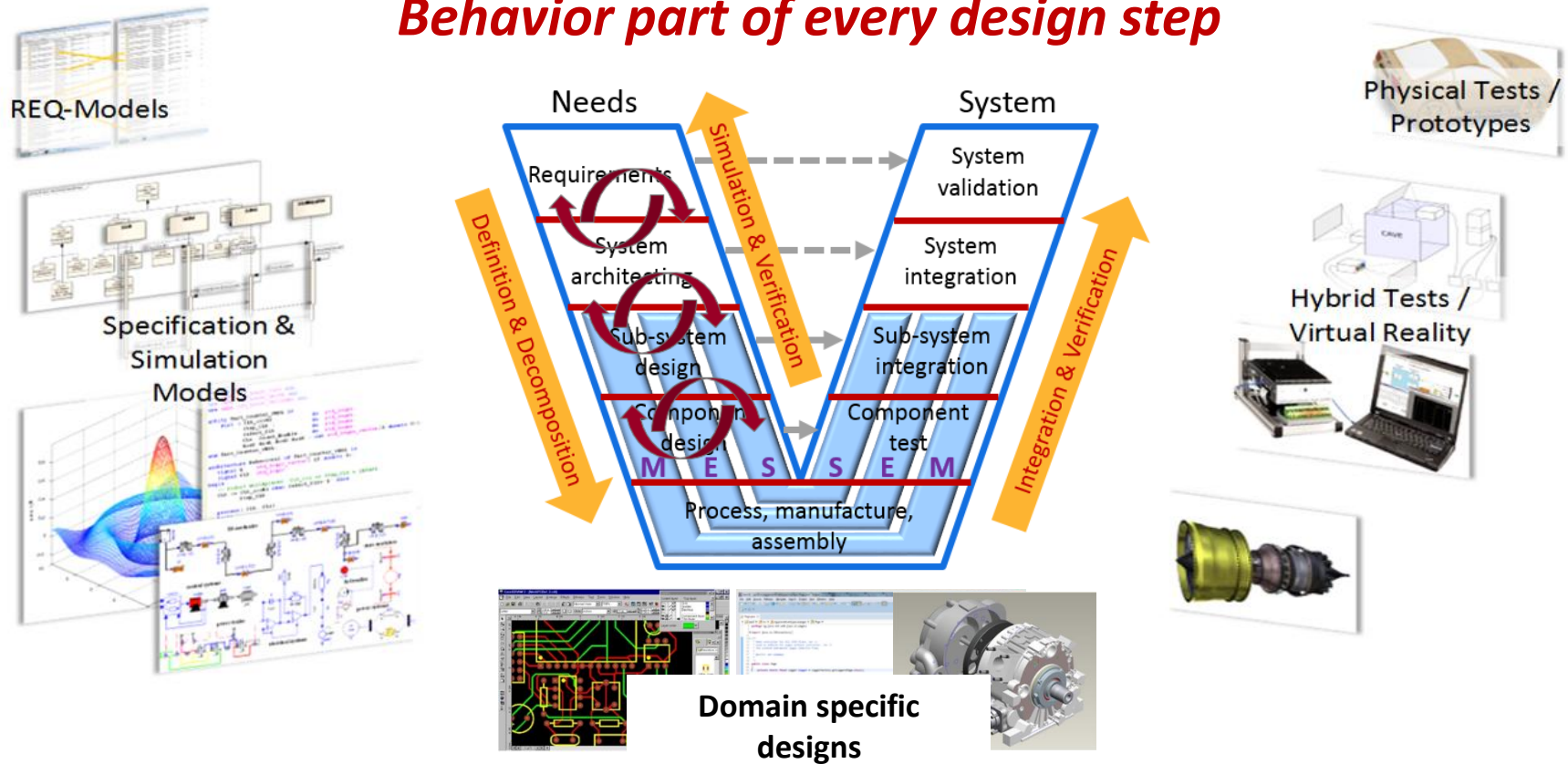
- The Business of Engineering
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# SE spans many tools, domains, & data models

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## *Behavior part of every design step*

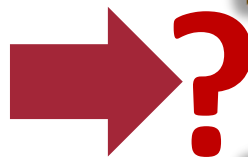


# Connecting MBSE to Design domains in PLM

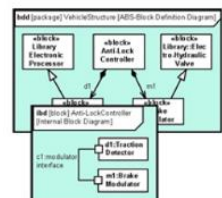
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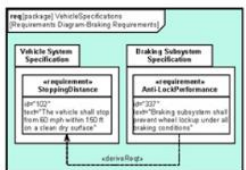
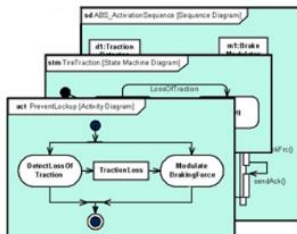
*OK, but  
how*



## 1. Structure

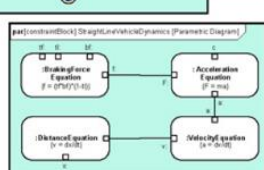


## 2. Behavior



## 3. Requirements

## 4. Parametrics



# Cross-domain Connectors

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## ■ MCAD – explicit

- MCAD file = PLM Part/Assembly (BOM)
- MCAD files mapped to PLM Parts



*Natural fit with PLM*

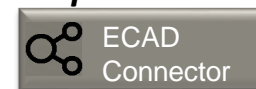


## ■ ECAD – extractable

- ECAD file  $\neq$  PLM Part/Assembly (BOM)
- Components mapped to PLM Parts



*Challenge with mapping files to PLM parts*



## ■ Embedded Software – indirect

- IDE files  $\neq$  PLM Part/Assembly (BOM)
- Released binary mapped to PLM Part(s)



*Reference Architecture with Airbus & IBM*



## ■ System – TBD

- Requirements?
- Block diagrams (functional & logical)?
- Models as input, Reports as outputs?



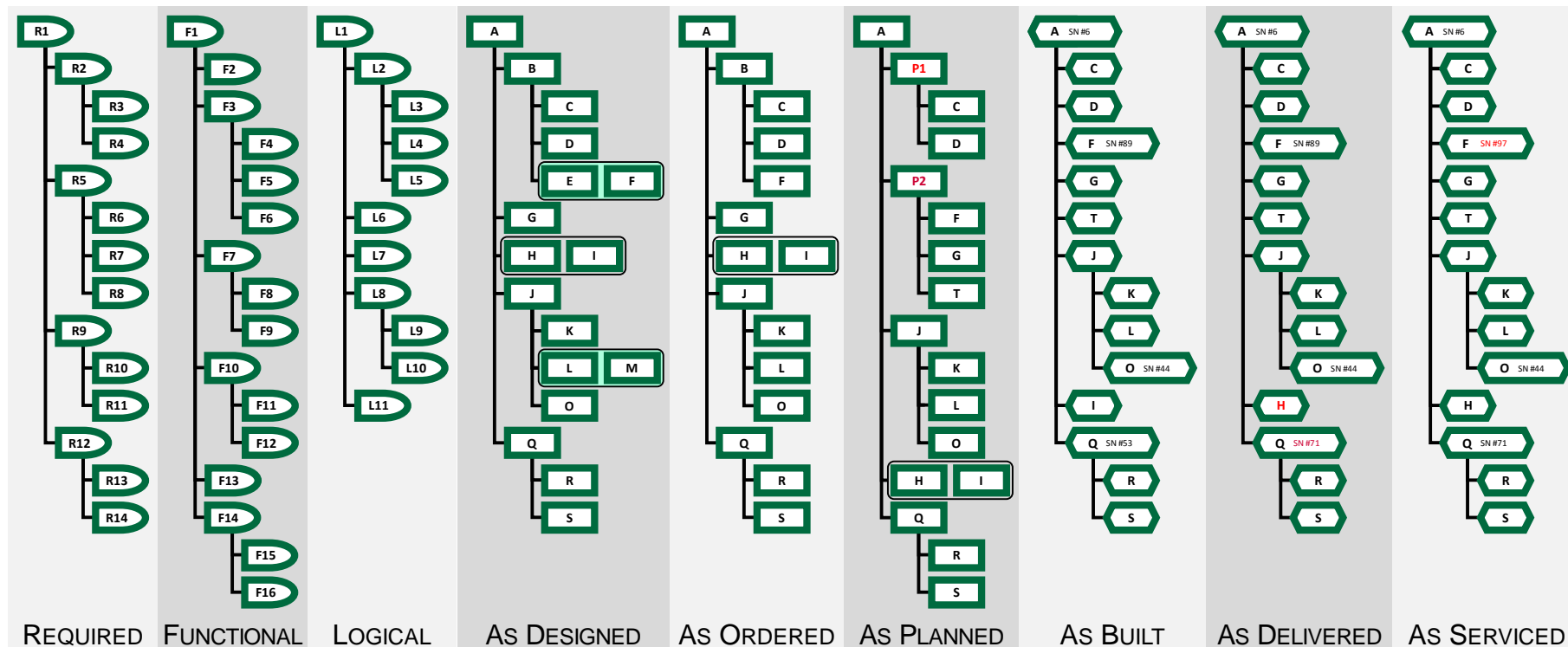
*Similar to ECAD schematics?  
Explicit SysML data model?*

*It will take more finesse than this!*



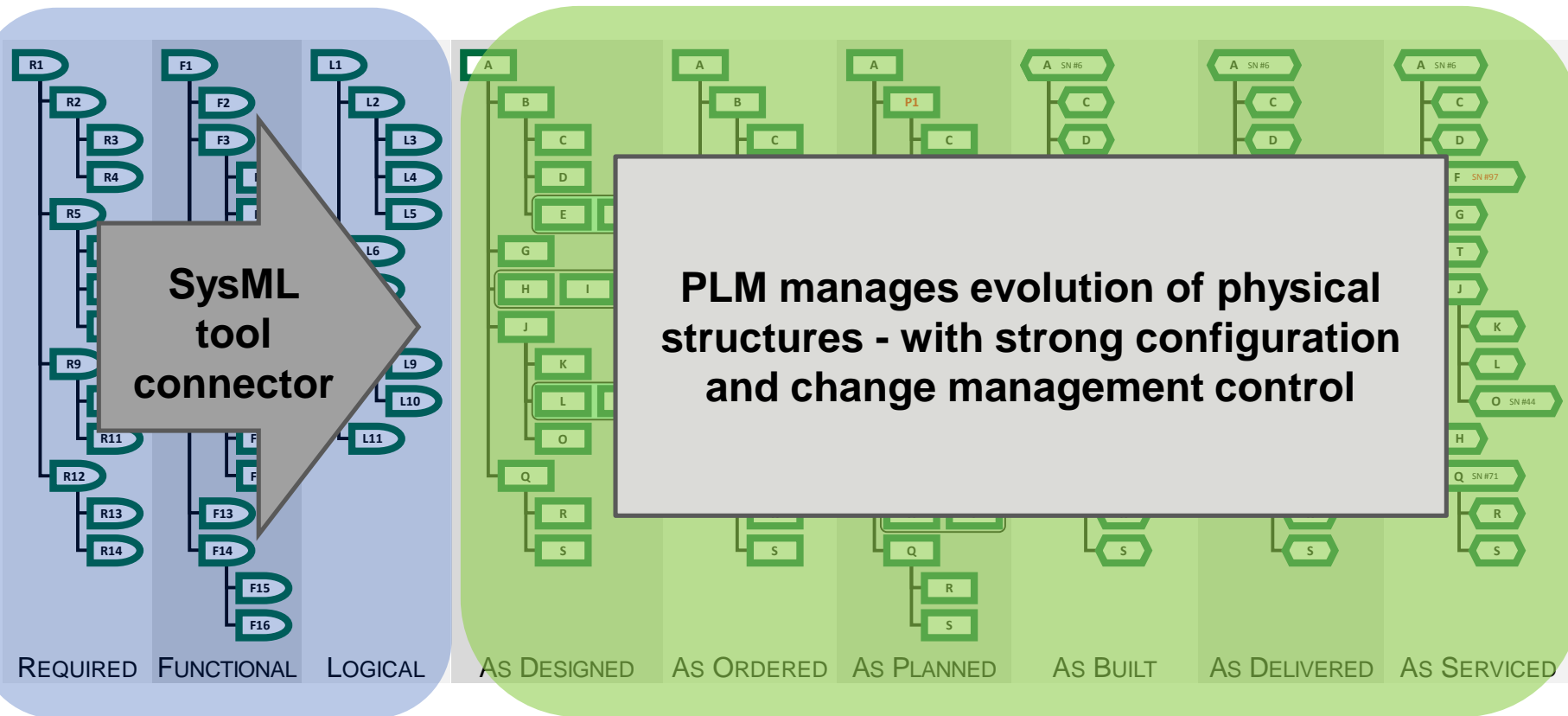
# “Holy Grail” of PLM

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# System Model structures in PLM

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## RFLP - Collaboration and Traceability

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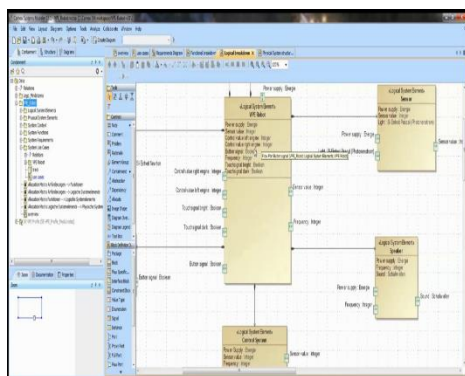
## Magic Draw



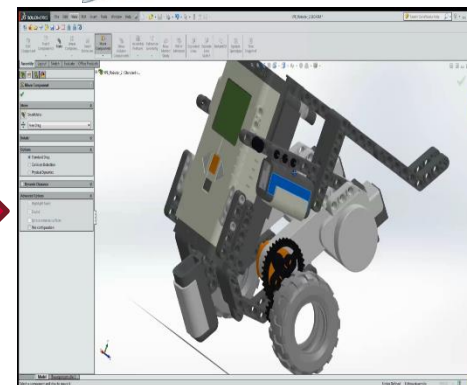
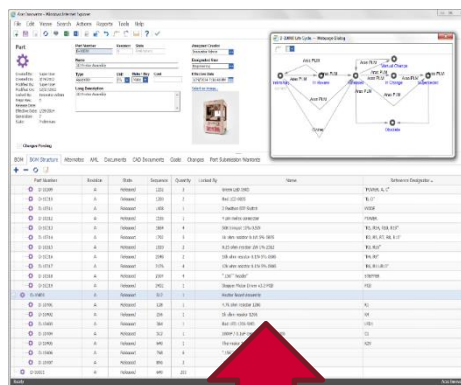
## Aras PLM



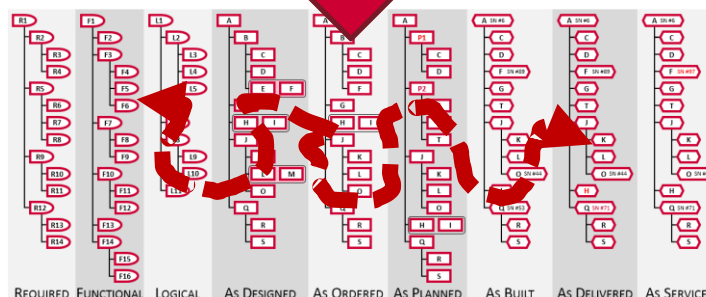
## SOLIDWORKS



*From/To  
a SysML item*

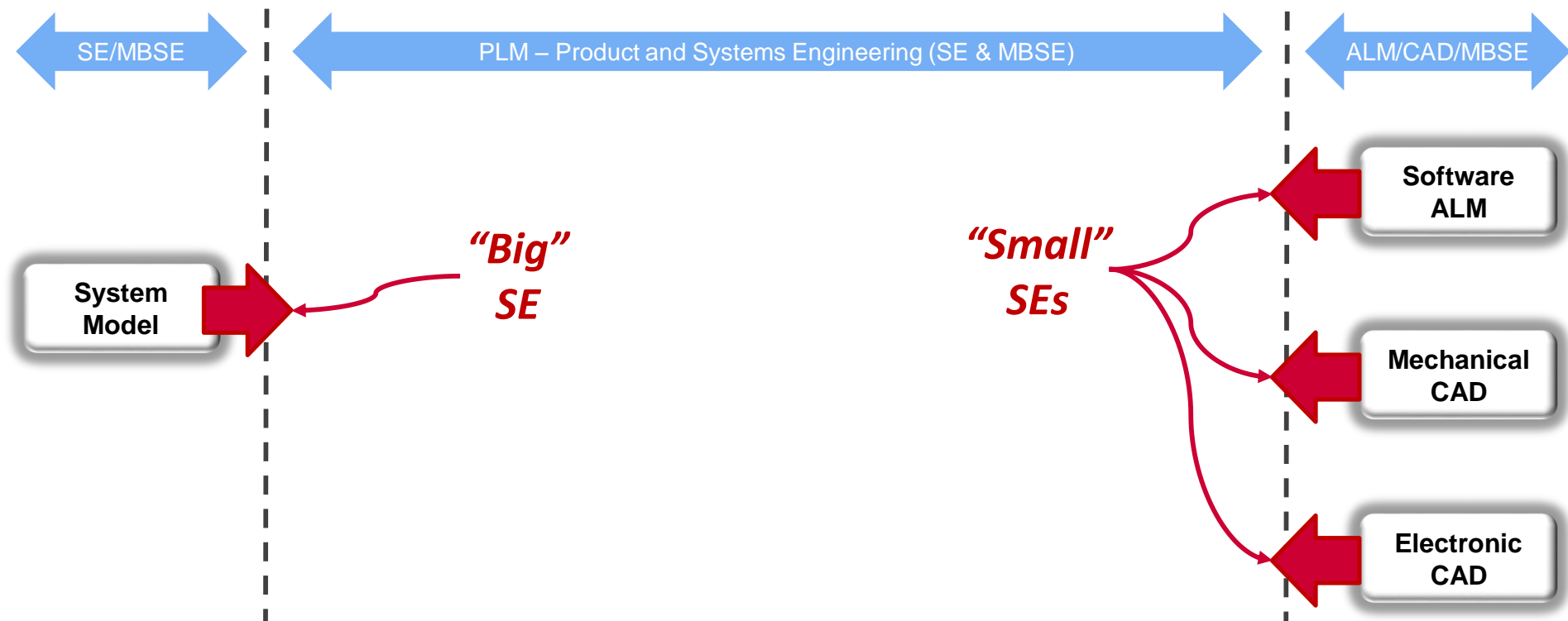


*From/To  
a physical part*



# System Models & PLM

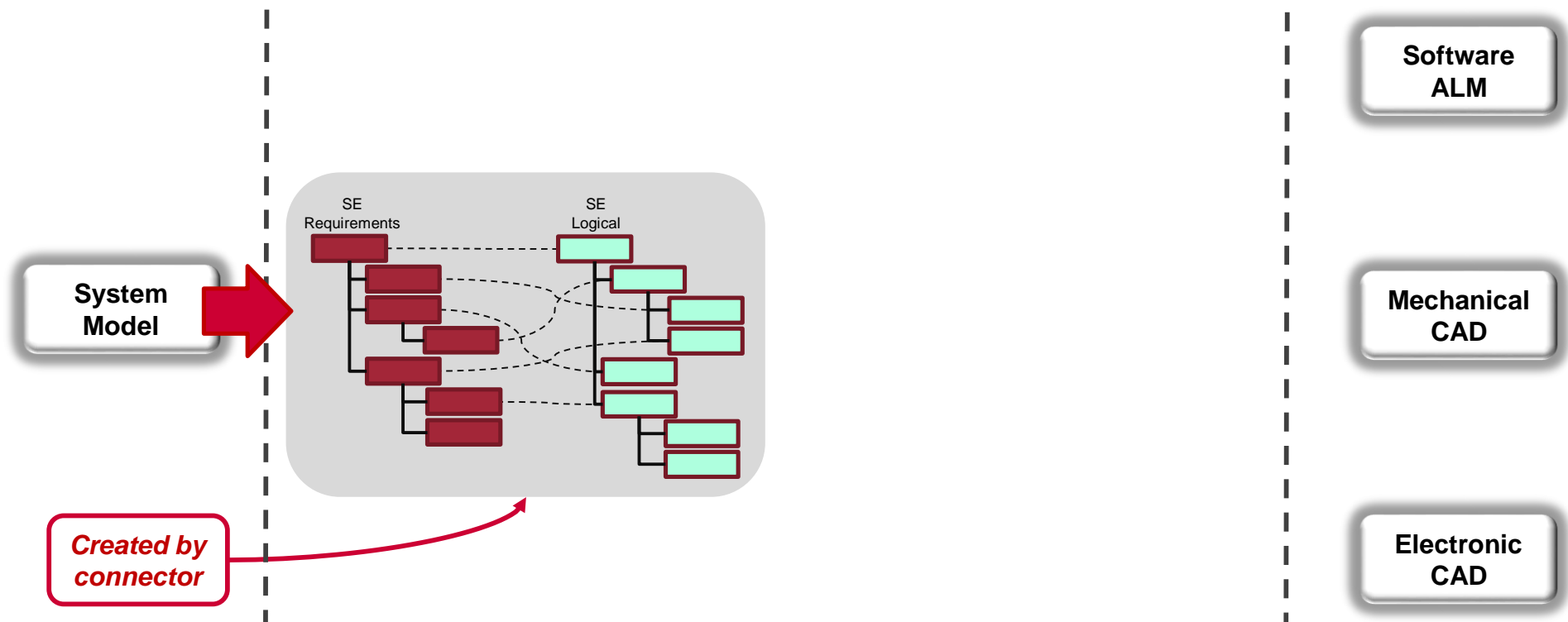
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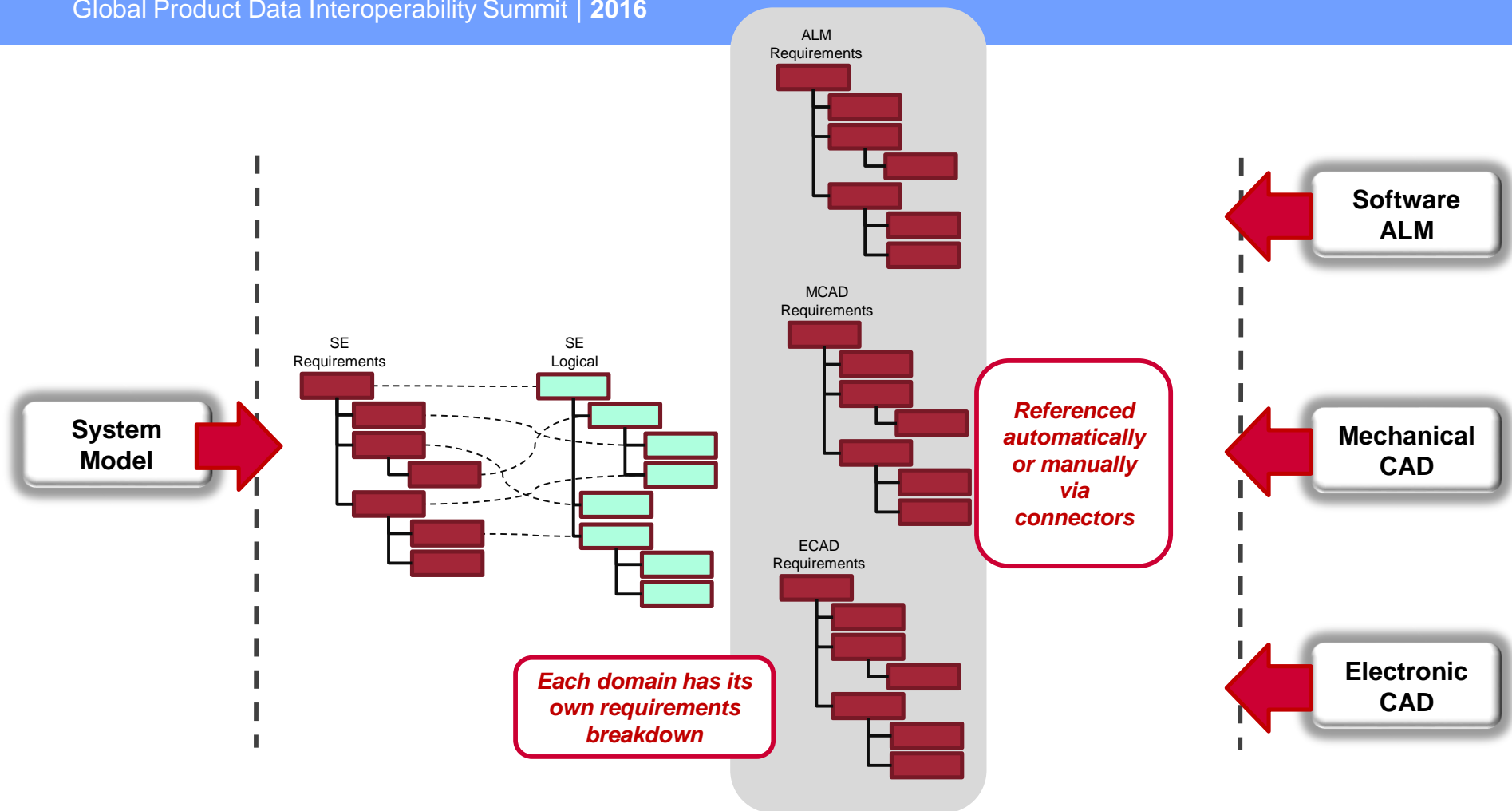
# Add SysML structures

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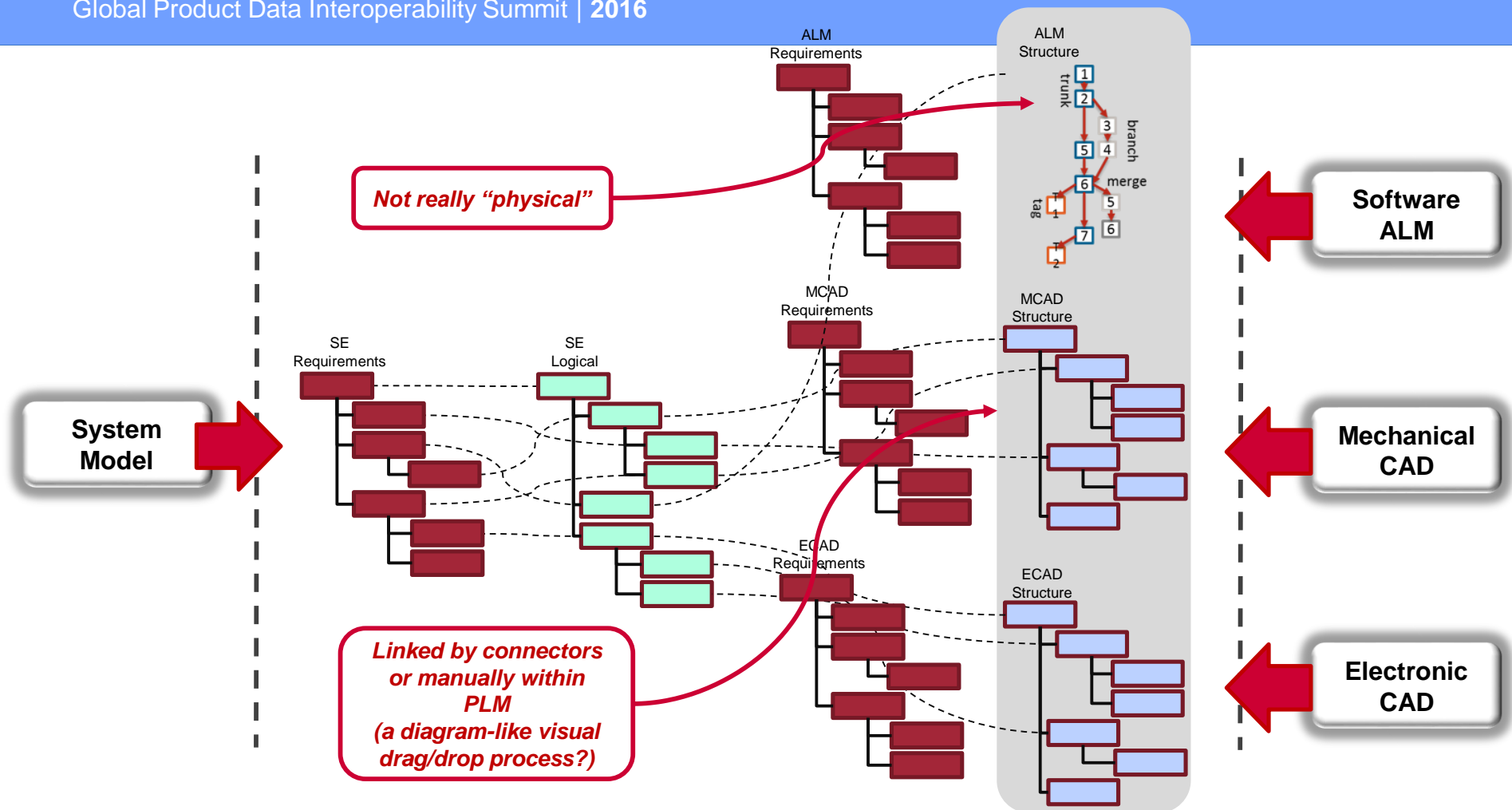
# Add Requirements decomposition

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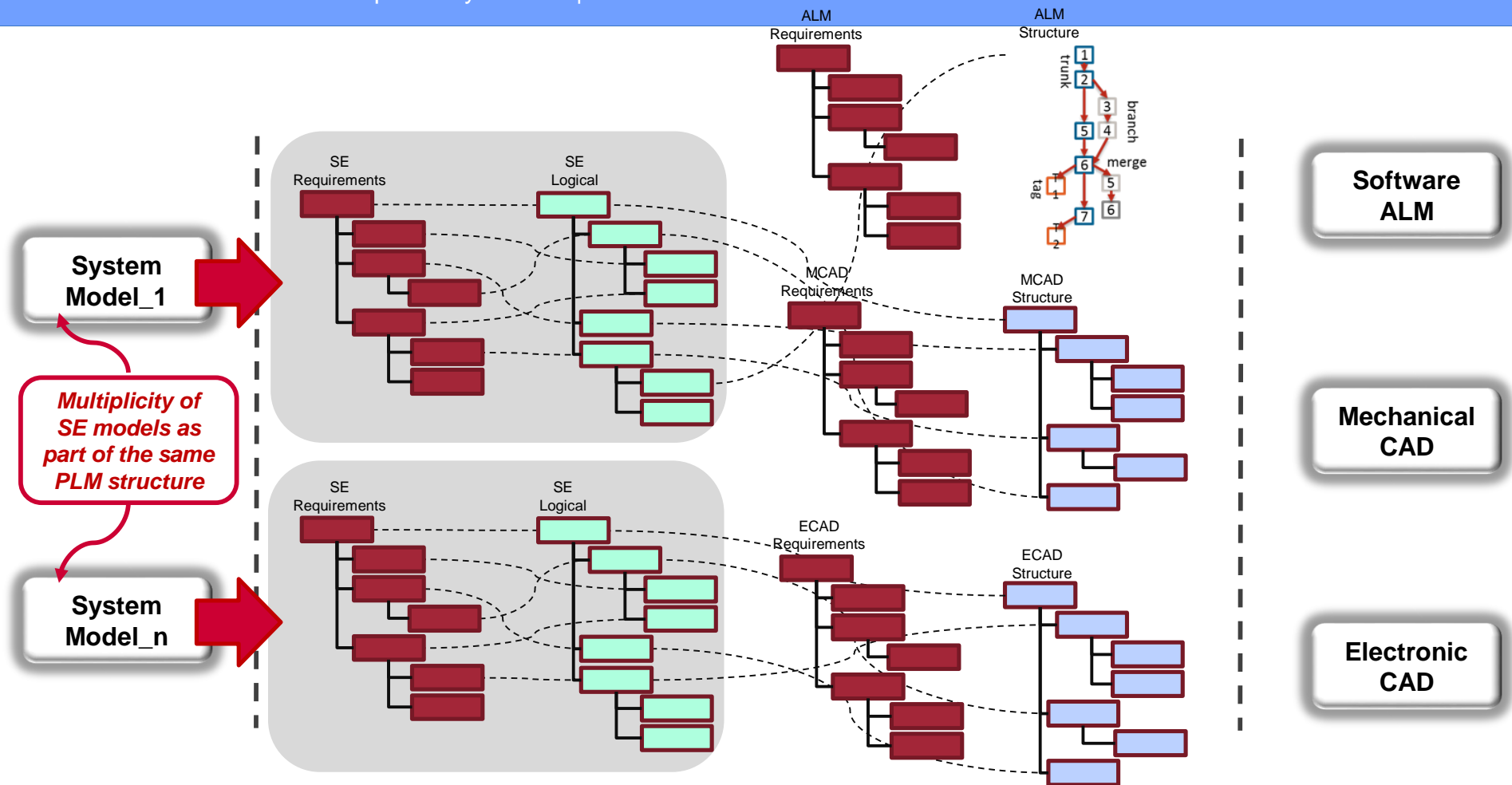
# Add Logical to Physical

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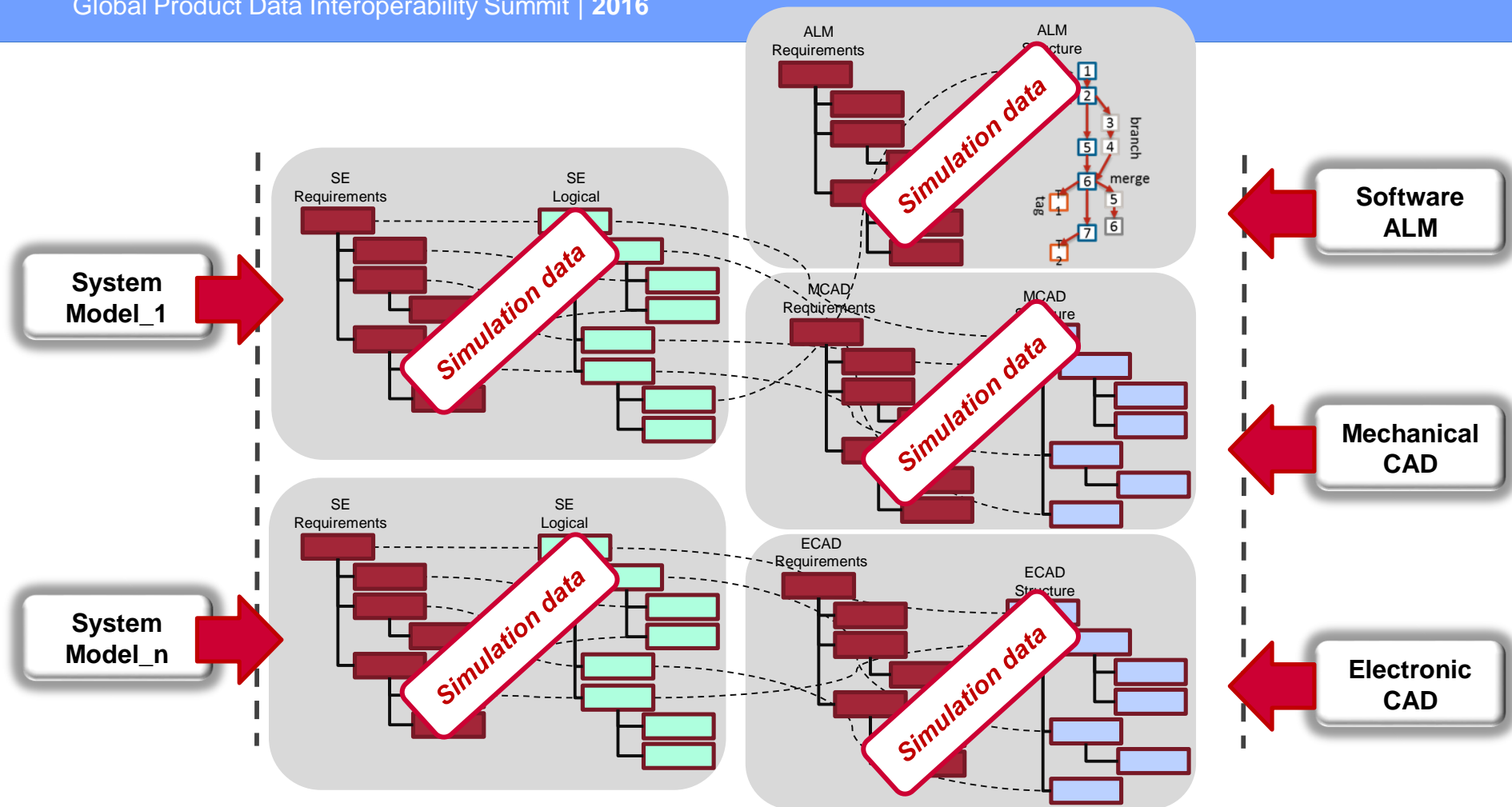
# Add multiple models

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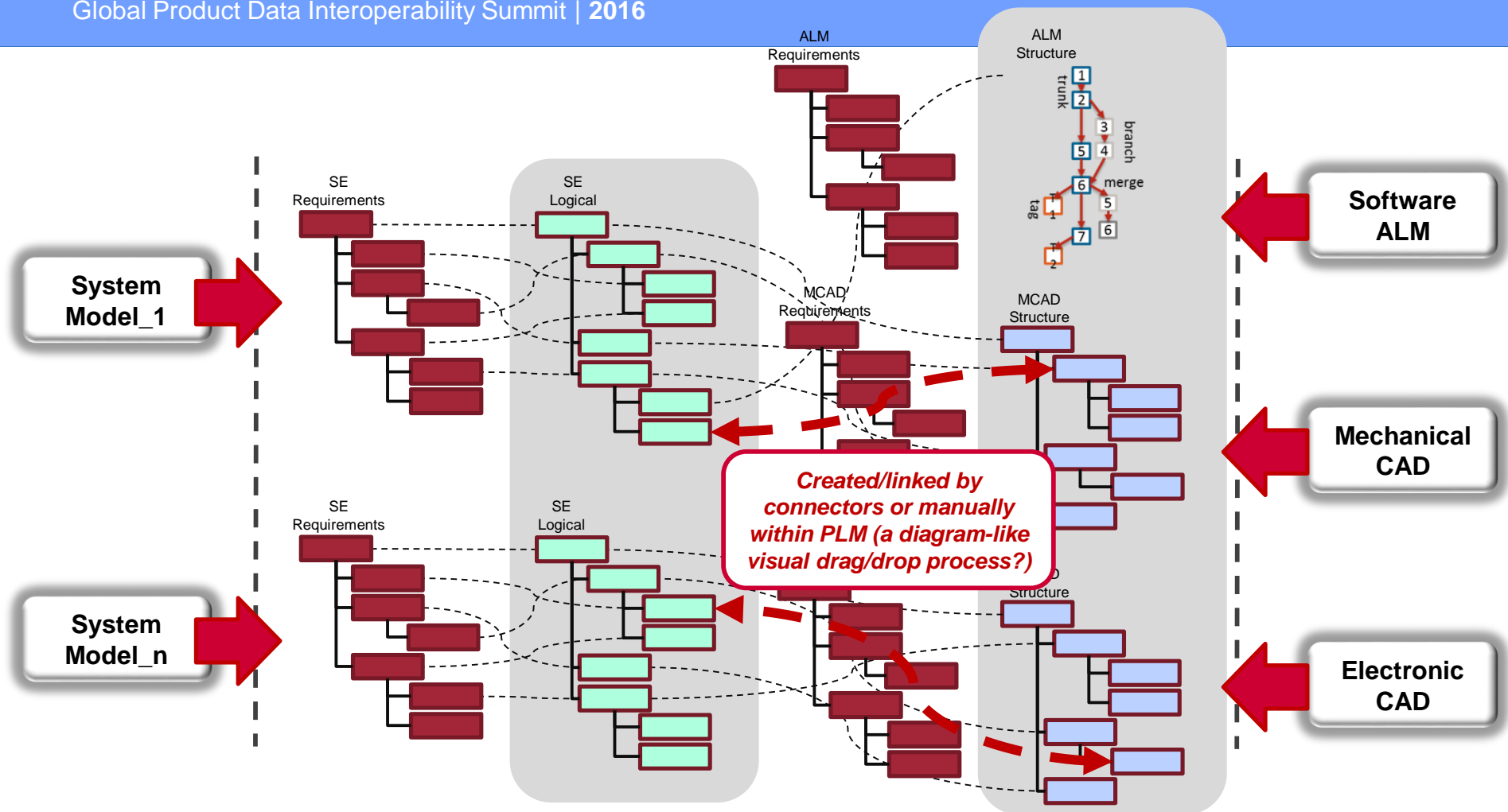
# Add simulation data

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# Add “System” properties (data/control flow)

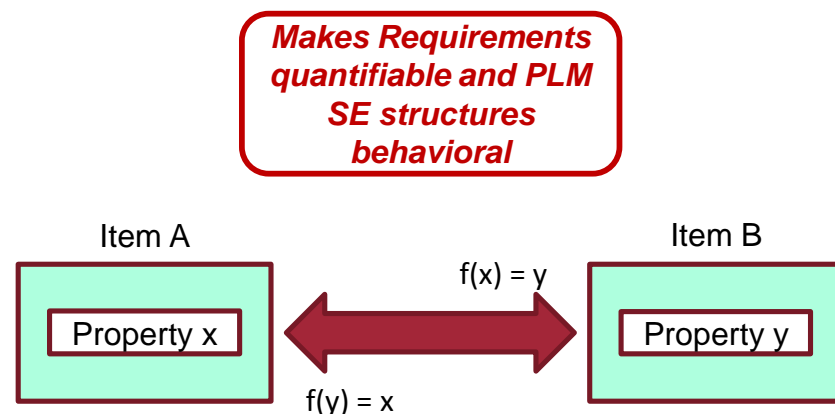
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# Properties are cross-domain negotiable “Contracts”

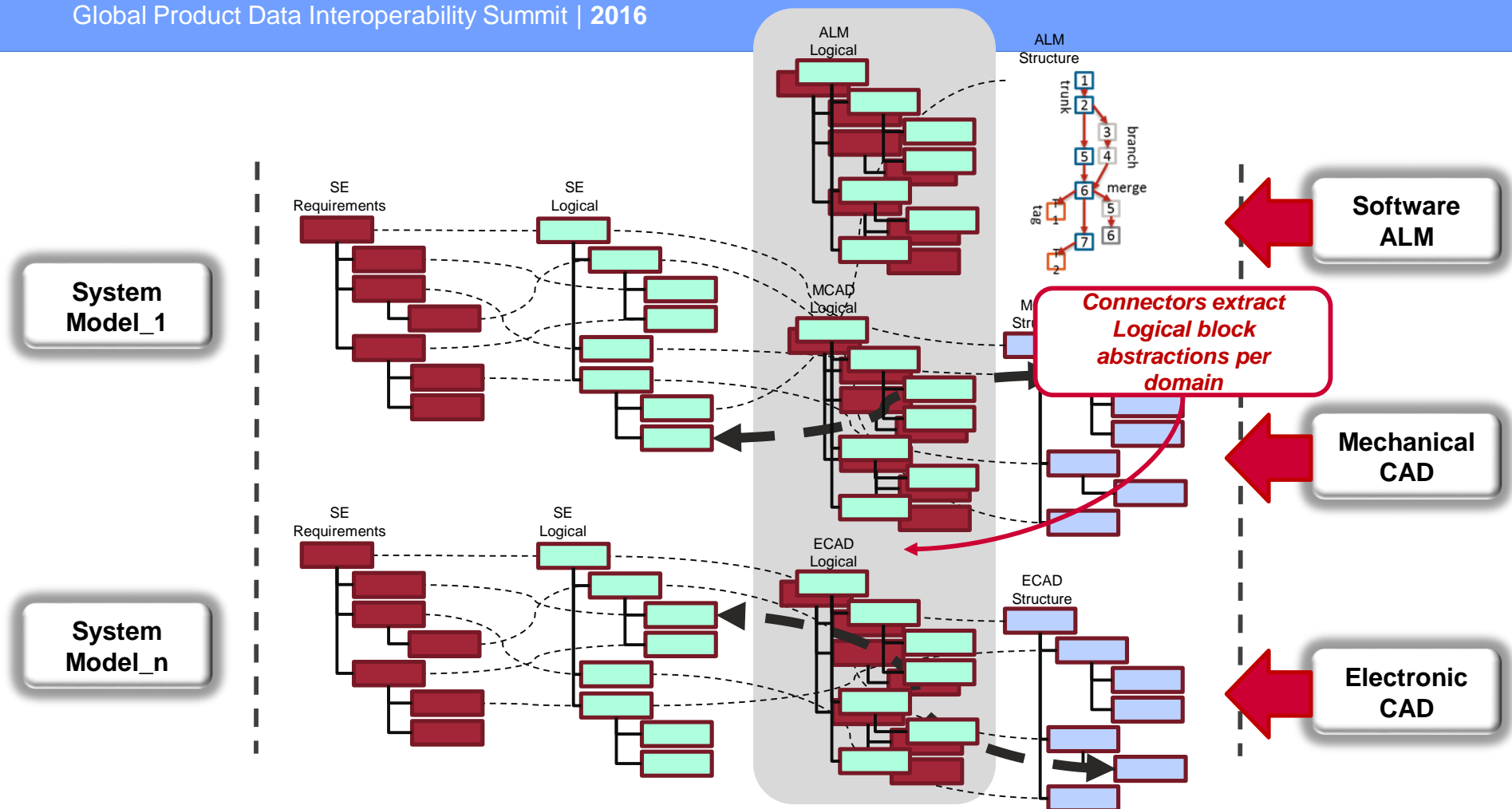
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- Linked between any two structural items
- Value, range, enumerated list
- Units
- Fixed or a target (a budget)
- A domain owner
- On a structural item or accumulative for an assembly
- Transformation function on a property link
- Created/linked by connectors or manually (a diagram-like visual drag/drop process within PLM?)



# Add Logical to Logical

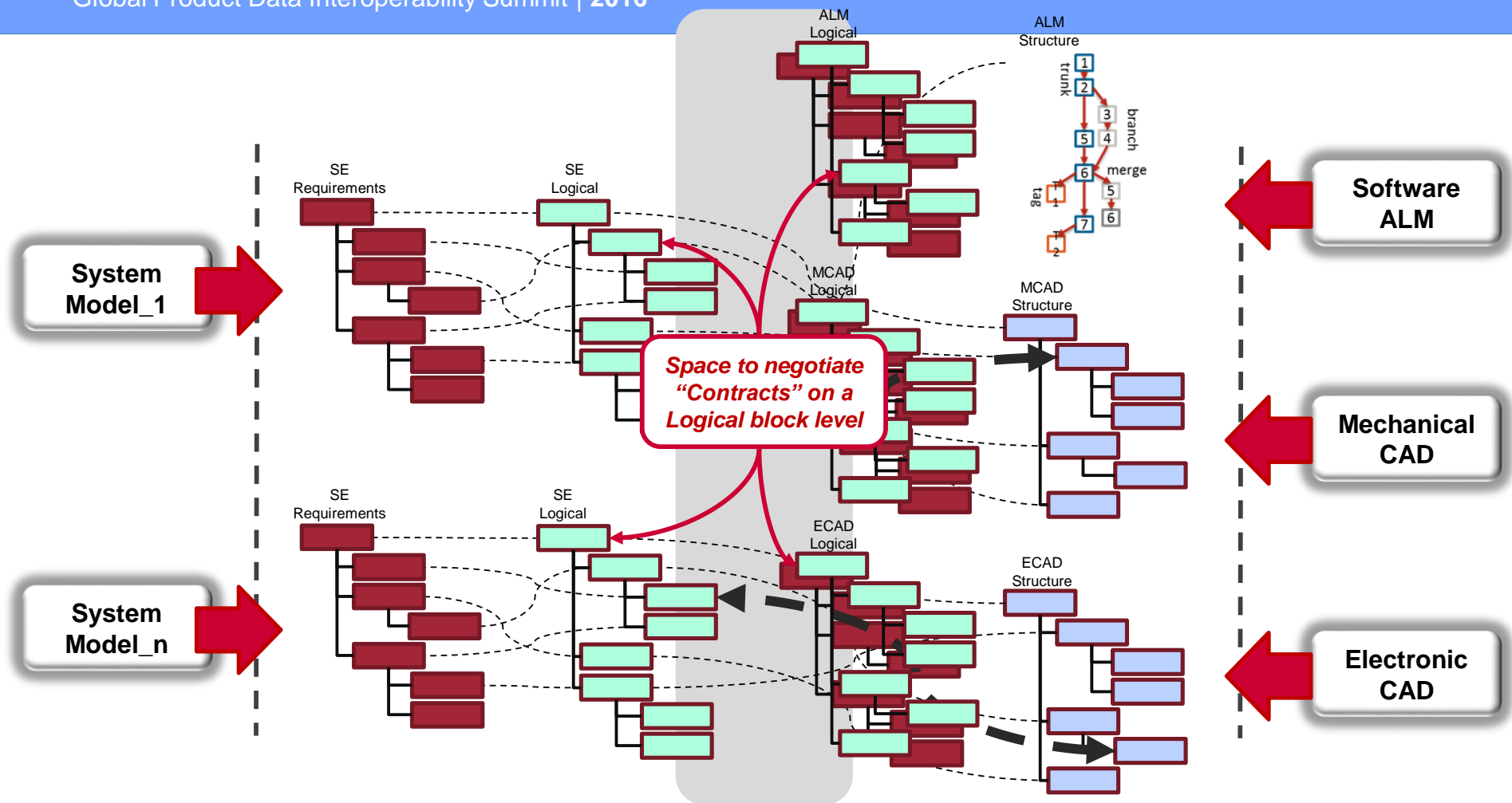
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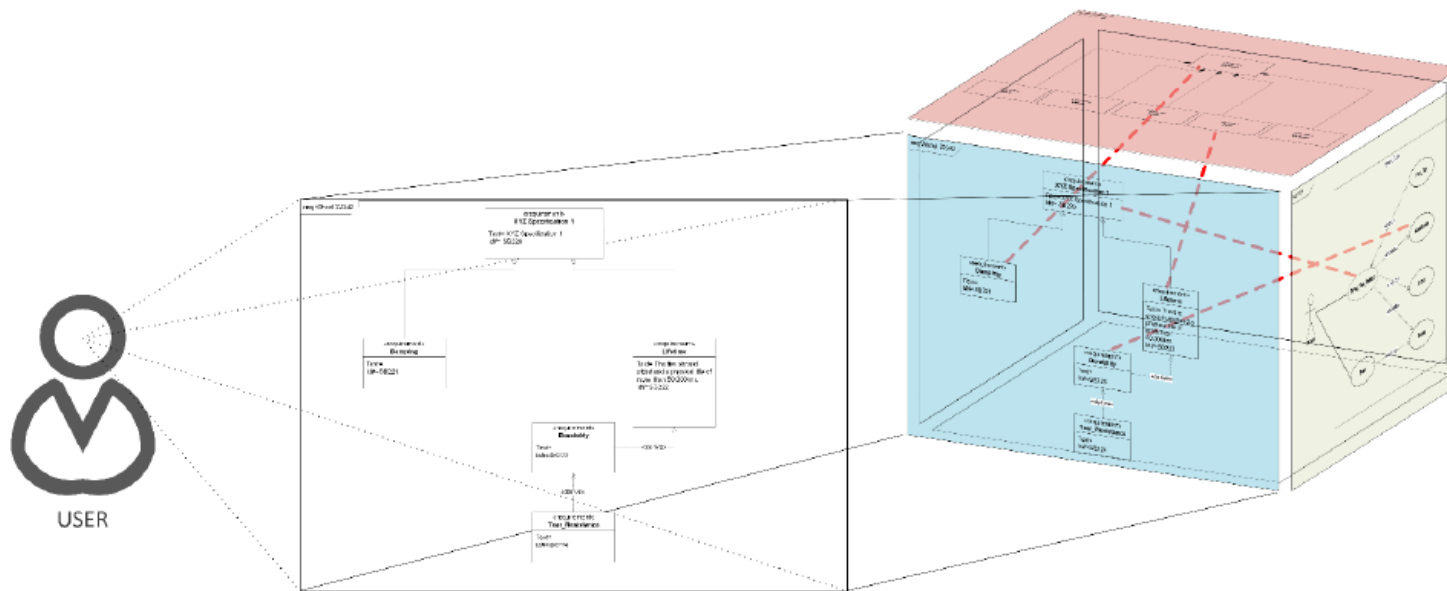
# Enable Negotiations

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# SysML Graphs approach

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*Complex relationships via comprehensible views in context*

# Agenda

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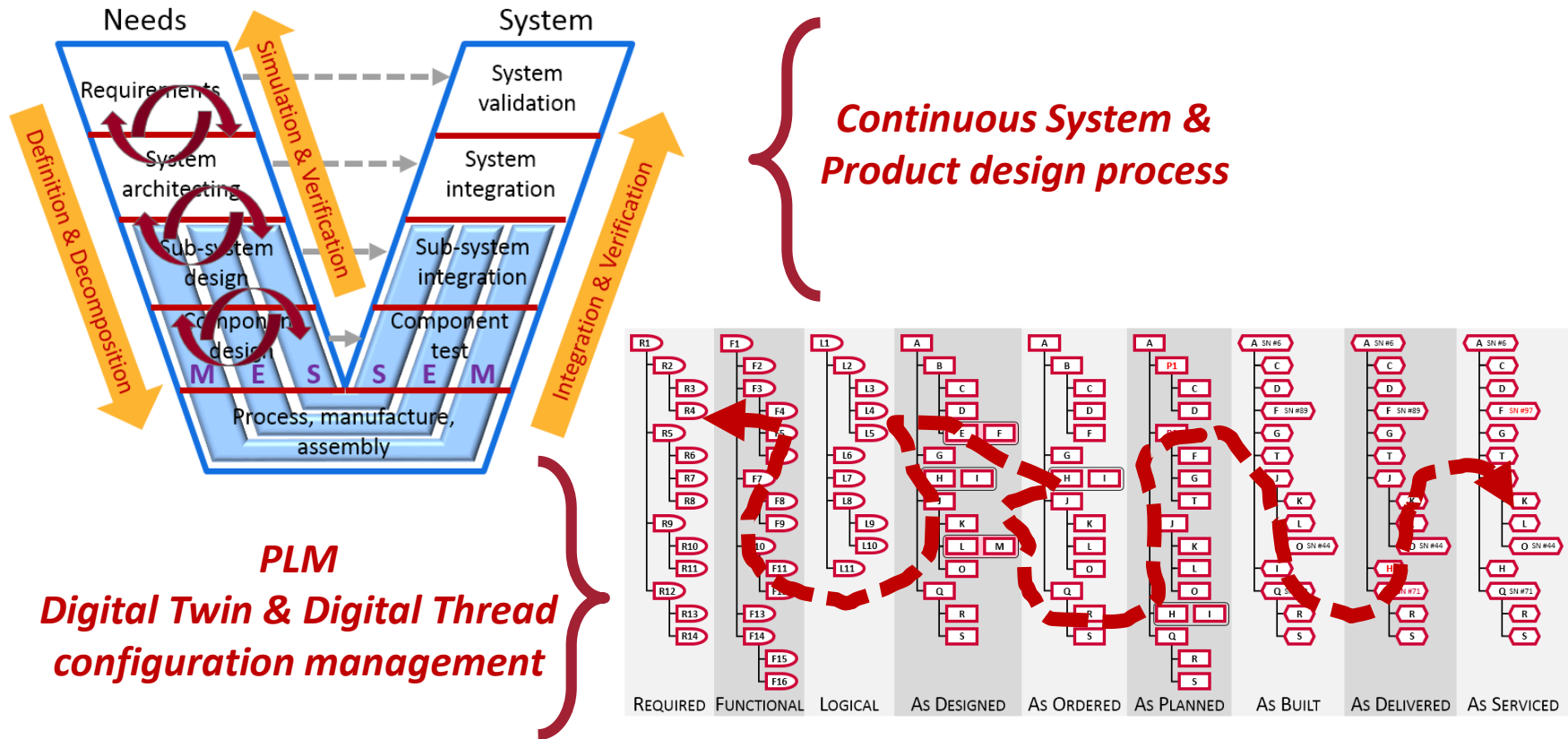
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# Demo video

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# Business of Engineering

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# Partnering with

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



# Acknowledgements

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

