

AD PAG Digital Twin/Digital Thread Benchmark

PLM Road Map & PDT North America 2025

PLM Road Map™ & PDT North America 2025
PLM's Integral Role in Digital Transformation: From Strategy to Execution
Elevating PLM to an Enterprise system,
the PLM Professional's Role and Road Map to Success
CIMdata® May 7 & 8 -eurostep-



Value Potential of Digital Twins and Digital Threads

Results of Industry Research


Daniel Gladysz, PLM Business Architect, Moog Inc.
Member, AD PAG Digital Twin-Digital Thread Project Team

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Presenter's Profile


Daniel Gladysz , PLM Business Architect, Moog Inc.



- 30 years of experience in the Aerospace Engineering industry working for Moog
- Started his career in product engineering on aircraft flight controls and has held engineering management roles within the delivery, NPI, sustainment, operations, and customer-facing domains
- Experience working with on collaborative teams on both the authoring and consumer side of engineering data gives Dan a unique perspective into the challenges and limitations of disconnected data, and the opportunities that well-structured PLM architecture can offer
- Transitioned into PLM management in 2018 and is passionate about applying systems thinking in developing cutting edge solutions for digital transformation
- Holds a Mechanical Engineering degree from Rochester Institute of Technology

James Roche
Senior Director of PLM
Manufacturing

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Agenda

- Introduction
- Benchmark Plan
- Early Results
- What's Next
- Closing Remarks
- Q & A

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Aerospace & Defense PLM Action Group

Founded in February 2014

Mission

An association of aerospace & defense companies within CIMdata's globally recognized PLM Community Program, which functions as a **PLM advocacy group** to . . .

Members



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Project Workstreams

- PLM Technology Obsolescence Management
- Global Collaboration
- Model-based Definition (MBD)
- Multiple View Bill of Material (Multi-view BoM)
- Model-Based Systems Engineering (MBSE)
- Interoperability Standards
- Digital Twin/Digital Thread

Collaborative Research with Solution Providers

- Digital Thread
- Model-based Systems Engineering

Website: www.ad-pag.com

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AD PAG Digital Twin-Digital Thread Project

Purpose

- Define the objectives, requirements, and roadmaps for Digital Twin/Digital Thread solutions for creating and managing the digital representation of a product through the product lifecycle within the A&D ecosystem
- Identify, define and demonstrate use case level value propositions
- Validate benefits to the PLM ecosystem
 - Improved data portability and transparency of PLM events
 - Reduced operational friction resulting in lower operations costs
 - Improved product operational transparency resulted in improved safety, operational efficiencies, and product design

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AD PAG Digital Twin-Digital Thread Project

Approach

- Agile methods employed to publish at the speed of consensus
- Release five position papers addressing varying aspects of Digital Twin / Digital Thread concepts and capabilities related to the aerospace industry
 - Phase 1: Digital Twin/Thread – Research & Scoping
 - Phase 2: Digital Twin/Thread Position Paper
 - Phase 3: Digital Twin/Thread Business Architecture / Methodologies paper
 - Phase 4: Digital Twin/Thread Comparative Analysis of Industry Standards paper
 - ➔ ■ Phase 5: Value proposition of the Digital Twin/Digital Thread to the A&D industry
 - Phase 6: Forward-looking Digital Twin/Thread Strategy and Roadmap
 - Phase 7: Project Consolidation
- Scope the project to deliver value early and iterate
 - Scope to the A&D industry
 - Time box the effort to approximately 24 months

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Benchmark Plan

Objectives

Primary

1. A broad assessment of the capabilities of commercially available digital twin/digital thread solution offerings, including software and services
2. Mutual education and alignment of thought leaders from industry and leading solution providers on digital twin/digital thread use cases and solution strategies
3. Advancement of industry's awareness and understanding of the current practical value potential of digital twin/digital thread investment

Secondary

4. Content that will be useful for future engagement with standards organizations for enrichment of standards to address digital twin-digital thread requirements

Provide a generalized assessment of the state of the industry and not a competitive comparison between the benchmarked solutions

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Benchmark Plan

Approach

- Tailored Approach
 - Partner with other industry organizations
 - Invite participation of a broad community of solution providers
 - Capitalize on existing use case solutions
 - Natural selection of what is possible today from the virtually unlimited set of possibilities
 - Dramatically reduces the effort required to prepare and conduct the benchmark demonstrations
- Use Case Selection and Preparation
 - Compare the participating solution provider's use case library with the AD PAG's use case library
 - Select a set of use cases where there is a close match for demonstration
 - Default demonstration environment is that of the participating solution provider
 - Data sets, applications, computing and network infrastructure

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Benchmark Plan

Industry partners and participating solution providers

Collaboration with Industry Organizations

AIAA, Digital Engineering Integration Committee
 OMG, Digital Twin Consortium, A&D sub-team
 Prostep iViP, Collaborative Digital Twin (CDT) working group
 SAE International, G-31 Digital Communications Committee

- All have agreed to participate
- All have contributed use cases

Participating Solution Providers



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Benchmark Plan

What we are looking to learn

Switched mindset to a blended perspective of evaluation and collaborative mutual learning, i.e.,

- From “measuring how well it is done”
- To “understanding how it is done, what is real today, and where is it going”

Solution Provider Engagement

Part 1

1. Welcome and Meeting Objectives
2. Solution Strategy
3. Implementation Approach

Part 2

4. Use Case Demonstrations

*** Agenda Item 4 to be repeated for each use case ***

Part 3

5. Solution Provider’s View to the Future
6. A&D industry’s view of future
7. Wrap-Up

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Benchmark Plan

What we are sharing today – Early findings from Part 1 Engagement

Solution Strategy

- Solution strategy overview
- Digital twin and digital thread definitions
- Overview of implementation approach
- Solution architectures
- A&D-specific solution characteristics

Implementation Approach

- Customer engagement processes
- Adapting architecture to customer needs
- Roles and responsibilities
- Technical development and deployment

Solution Provider Engagement

Part 1

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2. Solution Strategy
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Part 2

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Part 3

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6. A&D industry’s view of future
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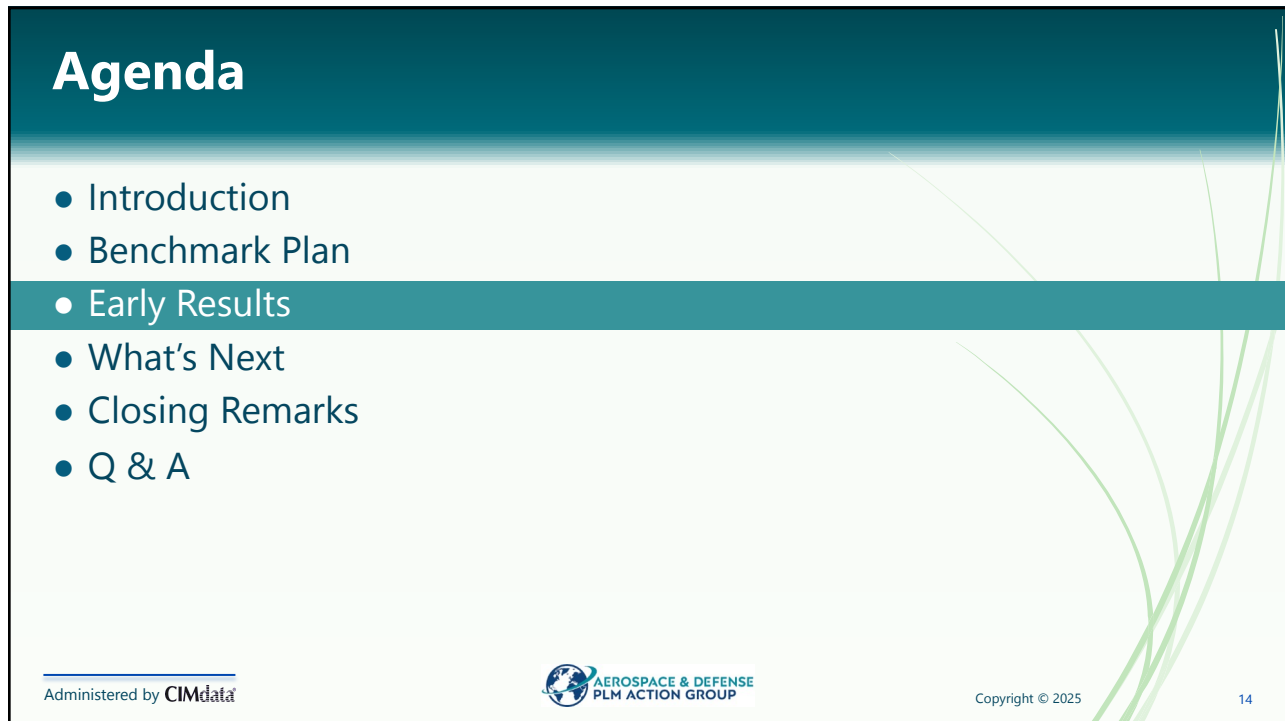
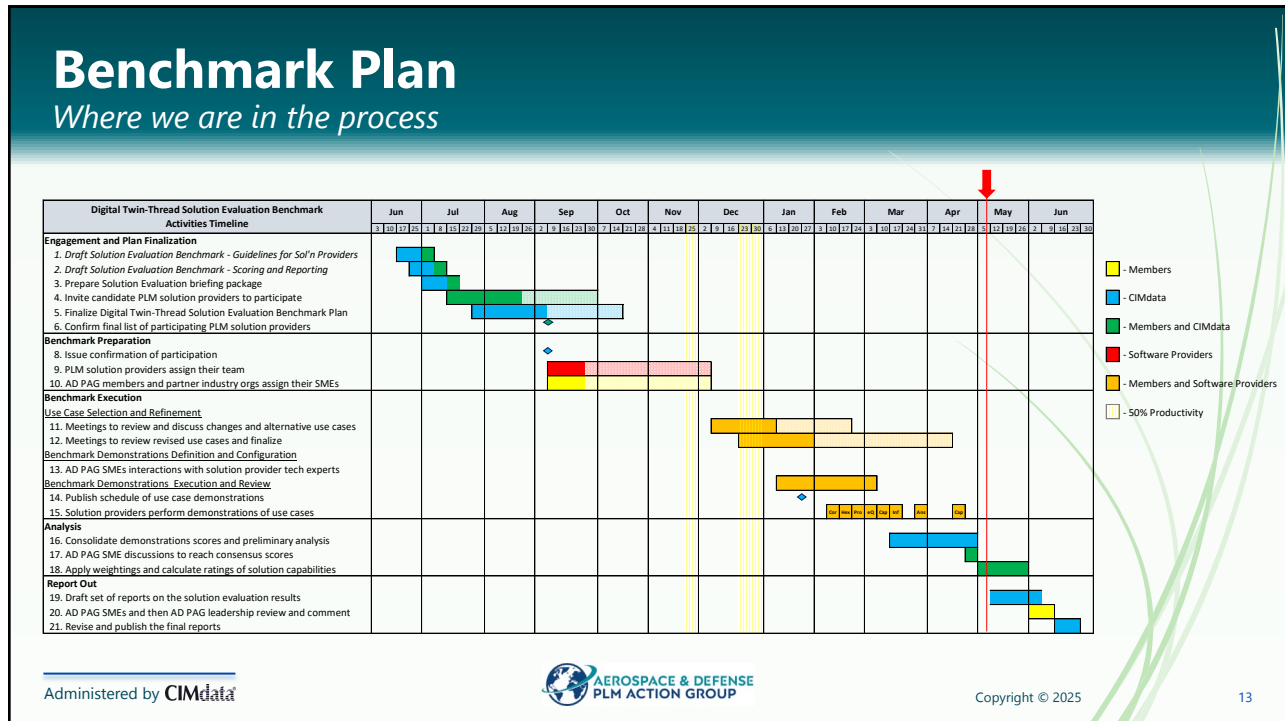


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Use Cases

Compilation of a rich set from diverse sources

Digital Twin Use Cases

Defined	
▪ AD PAG members	3
▪ Industry organizations	14
▪ Solution providers	<u>17</u>
Total	34

Digital Thread Use Cases

Defined	
▪ AD PAG members	23
▪ Industry organizations	5
▪ Solution providers	<u>29</u>
Total	57

Demonstrated 9²

Demonstrated 19²

Notes

1. Several use cases were demonstrated by multiple solution providers
2. In many instances, solution providers combined multiple use cases from AD PAG members and industry organizations into a single use case for demonstration
3. Over 60 hours of online evaluation sessions with the solution providers

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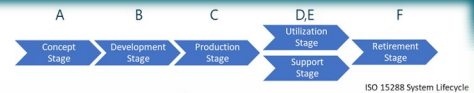


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Use Cases

Examples – Digital Twins



Contributing Organization	Unique Identifier	Title	Description	PLM Phase(s)
Industry Contributor	UCDtw001	Digital Twin Calibration	Validation/Calibration of digital twins based on real-world product operational data/conditions (e.g., coupon tests, wind tunnel tests, ground tests, flight tests, operational tests)	B
Industry Contributor	UCDtw003	Design optimization and Upgrade Analysis	Analyze product performance under various conditions and make adjustments in the virtual world to ensure that the next physical product will perform exactly as planned in the field.	B
AD PAG	UCDtw015	As-operated digital Twin	The As-Operated product digital twin is a digital representation of the aircraft in operation with the up-to-date configuration that simplifies access to the related data and services	E
AD PAG	UCDtw017	Airport Operations	Aircraft operators can incur costly delays and inefficiencies due to lack of service availability while on the ground, relating to airport layouts and gate/stand allocation (e.g., ground-power, connectivity – maintenance data offload and software part upload – payload logistics, and refueling).	E
PLM Solution Provider	UCDtw029	Global Collaboration with External Partners	Context related export use cases, data for manufacturing - release data only. / engineering change for CAD modification (check out data for lock) - product and production.	B

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Use Case

Examples – Digital Threads

Contributing Organization	Unique Identifier	Title	Description	PLM Phase(s)
Industry Contributor	UCDth002	Lifecycle BOM Management	Complete highly visual product definition driven from Computer-Aided Design (CAD) and other descriptive artifacts for comprehensive configuration management across the product lifecycle	A, B, C, E, F
Industry Contributor	UCDth007	Supply Chain Collaboration	Co-design connectivity across the supply chain for both the product and production	B, C, E
AD PAG	UCDth008	Support Product in Service	Capture, as closely as possible, the state of the product (i.e., configuration, maintenance and repair, operations) to provide adapted support (malfunction solving, repair solutions, etc.)	E
AD PAG	UCDth023	Digital Thread Design Certification	Certification of designs without multiple prototypes; the digital thread facilitates the digital twin design simulations and certification, replacing the need for constructing prototypes. A prototype is developed to validate digital twin simulation accuracy and to support the certification process.	A, B
PLM Solution Provider	UCDth038	Virtual Assembly	Using 3D geometry data of the real parts being manufactured to virtually predict the compliance of next assembly system; and subsequent corrective actions needed if not compliant	B, C

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Solution Providers Mapping

Use cases demonstrated

Digital Twin	Both	Digital Thread

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Solution Provider Comparison


Solution strategy

Initial Findings: To Be Verified

- ✓ Cross-Domain Lifecycle Traceability → design, engineering, manufacturing, operations, and sustainment
- ✓ System Integration Emphasis → criticality of PLM, ERP, MES, and simulation systems
- ✓ Security and Compliance Focus → role-based access controls, encryption, and regulation compliance
- ✓ Model-Based Systems Engineering (MBSE) → aligned to ensure system-level traceability and integration

- Strategic Focus Areas (differences)
 - Some heavily focus on simulation and validation
 - One emphasizes technical publication
 - Another specializes in virtualized data orchestration without heavy reliance on simulation or replication
- Primary Industry Solutions (differences)
 - Some balance defense and commercial lifecycle management
 - One is deeply focused on sustainment and training for A&D
 - Another emphasizes multi-OEM collaboration and standards compliance

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Solution Provider Comparison


Definition of digital twin and digital thread

Initial Findings: To Be Verified

- ✓ Definition of Digital Thread → a connected, traceable flow of data across the entire product lifecycle, linking design, manufacturing, sustainment, and service
- ✓ Definition of Digital Twin → a digital representation of a physical product, asset, or system enriched with real-world, simulation, or lifecycle data

- Nature of Digital Twin (differences)
 - Some stress simulation-based or event-driven dynamic twins
 - Another promotes an “information twin” focused on technical data evolution rather than physics-based performance

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Solution Provider Comparison

Solution implementation approach

Initial Findings: To Be Verified

- ✓ Agile and Iterative Implementation Approach → pilots, phased rollouts, co-development engagements
- ✓ Customization for Customer Needs → adaptable, configurable, templates, and adapters
- Implementation Methodology (differences)
 - Some adopt DevSecOps and CI/CD methodologies for continuous rollout
 - Others prefer agile pilot-based rollouts
 - Another favors phased integration aligned with standards like TISAX and S1000D
- Customer Role Emphasis (differences)
 - One heavily involves SMEs and business owners directly in modeling outcomes
 - Some emphasize engineering and quality domains
 - One aligns more with sustainment leads and documentation teams
- Handling of Legacy Systems (differences)
 - Some offer extensive legacy system support through adapters and non-invasive integration models
 - Others also support legacy but focus more on modernization through MBSE integration layers

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Solution Provider Comparison

Solution architecture

Initial Findings: To Be Verified

- ✓ Use of Scalable Architectures → modular, micro-services-based, or platform-centric, capable of cloud, on-premises, or hybrid deployments
- Integration Model (differences)
 - Some emphasize direct simulation-platform linkages
 - One uses no-code, live data virtualization, avoiding data lakes
 - Another focuses on open standards and neutral data models
 - Another relies on reference architectures and predefined accelerators
- Architectural Flexibility (differences)
 - Some highlight no-code/low-code configurability and containerized, cloud-native models
 - Others focus on event-driven, simulation-intensive hybrid models with robust connectors
- Tool and Platform Dependencies (differences)
 - One promotes tool-agnostic integration
 - Another tightly couples with simulation platforms
 - Another utilizes a mix of enterprise PLM/ALM tools and cloud analytics platforms

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Solution Provider Comparison

A&D-specific solution characteristics

**Initial Findings:
To Be Verified**

- ✓ Support of Aerospace & Defense (A&D) → each solution addresses industry requirements like compliance workflows, certification traceability, high-fidelity validation, and legacy system integration
- Standards and Compliance Orientation (differences)
 - Several have strong alignment to aerospace standards like S1000D and ISO 9001
 - Another emphasizes secure, flexible architectures over rigid compliance frameworks

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What's Next

Wrapping up a 1-year effort



Event	Status, Target Dates
Solution demonstrations	Completed on 23 Apr
Presentation of early findings	7 & 13 May
Analysis	30 May
Report release	27 Jun

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* Prostep iVIP Symposium 2025

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Closing Remarks

Initial observations

- Surprising level of difficulty, time and effort to reach agreement and document demonstration use cases
- Assembling a rich catalogue of digital twin and digital thread use cases was an unanticipated deliverable of the project
- The exposure and learning gained by the team was outstanding, and somewhat unexpected
- Appreciation for broad range of perspectives for digital twin and digital thread
- Digital twin and Digital thread implementations are not prescriptive
- Hard to comprehend and assess the far-ranging capabilities in 'limited timeframe'
 - Even 60 hours of demonstrations seems like barely enough to do the subject justice

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To Learn More...

- Access A&D PLM Action Group resources at QR code below
 - A&D PLM Action Group Model-Based Systems Engineering Research, report, Dec 2024
 - Digital Twin-Thread: Phase 4 – A&D Industry Digital Twin/Digital Thread Standards, position paper, Nov 2023
 - A&D PLM Action Group Digital Thread Collaborative Research, report, Aug 2023
 - Digital Twin-Thread: Phase 3 – Business Architecture Frameworks/Methodologies, position paper, Feb 2023
 - Digital Twin-Thread: Phase 2 – Problem, Objectives, Proposed Definitions, position paper, Jul 2022
- Access CIMdata resources at www.CIMdata.com
 - Promise and Reality of the Digital Thread - Results of Industry Research, webinar, Mar 2023
 - Multi-view BOM Value Potential, webinar, Apr 2022
 - The Digital Thread is Really a Web, with the Engineering Bill of Materials at Its Center, webinar, Sep 2021
- Contact for further discussion
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