

Welcome to the INCOSE Webinar

16 September 2026 INCOSE Webinar #205

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Webinar205: Accelerating Aerospace & Defense Transformation with PLE: Lessons from Lockheed Martin, Safran Seats & PTC



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PTC

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The full recording and slide deck will be made available to all INCOSE members and CAB associates within 10-12 business days from the original air date in the INCOSE Library.

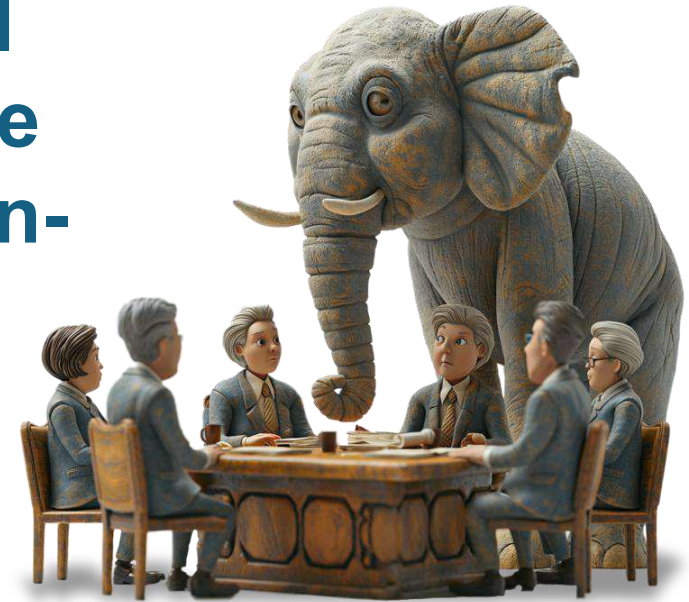
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Email us at: webinars@incose.net!

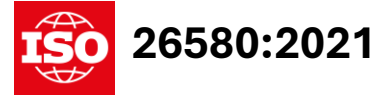
WHAT IS PRODUCT LINE ENGINEERING (PLE)?

- Rephrased: When is Engineering considered to be Product Line Engineering

If organizations **manage a family of systems and mission configurations as one digital engineering ecosystem, maximizing reuse while maintaining strict control of mission-specific variations.**



PLE ENABLES A SYSTEM DESIGN FOR MULTIPLE MISSIONS/PROGRAMS

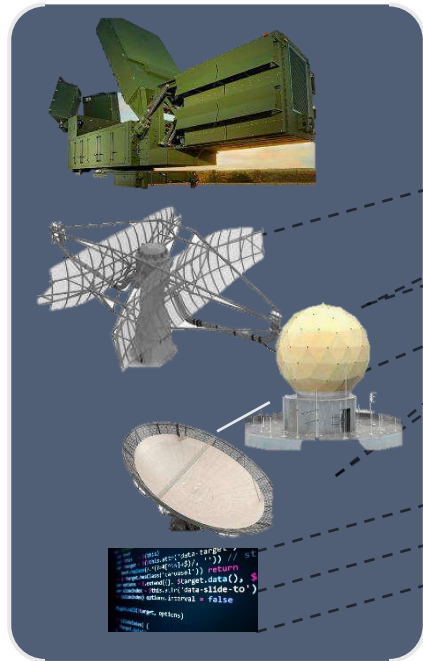


Product Line

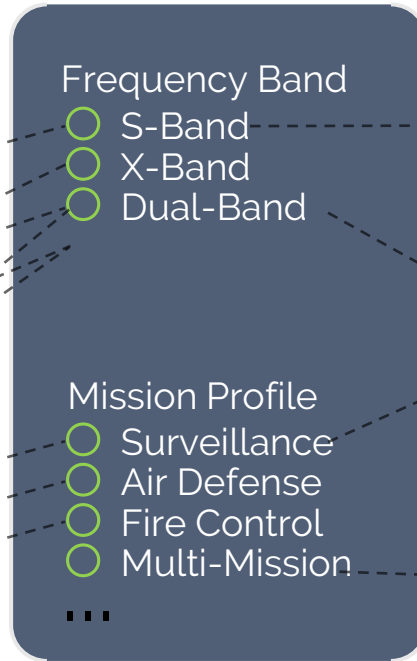
Feature Catalog

Bill-of-Features

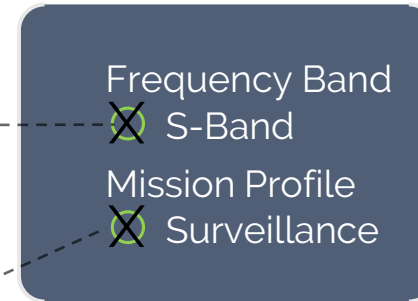
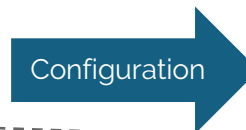
Variant



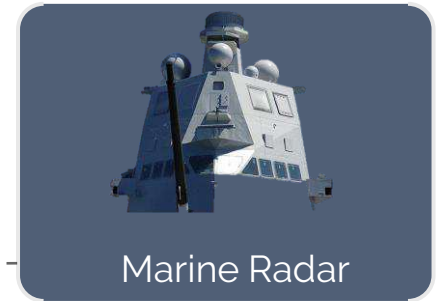
**150%
Model Assets**



Variability Model



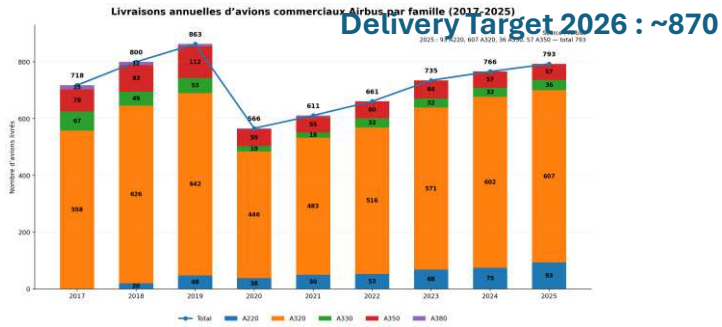
Validated Selections



**100% Model
Assets Instances**

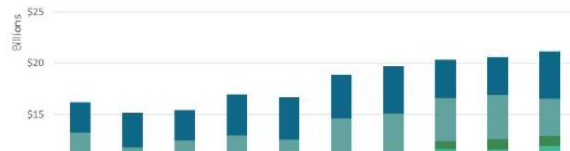
SAFRAN SEATS POV

Market Overview and Context



Source :
[Flash conjoncture France - Les livraisons d'Airbus progressent en 2024](#) | Direction générale du Trésor
[Airbus reports Full-Year \(FY\) 2025 results](#) | Airbus
[Airbus reports Half-Year \(H1\) 2026 results](#)

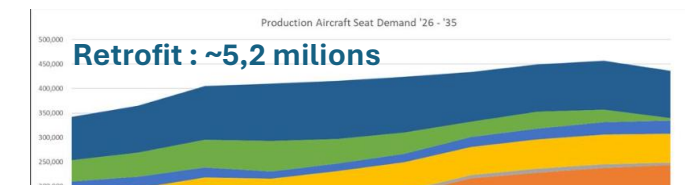
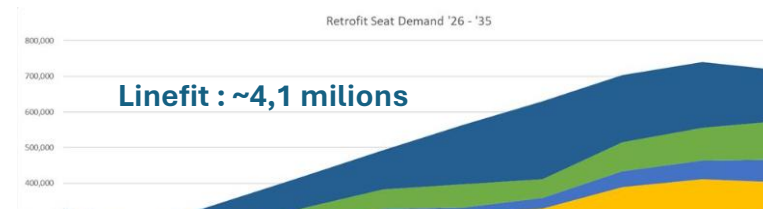
2026-2035 Interiors Spend Forecast



Source : [Graphique: Les vols sans escale les plus longs au monde](#) | Statista



Source : [Chart: Global Air Passenger Traffic Expected To Grow by 5 Percent Annually](#) | Statista



New estimation gives 9.3 millions new seats over the next decade (+9% since 2025 estimation)

The market, encompassing Head of Version and Retrofit Aircraft, is expanding, with new technologies enabling novel aircraft applications that drive demand for innovative interior designs.

Source : [IAC Interiors Forecast](#)

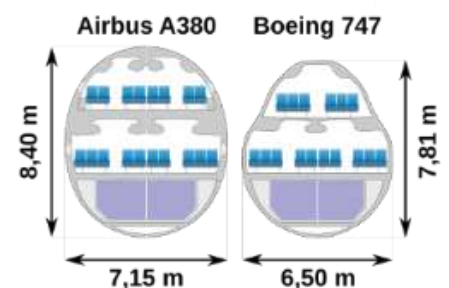
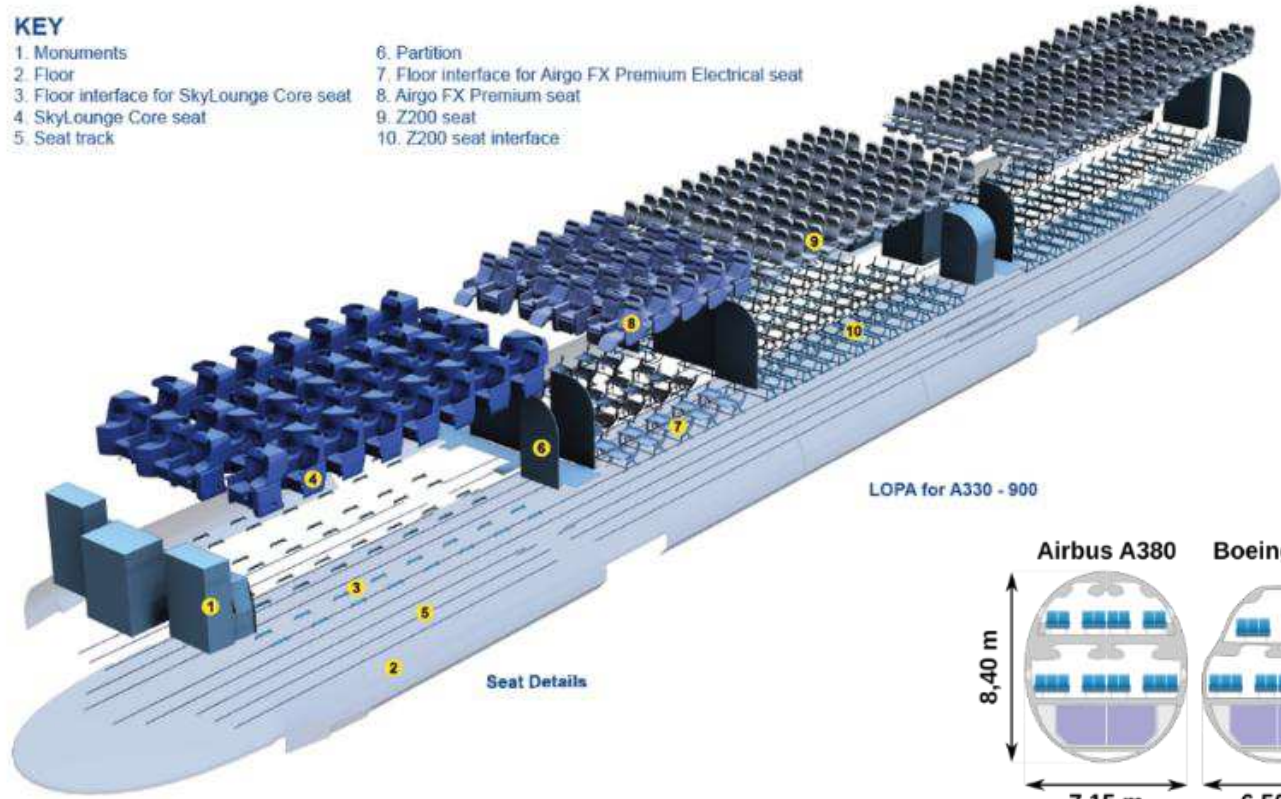
Source : [IAC Interiors Forecast](#)

Source : [IAC Interiors Forecast](#)

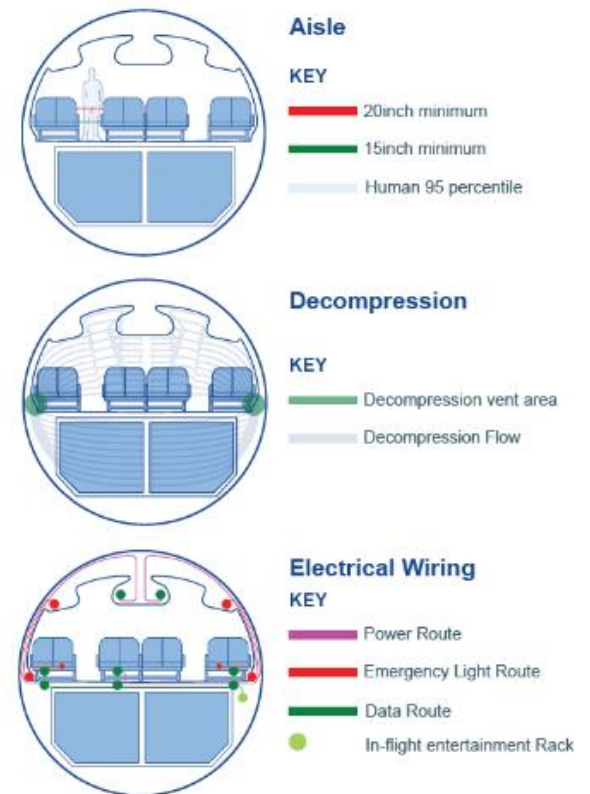
Aircraft interiors are a major factor that distinguishes airlines, serving as a reflection of the brand's identity.



How the Layout of Passenger Accommodation (LOPA) is considered



Source : [Avion à fuselage large — Wikipédia](#)



Variability is influenced by both the type of aircraft and its integration.

Why PLE matters in the interiors contextes

Principal Reasons

- Challenges in Seat Development
 - Repeated redesigns cause inefficiencies and high costs across engineering and supply chains.
- Shift to Function-Centric Design
 - Modularity focuses on reusable core passenger and system function modules instead of full seats.
- Strategic Importance
 - Modularity enables focus on innovation and differentiation while stabilizing proven solutions.

Some others Reason

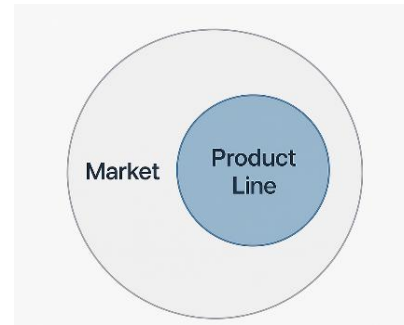
- Propose flexibility, reusability and customization
- Simplify industrialization and logistic (optimize the assembling flow)
- Improve standardization and quality

Key success factor:

- Align all the organization of the same KPI for RC and NRC costs?

Attention Points

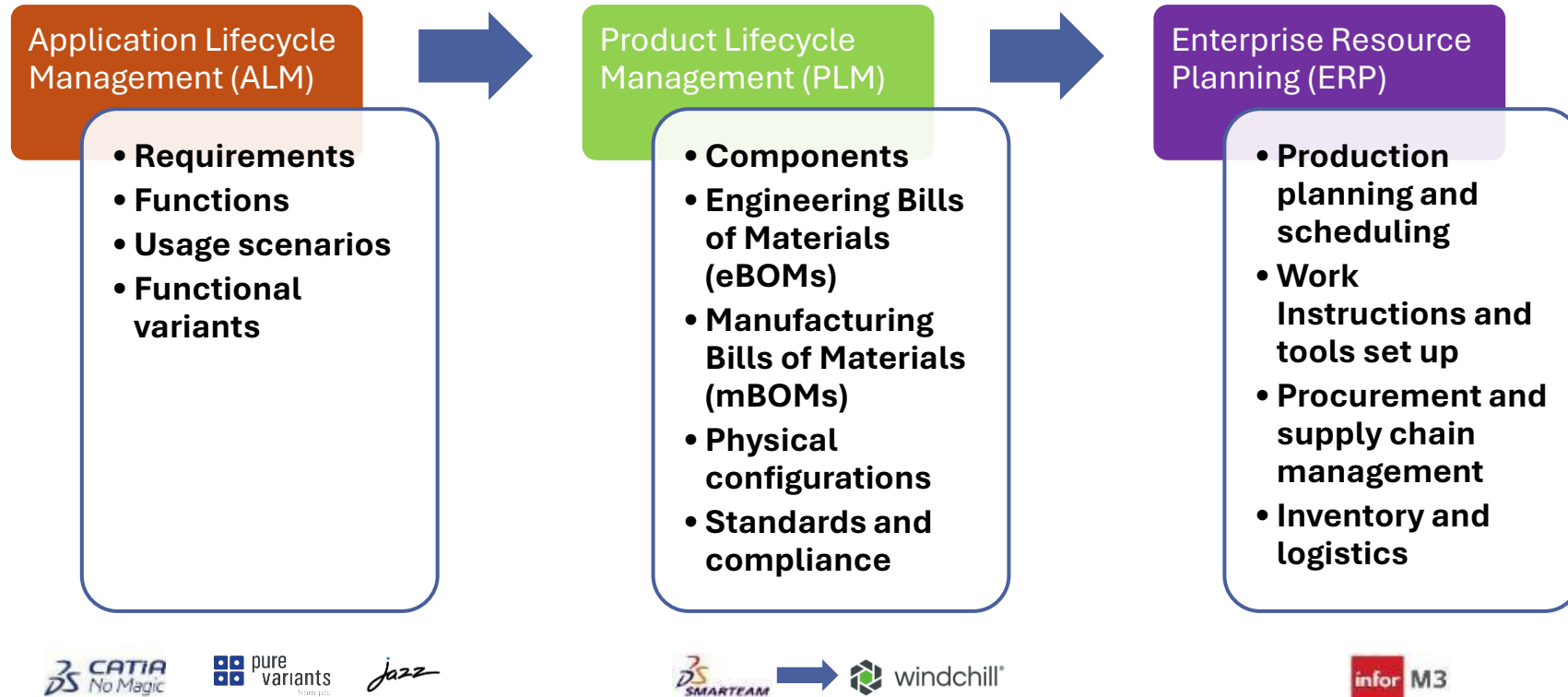
- Manage the loss of break even of the PLE in the early phase of the PLE (3 projects)



A successful product line should be tailored to a well-defined market segment to guarantee a favorable return on investment.

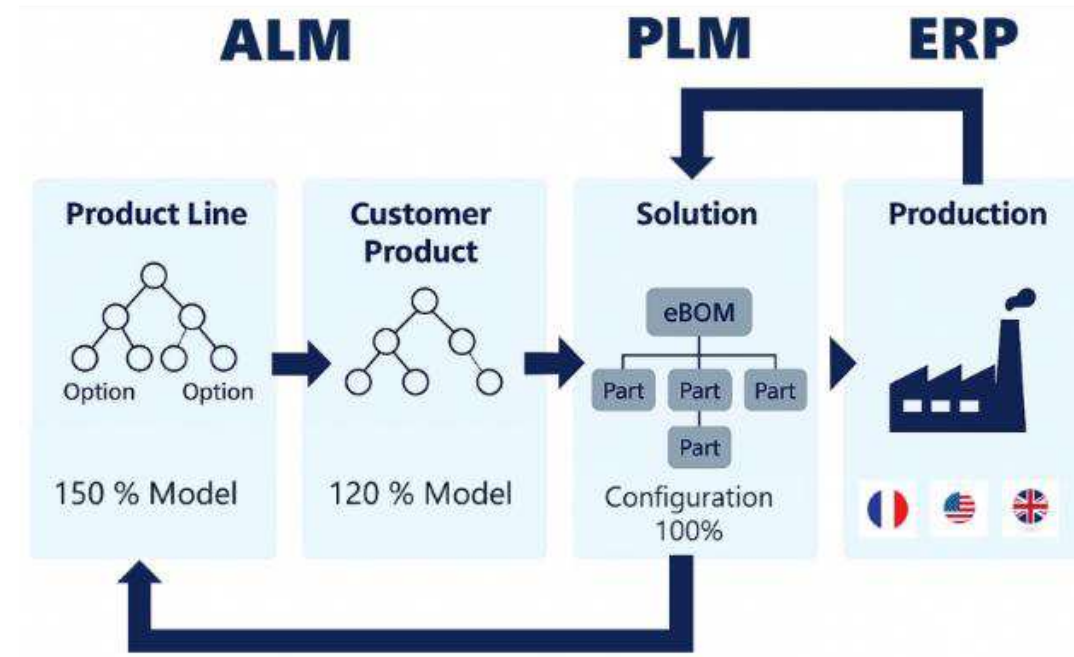
A universal product line that suits everyone remains an idealistic notion (PLE perimeter)

End-to-end Digital Transformation : from ALM to ERP for a optimize MLPE sizing



MBPLE

From theory to legacy world into SoS world



In a theoretical framework, the process flows from Requirement to Product Delivery
However, since the product often predates system engineering, the product line should be supplemented with legacy information.

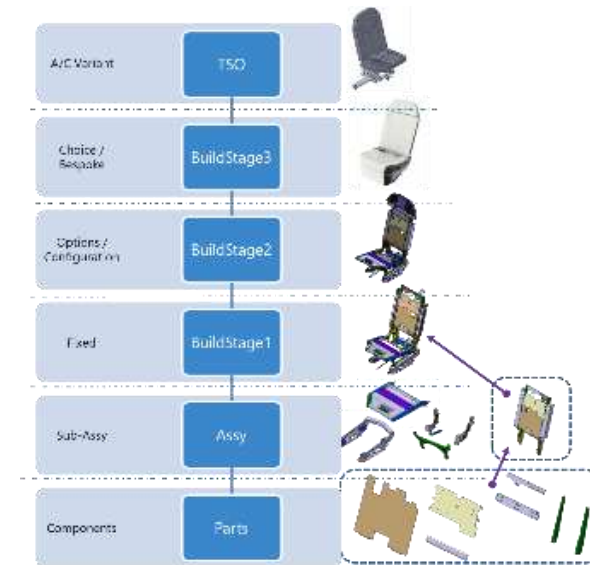
NEXT STEPS

PLM and ALM Integration (after in the presentation)

- ALM and PLM to share platform definition, logic and rules for variability

Skills Assessment and Enterprise Architecture

- Extension of the INCOSE Competency Framework for the product line with INCOSE PLE WG
- The automotive sector has widely embraced and implemented practices associated with the customize-to-order model.
- In contrast, instances of the engineering-to-order approach are relatively rare and generally confined to aerospace firms.
- We are interested in collaborating with INCOSE or a small team to develop engineering-to-order best practices.



**Which is the good level of reuse
in engineering-to-order
processes**

LOCKHEED MARTIN POV

LOCKHEED MARTIN BUSINESSES



Our corporation, headquartered in Bethesda, Maryland, is organized around our core business areas specializing in defense tech.



Aeronautics, with approximately \$30.3 billion in 2025 sales which includes tactical aircraft, airlift, sustainment and aeronautical research and development lines of business.



Missiles and Fire Control, with approximately \$14.4 billion in 2025 sales, which includes innovative and competitive integrated air and missile defense, strike, precision fires, air superiority and close combat weapon systems.



Rotary and Mission Systems, with approximately \$17.3 billion in 2025 sales, which includes Sikorsky helicopters, maritime systems, sensors, radar systems, command and control, combat simulation and training, undersea systems and full-spectrum cyber capabilities.



Space, with approximately \$13 billion in 2025 sales, which includes development of national security, civil, commercial and weather spacecraft, strategic and missile defense solutions and hypersonics missions.

“THE PROBLEM” - CURRENT STATE

Large enterprise, Business Areas

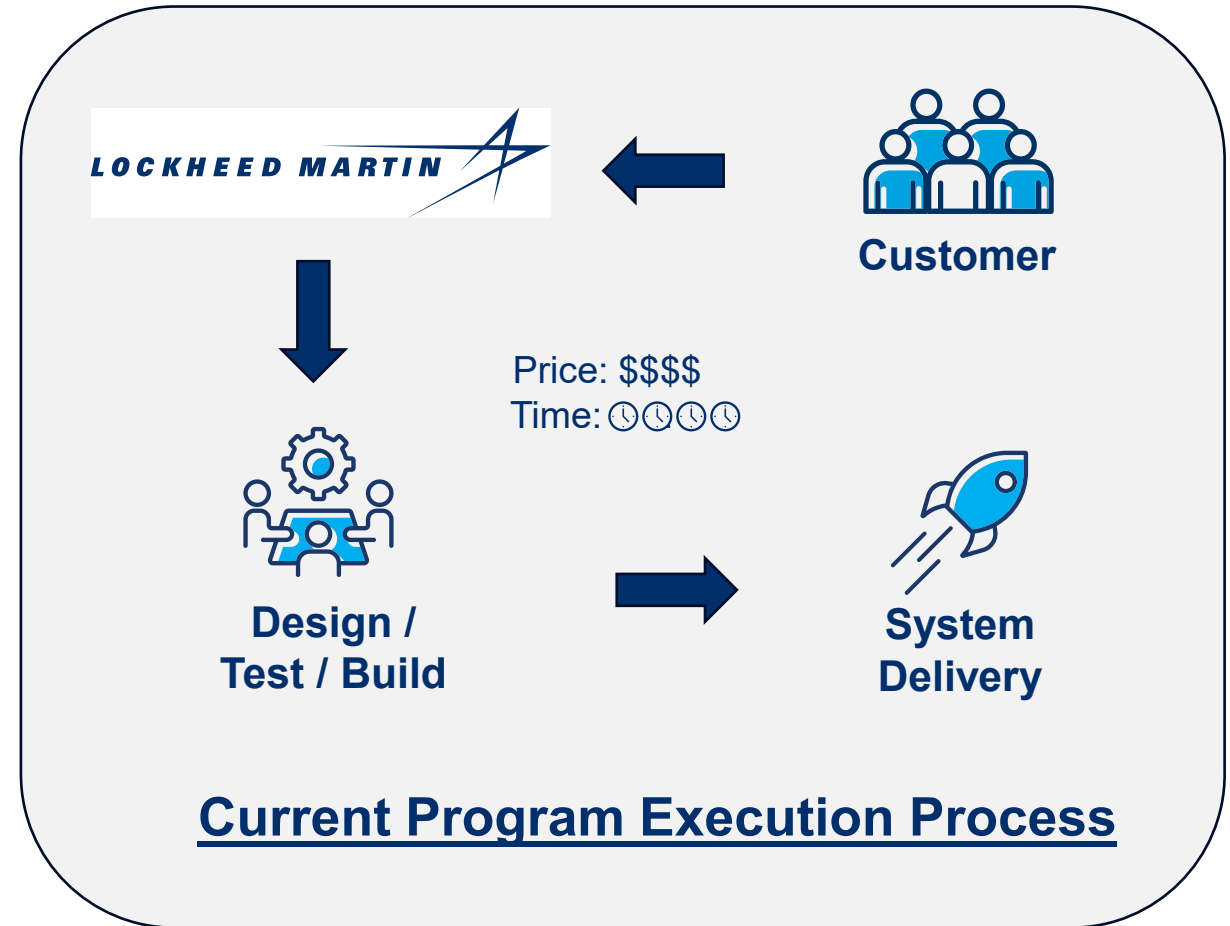
- Many programs within a Business Area

Current Approach

- Program centric
- Customer centric
- “Clone and own”

Customer Needs

- Increased volume
- Decreased cost
- Faster delivery
- Custom, made-to-order solutions



How do we change our approach to more effectively meet customer needs?

PLE Strategy

① Strategic Vision

- Establish top-down support
- Establish policy alignment (MBSE, Concurrent Engineering, Digital Threads, etc.)

② Methodology Setup

- Establish:
 - Processes
 - Governance
 - Organization functions (R&Rs)

③ Infrastructure Setup

- Establish:
 - Tools
 - Networks
 - Capabilities

④ Product Line Identification

- Perform domain analysis & identify market opportunities
- Define product line scope
- Define value proposition

⑤ “First Movers” / Pilot Implementation

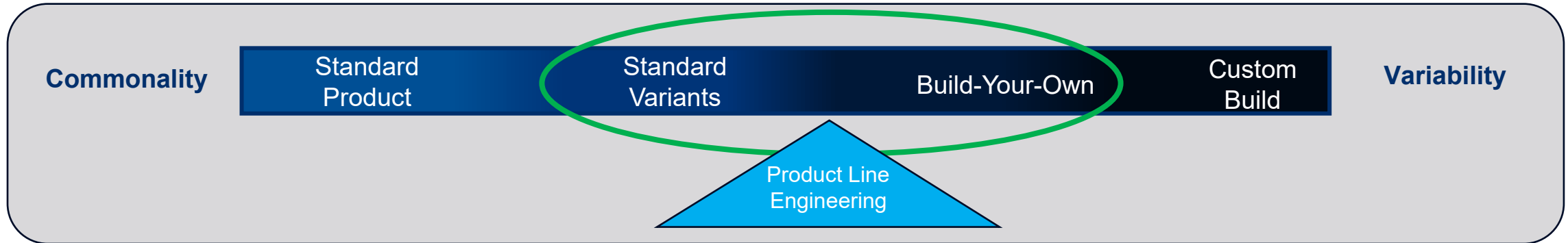
- Prove value with representative use cases
- Drive towards a “mission focused” approach

⑥ Institutionalize & Scale

- Formalize governance
- Expand adoption
- Expand offerings

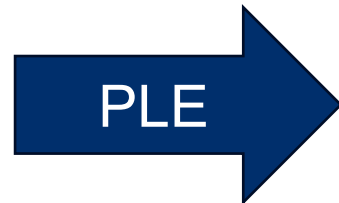
Lockheed Martin recommends a phased PLE Strategy that continuously evolves/adapts.

Turning Complexity into Competitive Advantage



The Complexity

- PLE complexity
 - Many different variants
 - Many different assets
 - Many different programs / BA
 - Many different customers / missions
 - Standards, Compliance
 - Rapid technology changes
- Customer needs complexity



Competitive Advantage

- PLE Strategy
 - Centralize & systemically capture knowledge / artifacts
 - Improve speed, cost, quality, adaptability, flexibility
 - **Measurable PLE Savings**
 - Combat system: 53% cost avoidance for requirement changes
 - Radar program: 33% reduction in product labor cost
 - Satellite proposal: configuration time savings, weeks → hours
- (cited from 2019 internal Lockheed Martin White Paper)

PLE empowers teams to deliver diverse, high-performance systems faster and with greater confidence.

PTC POV

THE REUSE PITFALL: WHEN THE LAW OF INTENDED CONSEQUENCES IS AROUND THE CORNER



Tailored MBSE with Low Reuse of the Model

Although MBSE introduces libraries, patterns, and reusable components, most implementations remain focused on a single development effort and clone-and-own. The result is improved engineering rigor, but limited reuse across the enterprise.



PLE-Focused Reuse of Realized BOMs

Organizations often attempt to reuse finished designs, products, and BOMs rather than reusable engineering knowledge. By the time a system is realized, program-specific decisions and IP constraints have already limited its reuse potential.



Breaks the Digital Thread between Models. The MBSE Silo!

Reuse approaches are often limited to a single engineering domain.

Models, requirements, software, and product data evolve in separate silos.

Valuable engineering knowledge is transferred between tools but rarely reused as an end-to-end digital asset.

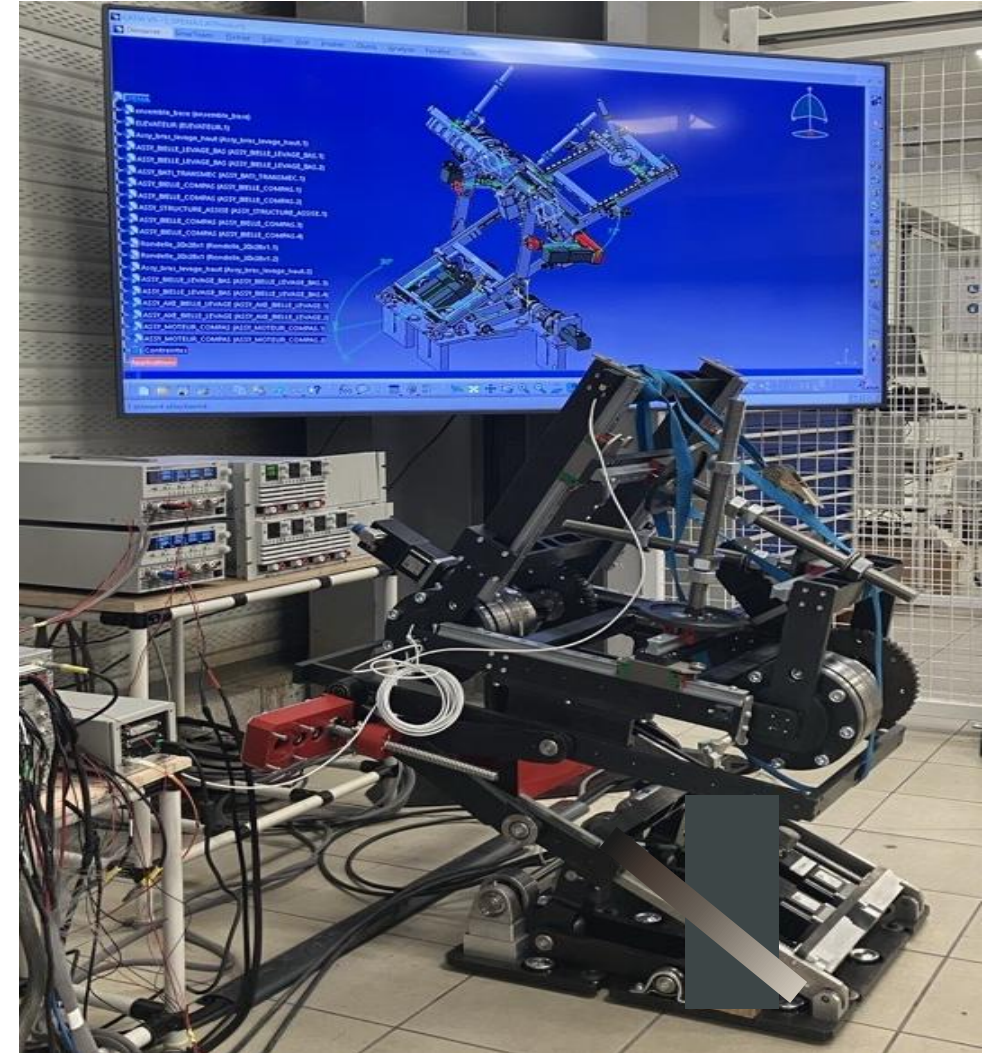
PLE: A REAL-LIFE EXAMPLE OF BUSINESS CLASS SEATS



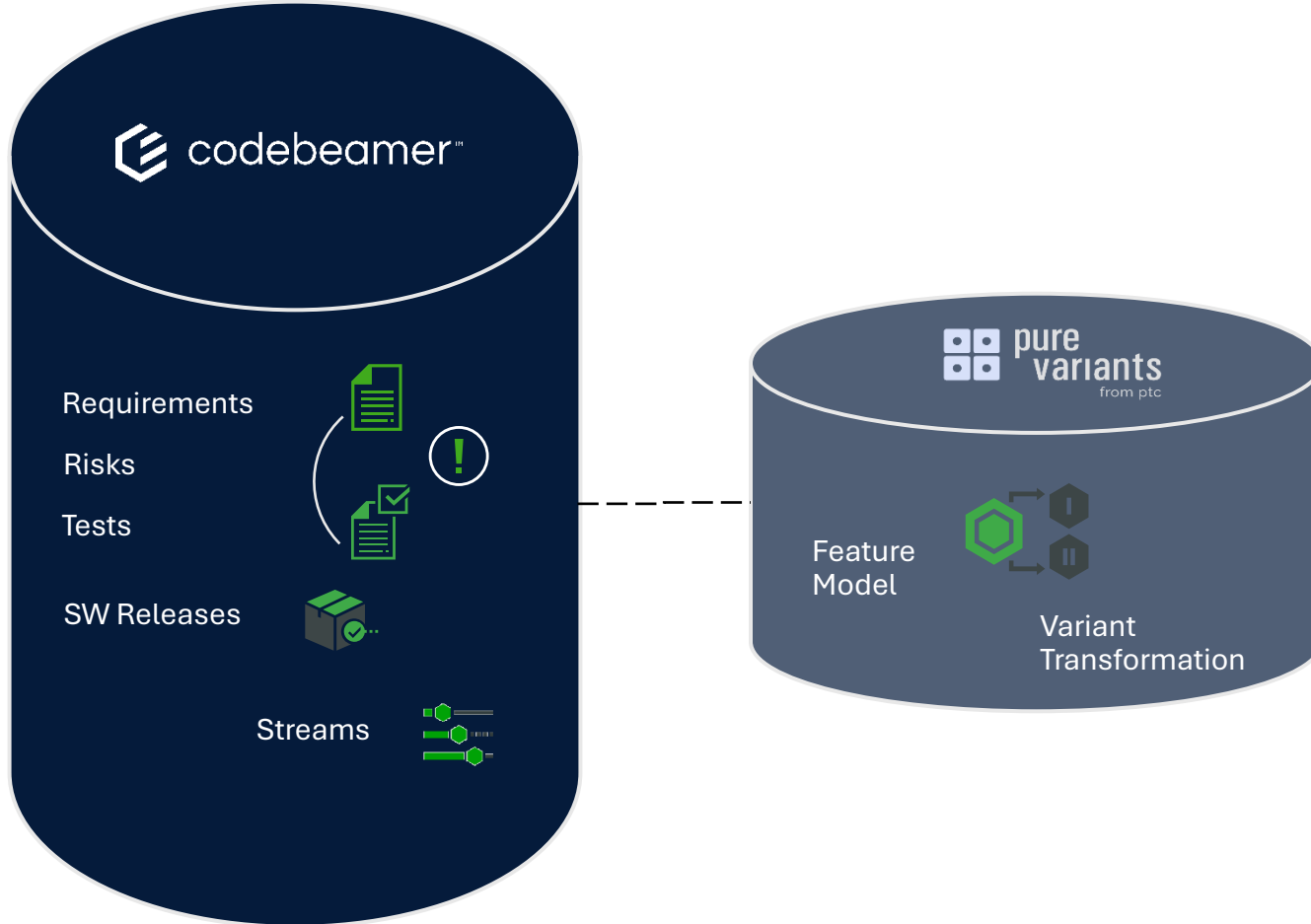
STARTING FROM PROTOTYPING*

- Prototype seat used for **Hardware-in-the-Loop simulation**
- Variants: **Fully Simulated**, **Physical Prototype** and **Hybrid Prototype**
- Represents actuation, control, instrumentation
- Used as **demonstrator** for **variability propagation**
- Reduced variability, but **fully representative**

*This example is based on a real-world Safran Seats use case and has been adapted to illustrate the broader digital engineering workflow, including PTC enhancements such as the Codebeamer integration.



PLE & APPLICATION LIFECYCLE MANAGEMENT



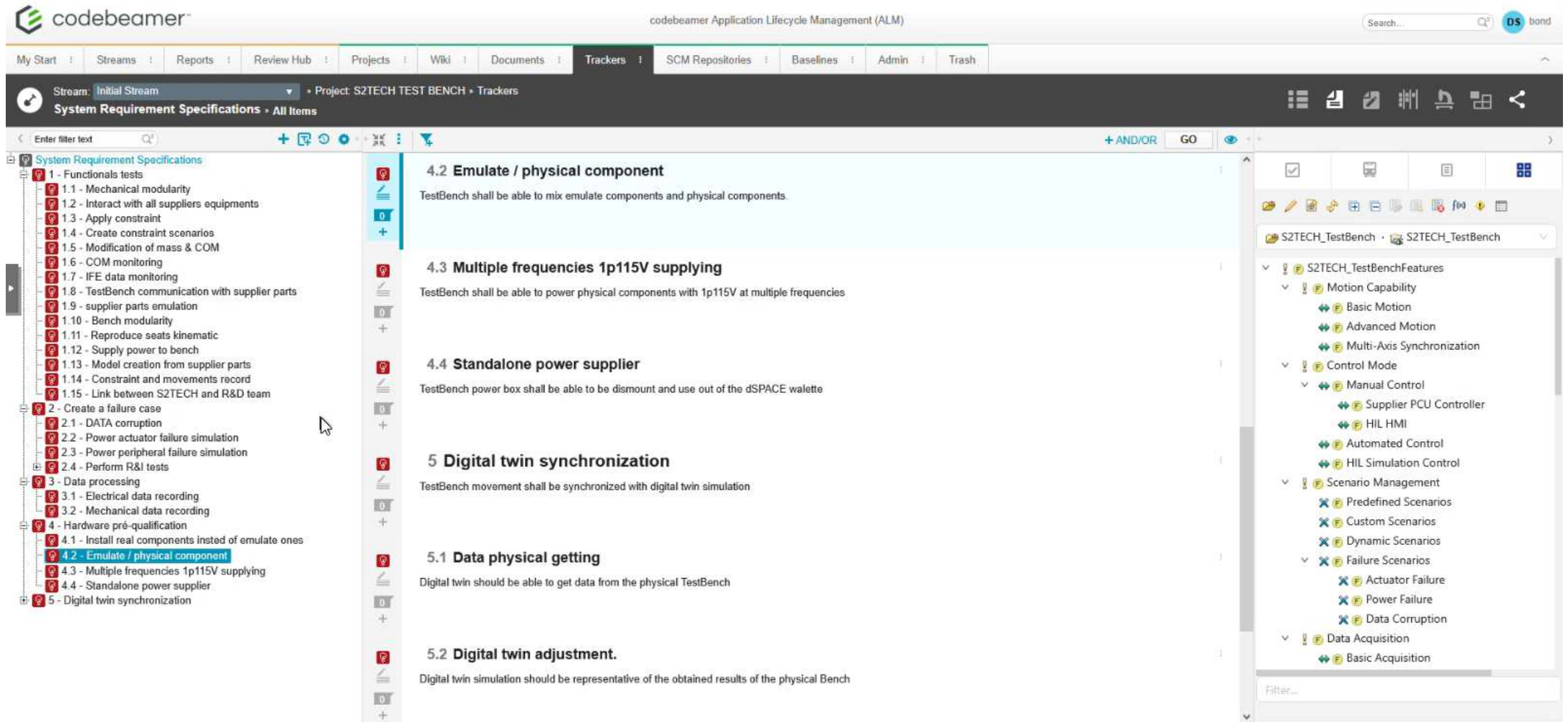
CODEBEAMER

- **ALM platform** built for complex **product development**
- End-to-end **traceability** across **requirements, risk, test**, and release management
- **Flexible templates** accelerate compliance and streamline audits.

PURE VARIANTS

- **PLE solution** that manages complexity across **product variants**
- **Systematic reuse** of **requirements** and **test cases** across your product family
- **Automated** and **traceable**
- **Centralized** variability and asset control

PLE & APPLICATION LIFECYCLE MANAGEMENT



The screenshot displays the codebeamer Application Lifecycle Management (ALM) web interface. The top navigation bar includes tabs for My Start, Streams, Reports, Review Hub, Projects, Wiki, Documents, Trackers, SCM Repositories, Baselines, Admin, and Trash. The current view is 'System Requirement Specifications' for the 'S2TECH TEST BENCH' project, showing 'All Items'.

The left sidebar lists a hierarchy of requirements:

- 1 - Functionals tests
 - 1.1 - Mechanical modularity
 - 1.2 - Interact with all suppliers equipments
 - 1.3 - Apply constraint
 - 1.4 - Create constraint scenarios
 - 1.5 - Modification of mass & COM
 - 1.6 - COM monitoring
 - 1.7 - IFE data monitoring
 - 1.8 - TestBench communication with supplier parts
 - 1.9 - supplier parts emulation
 - 1.10 - Bench modularity
 - 1.11 - Reproduce seats kinematic
 - 1.12 - Supply power to bench
 - 1.13 - Model creation from supplier parts
 - 1.14 - Constraint and movements record
 - 1.15 - Link between S2TECH and R&D team
- 2 - Create a failure case
 - 2.1 - DATA corruption
 - 2.2 - Power actuator failure simulation
 - 2.3 - Power peripheral failure simulation
 - 2.4 - Perform R&I tests
- 3 - Data processing
 - 3.1 - Electrical data recording
 - 3.2 - Mechanical data recording
- 4 - Hardware pré-qualification
 - 4.1 - Install real components insted of emulate ones
 - 4.2 - Emulate / physical component** (highlighted)
 - 4.3 - Multiple frequencies 1p115V supplying
 - 4.4 - Standalone power supplier
- 5 - Digital twin synchronization

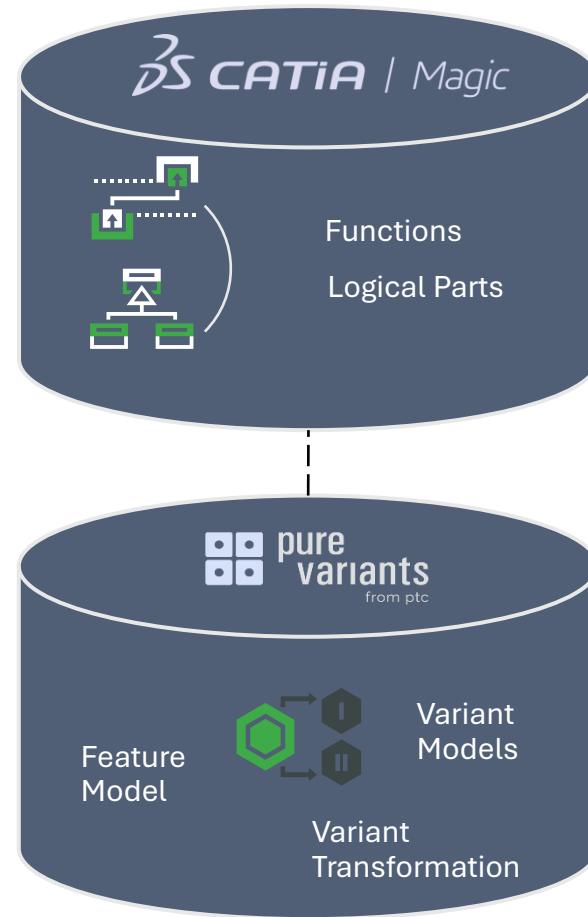
The main content area displays the details for the selected requirement, '4.2 Emulate / physical component', which states: 'TestBench shall be able to mix emulate components and physical components.' Below this, other requirements are listed:

- 4.3 Multiple frequencies 1p115V supplying**: TestBench shall be able to power physical components with 1p115V at multiple frequencies
- 4.4 Standalone power supplier**: TestBench power box shall be able to be dismount and use out of the dSPACE walette
- 5 Digital twin synchronization**: TestBench movement shall be synchronized with digital twin simulation
- 5.1 Data physical getting**: Digital twin should be able to get data from the physical TestBench
- 5.2 Digital twin adjustment.**: Digital twin simulation should be representative of the obtained results of the physical Bench

The right sidebar shows a tree view of the project structure, including 'S2TECH_TestBench' and 'S2TECH_TestBenchFeatures'. Under 'S2TECH_TestBenchFeatures', there are several sub-items:

- Motion Capability
 - Basic Motion
 - Advanced Motion
 - Multi-Axis Synchronization
- Control Mode
 - Manual Control
 - Supplier PCU Controller
 - HIL HMI
 - Automated Control
 - HIL Simulation Control
- Scenario Management
 - Predefined Scenarios
 - Custom Scenarios
 - Dynamic Scenarios
 - Failure Scenarios
 - Actuator Failure
 - Power Failure
 - Data Corruption
- Data Acquisition
 - Basic Acquisition

PLE & MODEL-BASED SYSTEMS ENGINEERING



CATIA MAGIC

- **MBSE Solution** built for complex **product development**
- **Multiple projects** enable architecture **composability**
- **Model Collaboration, Traceability and Model Execution** as enablers of Complex Systems Development

PURE VARIANTS

- **PLE solution** that manages complexity across **product variants**
- **Systematic reuse of system models** across your product family
- **Automated and traceable**
- **Centralized** variability and asset control

PLE & MODEL-BASED SYSTEMS ENGINEERING

CATIA | MagicDraw 2024x - S2TECH_TestBench_v5.0.mdzp [C:\Users\pure-systems\pure-variants-workspace-Snowmobile\Assets\]

File Edit View Layout Diagrams Options Tools Analyze Collaborate 3DEXPERIENCE Window Help

Perspective: Full Featured Create Diagram

Containment Diagrams Structure

Containment

- Mechanical Power
 - pour voir
 - Simulate and Emulate Digital SEATS
 - Simulate Digital SEATS Behavior
 - Simulate Physical SEATS
 - Acquire Data
 - Control Seat
 - Energize the system
 - Execute Test Scenarios
 - Generate Motion
 - Interact with humans
 - Test Physical Program SEATS
 - p1
 - p2
 - p3
 - p4
 - p5
- simulate and Emulate Digital SEATS multiphysics : Dossier Architecture Système:System Env
- simulate prototype physical SEATS : Dossier Architecture Système:System Env
- analyze Physical Performances : Dossier Architecture Système:System Env
- Energize the system : Dossier Architecture Système:System Env
- V&V Engineer : Dossier Architecture Système:System Env
- 3D SEAT Model : Dossier Architecture Système:System Env
- Architects : Dossier Architecture Système:System Env
- System Engineer : Dossier Architecture Système:System Env
- Electrical System Engineer : Dossier Architecture Système:System Env
- Passengers Body : Dossier Architecture Système:System Env
- Test Physical Program SEATS : Dossier Architecture Système:System Env
- Laboratory : Dossier Architecture Système:System Env
- Program Seats : Dossier Architecture Système:System Env
- Test Teams : Dossier Architecture Système:System Env
- pour voir : Dossier Architecture Système:Functional V
- Generate Motion : Dossier Architecture Système:Functional V
- Control Seat : Dossier Architecture Système:Functional V
- Execute Test Scenarios : Dossier Architecture Système:Functional V
- Acquire Data : Dossier Architecture Système:Functional V
- Interact with Users : Dossier Architecture Système:Functional V
- S2TECH_TestBenchFeatures_SystemConfiguration_Physical
- S2TECH_TestBenchFeatures_SystemConfiguration_Physical
- S2TECH_TestBenchFeatures_SystemConfiguration_Physical
- S2TECH_TestBenchFeatures_SystemConfiguration_Physical
- S2TECH_TestBenchFeatures_SystemConfiguration_Physical
- S2TECH_TestBenchFeatures_SystemConfiguration_Simulation
- S2TECH_TestBenchFeatures_SystemConfiguration_Simulation
- S2TECH_TestBenchFeatures_SystemConfiguration_Simulation
- S2TECH_TestBenchFeatures_SystemConfiguration_Simulation

Hyperlinks

Functional Behavior

Functional Model

Operational Needs

Environment New

Test Bench System Functionality

Criteria

Scope (optional): Operational Needs Filter: Y Context (optional): Drag elements from the Model Browser

#	Name	Text
1	Functional tests	TestBench shall be able to perform functionals tests
2	1.1 Link between S2TECH and R&D team	TestBench shall be able to use control command models from R&D teams
3	1.2 Constraint and movements record	TestBench shall be able to record all constraint and movements for further analysis
4	1.3 Mechanical modularity	TestBench shall be able to be equipped by all mechanical parts designed by R&D teams
5	1.4 Interact with all suppliers equipments	TestBench shall be able to interact with all suppliers equipments (IFE,...)
6	1.5 Apply constraint	TestBench shall be able to follow pré-defined constraint scenarios
7	1.6 Create constraint scenarios	TestBench shall be able to follow create quick constraint scenarios
8	1.7 Modification of mass & COM	Each part of the TestBench shall be able to feed the reals COM position and mass on all axis
9	1.8 COM monitoring	Each part of TestBench shall be able to perform real time monitoring of his center of mass position.
10	1.10 IFE data monitoring	TestBench shall be able to treat datas from few IFEs
11	1.11 TestBench communication with supplier parts	TestBench shall be able to communicate with supplier materials
12	1.12 supplier parts emulation	TestBench shall be able to emulate all supplier equipments
13	1.14 Bench modularity	TestBench shall be able to feat seat implementation
14	1.16 Reproduce seats kinematic	TestBench shall be able to reproduce seat kinematic
15	1.17 Supply power to bench	TestBench shall be able to supply power to bench actuators
16	1.18 Model creation from supplier parts	Users shall be able to easily create model from supplier parts
17	10 Create a failure case	TestBench shall be able to create a failure case scenarios
18	10.1 DATA corruption	TestBench shall be able to corrupt data on com links
19	10.2 Power actuator failure simulation	TestBench shall be able to cut power for each actuator
20	10.3 Power actuator failure simulation	TestBench shall be able to cut power for each

The table displays 41 of 41 total rows.

pure:variants

S2TECH_TestBench/S2TECH_TestBench

Select a Variant ...

- S2TECH_TestBenchFeatures
 - windchill:optiontype = 'SystemOption'
 - Motion Capability
 - Basic Motion
 - Advanced Motion
 - Multi-Axis Synchronization
 - Control Mode
 - Manual Control
 - Supplier PCU Controller
 - HIL HMI
 - Automated Control
 - HIL Simulation Control
 - Scenario Management
 - Predefined Scenarios
 - Custom Scenarios
 - Dynamic Scenarios
 - Failure Scenarios
 - Actuator Failure
 - Power Failure
 - Data Corruption
 - Data Acquisition
 - Basic Acquisition
 - Advanced Instrumentation
 - Force Measurement
 - Current Measurement
 - COM Monitoring
 - System Configuration
 - Simulated Components
 - SUPPLIERS Physical Components
 - Hybrid Configuration
 - User Interaction
 - Basic Interface
 - Advanced Interface
 - Digital Twin Integration
 - Data Synchronization
 - Co-Simulation

Show Description

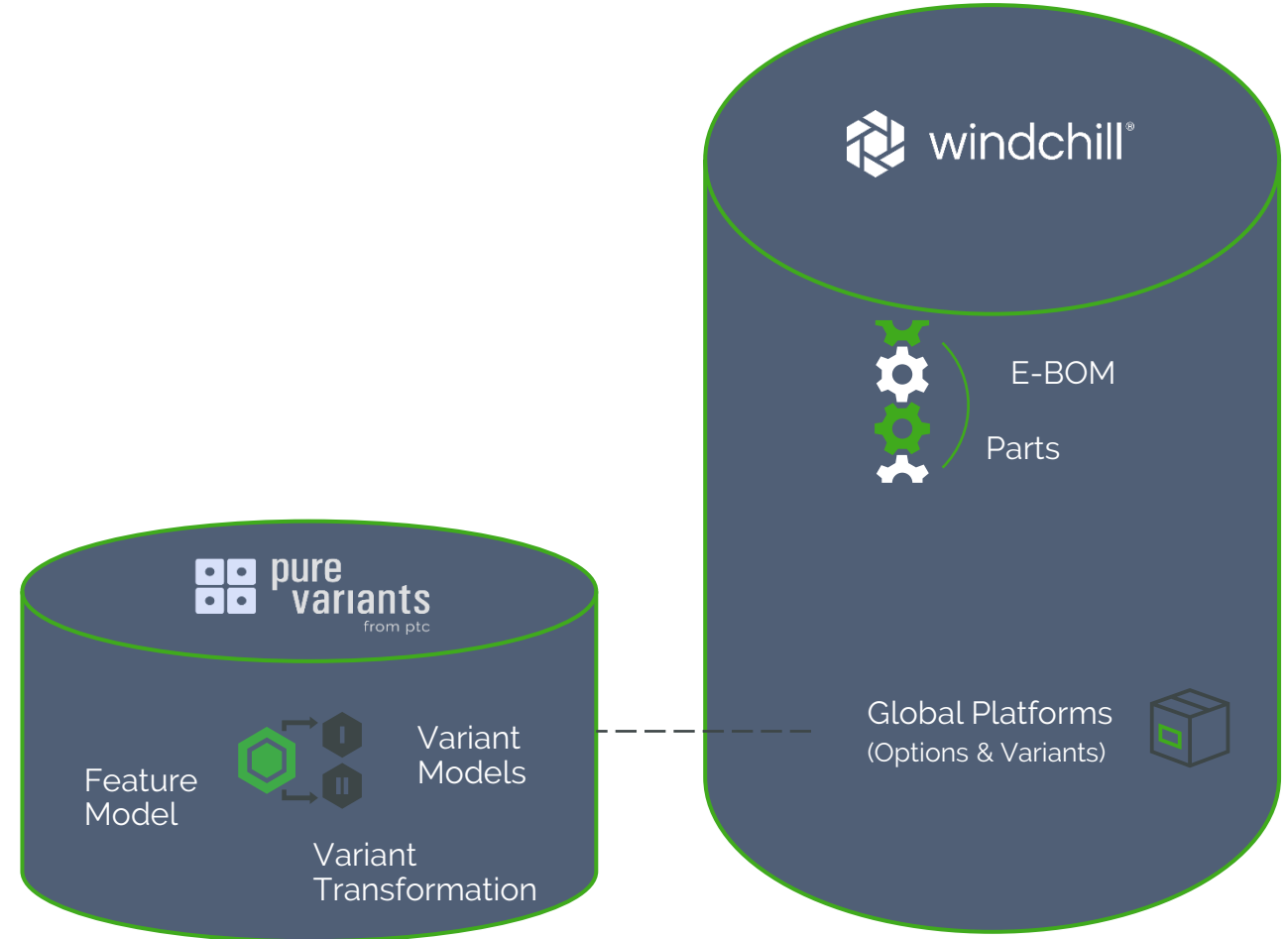
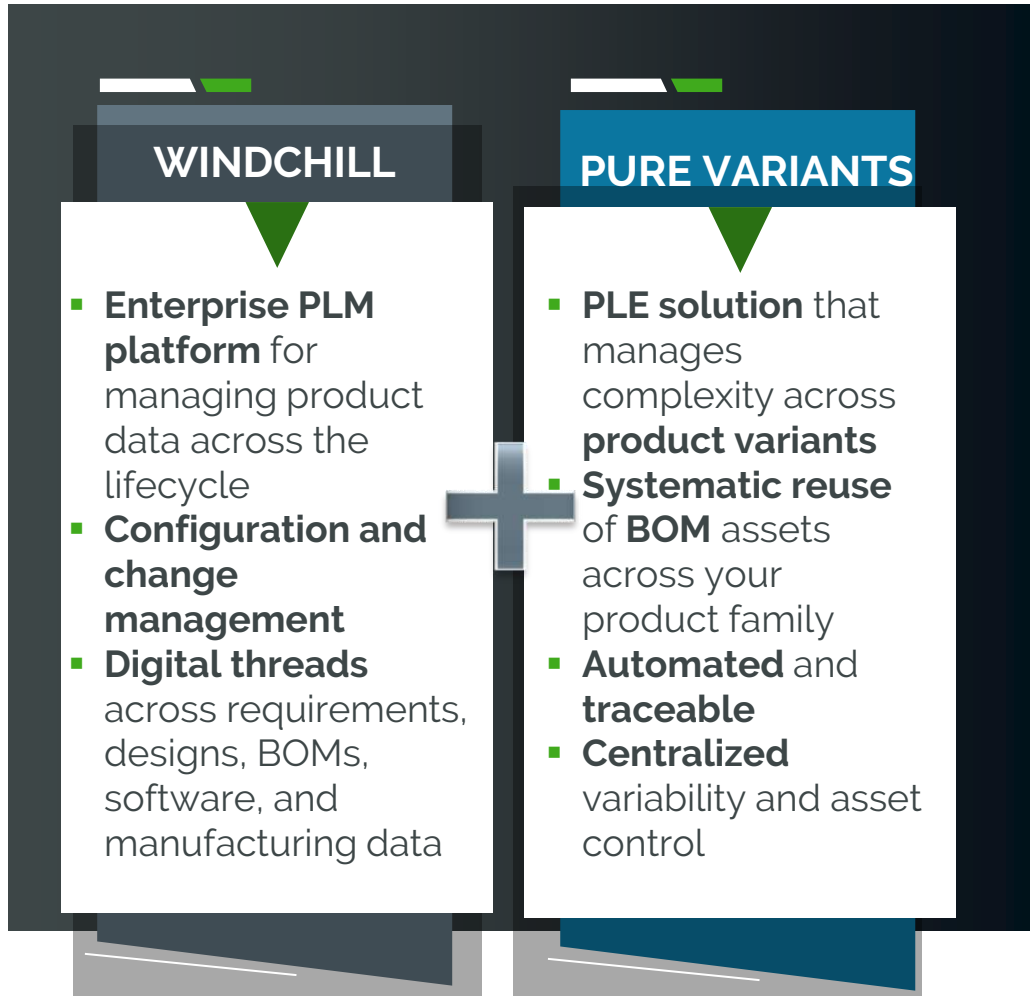
Status: 

Type here to filter

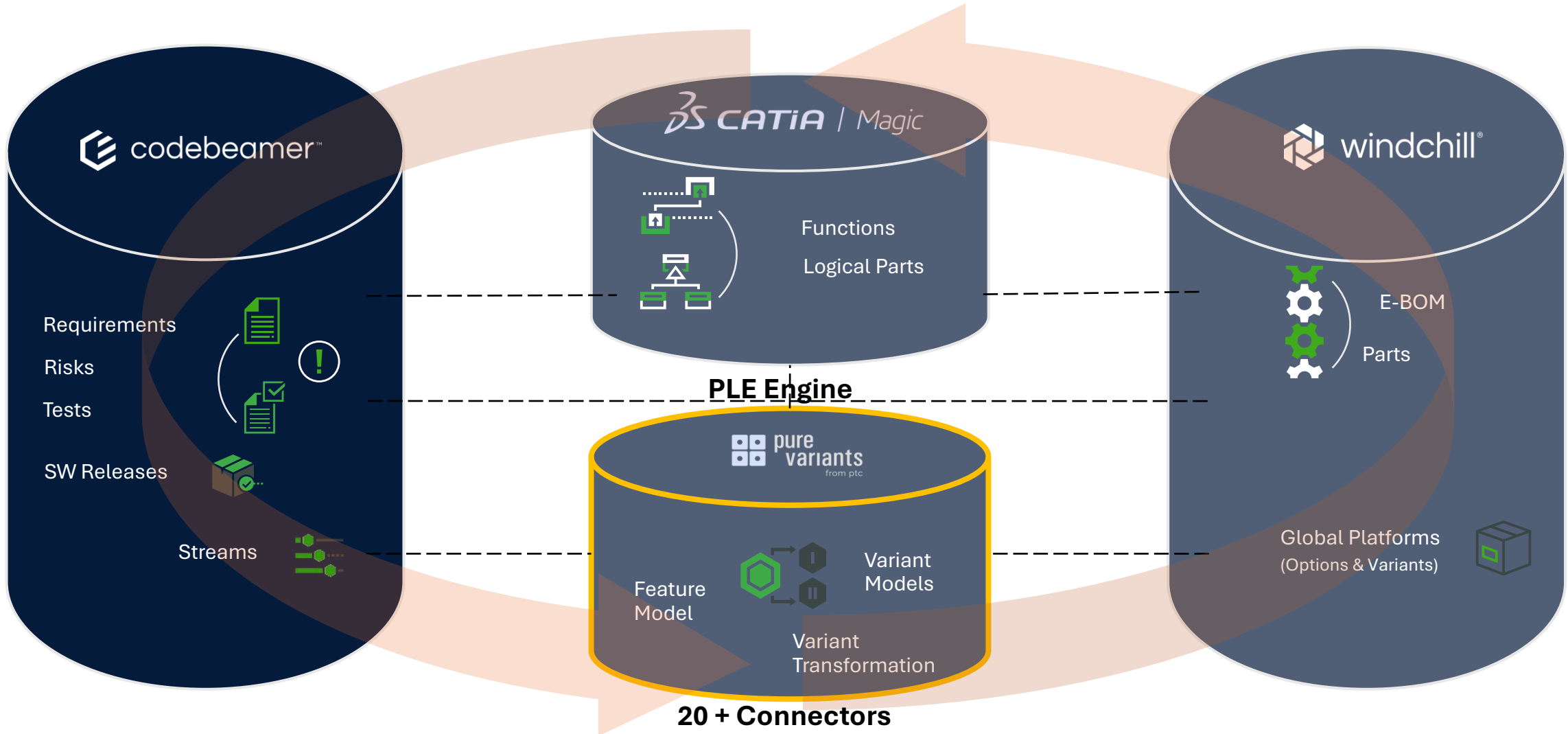
Ready

100% 3 W

PLE & PRODUCT LIFECYCLE MANAGEMENT



END-TO-END PRODUCT LINE ENGINEERING: BREAKING THE SILOS



Webinar205: Accelerating Aerospace & Defense Transformation with PLE: Lessons from Lockheed Martin, Safran Seats & PTC



April Luczywek

Lockheed Martin



Luca Palladino

Safran Seats



Marco Forlingieri

PTC

Q & A

Quick Reminders

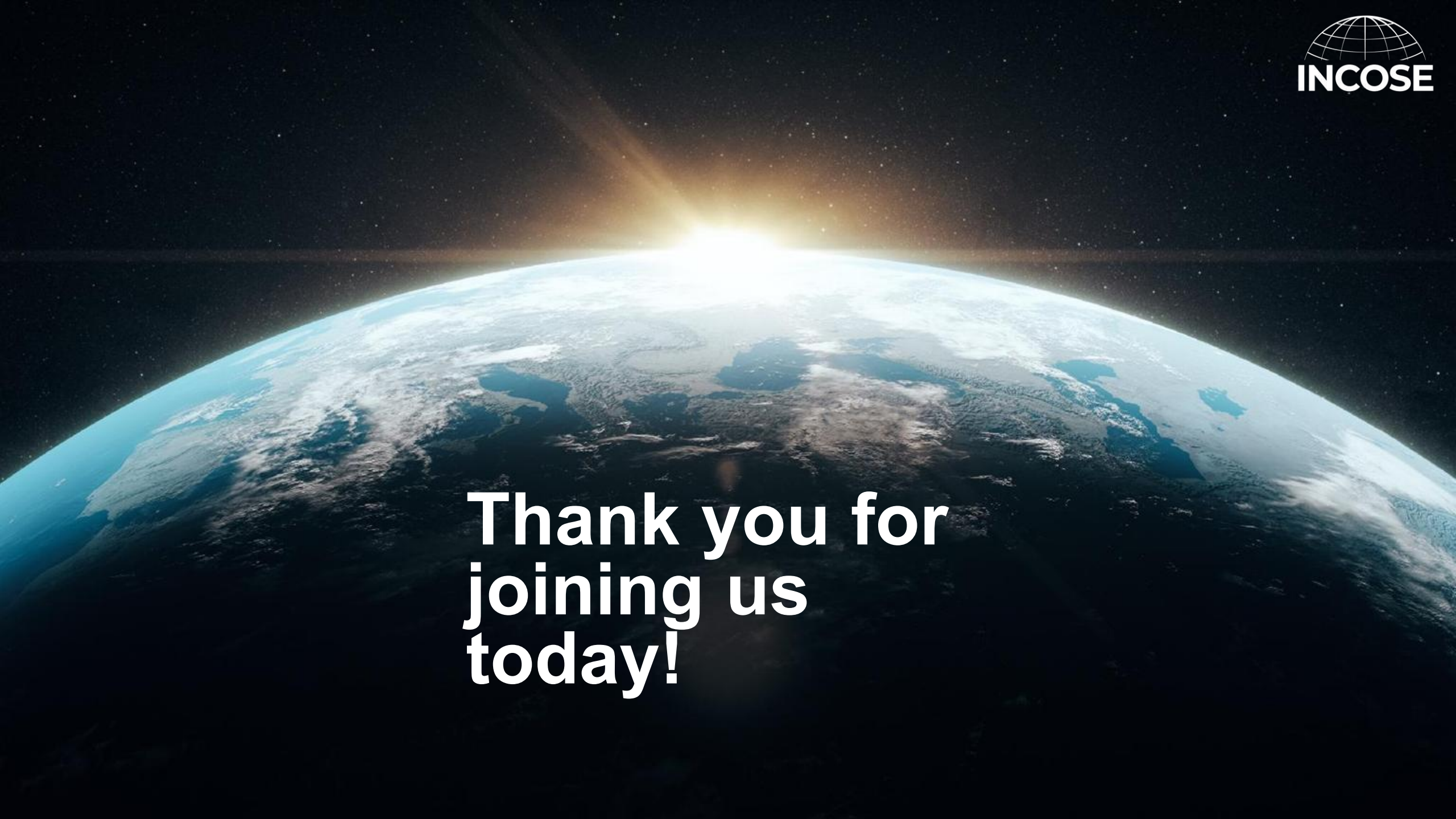
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