Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Agenda

- Introduction
- Benchmark Plan
- Use Cases
- Demonstration Results
- Concluding Remarks
- Q & A

3

Presenter's Profile

James Roche
Vice President, Aerospace & Defense Practice

At CIMdata

- Leads the creation and delivery of CIMdata's offerings for Aerospace & Defense industrial clients.
- Facilitates the Aerospace & Defense PLM Action Group, an advocacy group that sets the direction for the industry on PLM-related topics.

Previously

- Founded and managed PLM practices at CSC Consulting and at A.T. Kearney; delivering solutions for international clients in aero, auto, consumer products, high tech, and medical devices industries.
- With EDS, was chief architect for General Motors' global engineering systems modernization, and managed EDS' PLM delivery resources.

Education

- BS in Physics from Worcester Polytechnic Institute
- Post-graduate studies in Mechanical and Materials Engineering at Wayne State University and the University of Rochester

4

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Aerospace & Defense PLM Action Group

CIMdata

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

AIRBUS, BOEING, Bombardier, EATON, GE Aviation, GKN AEROSPACE, Gulfstream, Honda Jet, MOOG, Rolls-Royce, RTX (COLLINS AEROSPACE, PRATT & WHITNEY, RAYTHEON), SAFRAN

Project Workstreams

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

Research with Solution Providers

- Digital Thread
- Model-based Systems Engineering

Website: www.ad-pag.com

5

Key Takeaways

CIMdata

Value Potential of Digital Twins and Digital Threads—Research Findings

- Solution architectures are evolving from connectors to a virtual data landscape
- The role of the major PLM platform solutions is being challenged and redefined by more open, federated, and data-centric architectures
- Critical prerequisites for success include open standards for interoperability and robust data governance
- Persistent challenges and industry gaps include legacy system integration, long-term maintainability, and organizational readiness
- AI & ML have transitioned from conceptual ideas to practical enablers

6

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Agenda

- Introduction
- Benchmark Plan
- Use Cases
- Demonstration Results
- Concluding Remarks
- Q & A

7

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 36 months

8

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Benchmark Plan

CIMdata

Objectives

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

Provide a generalized assessment of the state of the industry and <u>not</u> a competitive comparison between the benchmarked solutions

9

Benchmark Plan

CIMdata

Execution strategy

Recognizing the breadth and the state of maturity of the topic, the benchmark inquiry was not focused solely on "measuring how well it is done" but more broadly on "understanding

- ***how*** it is done,
- ***what*** is real today, and
- ***where*** it is 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

10

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Benchmark Plan

CIMdata

Industry partners and participating solution providers

Industry Organization Partners

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 contributed use cases from their internal project libraries

Contributed 25 of the 80 use cases in the project Use Case Catalog

Participating Solution Providers

Ansys part of Synopsys

Capgemini

Cortona3D

eQ Technologic

HEXAGON

Infosys

PROSTEP

Contributed 24 use cases

Demonstrated 28 use cases from the project Use Case Catalog

11

Agenda

CIMdata

- Introduction
- Benchmark Plan
- Use Cases
- Demonstration Results
- Concluding Remarks
- Q & A

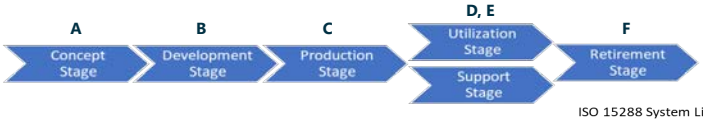
12

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Demonstration Use Cases

9 Digital Twin Use Cases—spanning the lifecycle



ISO 15288 System Lifecycle

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Material Modelling Twins As-Built Part / Component Twins for Quality						
Understanding the Performance of a Solar Aircraft Using Digital Twin						
OpenPDM - Bi-directional CAD integration between different vendor PLM's						
Virtual Commissioning Automotive Demonstrator for Body-in-White Assembly						
OpenDXM GlobalX - Collaboration with external partners						

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Model-Based Systems Engineering (MBSE) and Digital Twin Realization of a Drone						
Echo Digital Twin Application Development Framework – YVR & Pearson						
Battery Package Assembly Demonstrator for Creation of an Assembly Concept						
Modelling of Complex Multi-Fidelity, Multi-Domain, System-of-Systems (SoS) Mission						

Key: Create, Consume, Both

13

Demonstration Use Cases

19 Digital Thread Use Cases—spanning the lifecycle

Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Design of Axial Compressor for Gas Turbine Engine						
Collaborative System Engineering						
Cross System/Domain Impact Analysis						
Cameo PLM Integration						
Cross-Discipline Engineering						
Model-Based Systems Engineering and Associated Topics						
End2End Additive Manufacturing						
Virtual Quality Assurance						
Solution Architecture Model						
Integrated Enterprise Configuration Lifecycle Management and Baselining						

Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Digital Engineering Certification Solution (DECS)						
A Day in the Life of Data Workers with an Automated Digital Thread						
Long-Term Data Archival and Retrieval						
Generation, Configuration Management, and Impact Assessment of the Digital						
Virtual Assembly						
Production and Support						
Concession Management						
Technical Documentation in the Digital Thread						
Interactive Production and Maintenance						

14

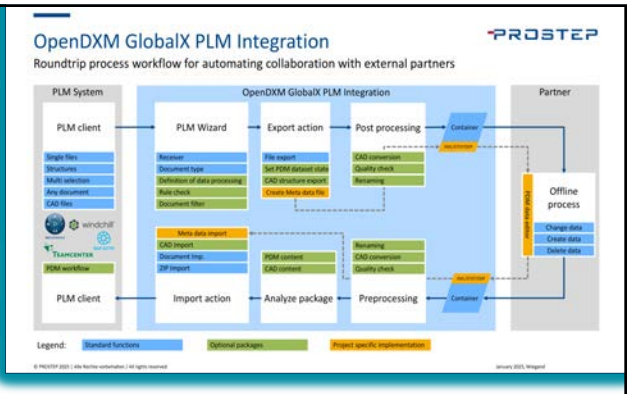
Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Demonstration Use Case

9 Digital Twin Use Cases—spanning the lifecycle

A Concept Stage → B Development Stage → C Production Stage



Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Material Modelling Twins As-Built Part / Component Twins for Quality						
Understanding the Performance of a Solar Aircraft Using Digital Twin						
OpenPDM - Bi-directional CAD integration between different vendor PLM's						
Virtual Commissioning Automotive Demonstrator for Body-in-White Assembly						
OpenDXM GlobalX - Collaboration with external partners						

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Model-Based Systems Engineering (MBSE) and Digital Twin Realization of a Drone						
Echo Digital Twin Application Development Framework – YVR & Pearson						
Battery Package Assembly Demonstrator for Creation of an Assembly Concept						
Modelling of Complex Multi-Fidelity, Multi-Domain, System-of-Systems (SoS) Mission						

Key: Create, Consume, Both

15

Demonstration Use Case

9 Digital Twin Use Cases—spanning the lifecycle

A Concept Stage → B Development Stage → C Production Stage

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Material Modelling Twins As-Built Part / Component Twins for Quality						
Understanding the Performance of a Solar Aircraft Using Digital Twin						
OpenPDM - Bi-directional CAD integration between different vendor PLM's						
Virtual Commissioning Automotive Demonstrator for Body-in-White Assembly						
OpenDXM GlobalX - Collaboration with external partners						

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Model-Based Systems Engineering (MBSE) and Digital Twin Realization of a Drone						
Echo Digital Twin Application Development Framework – YVR & Pearson						
Battery Package Assembly Demonstrator for Creation of an Assembly Concept						
Modelling of Complex Multi-Fidelity, Multi-Domain, System-of-Systems (SoS) Mission						

Key: Create, Consume, Both

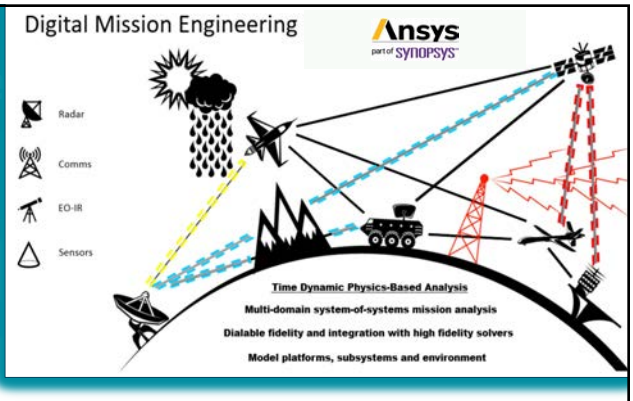
16

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Demonstration Use Case

9 Digital Twin Use Cases—spanning the lifecycle



A Concept Stage → B Development Stage → C Production Stage

Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Material Modelling Twins As-Built Part / Component Twins for Quality						
Understanding the Performance of a Solar Aircraft Using Digital Twin						
OpenPDM - Bi-directional CAD integration between different vendor PLM's						
Virtual Commissioning Automotive Demonstrator for Body-in-White Assembly						
OpenDXM GlobalX - Collaboration with external partners						

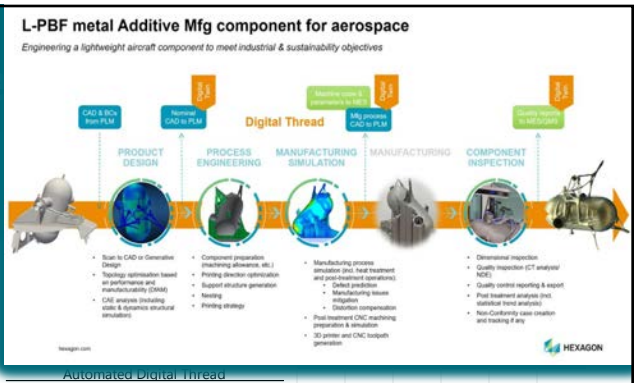
Digital Twin Use Case	Lifecycle Stage A	B	C	D	E	F
Model-Based Systems Engineering (MBSE) and Digital Twin Realization of a Drone						
Echo Digital Twin Application Development Framework – YVR & Pearson						
Battery Package Assembly Demonstrator for Creation of an Assembly Concept						
Modelling of Complex Multi-Fidelity, Multi-Domain, System-of-Systems (SoS) Mission						

Key: Create, Consume, Both

17

Demonstration Use Case

19 Digital Thread Use Cases—spanning the lifecycle



Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Design of Axial Compressor for Gas Turbine Engine						
Collaborative System Engineering						
Cross System/Domain Impact Analysis						
Cameo PLM Integration						
Cross-Discipline Engineering						
Model-Based Systems Engineering and Associated Topics						
End2End Additive Manufacturing						
Virtual Quality Assurance						
Solution Architecture Model						
Integrated Enterprise Configuration Lifecycle Management and Baselining						
Automated Digital Thread						
Long-Term Data Archival and Retrieval						
Generation, Configuration Management, and Impact Assessment of the Digital						
Virtual Assembly						
Production and Support						
Concession Management						
Technical Documentation in the Digital Thread						
Interactive Production and Maintenance						

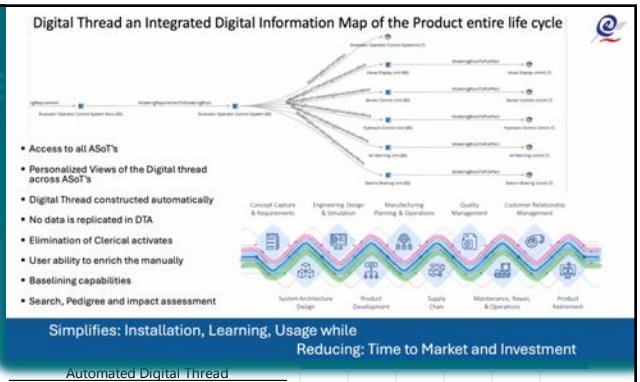
18

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Demonstration Use Case

19 Digital Thread Use Cases—spanning the lifecycle

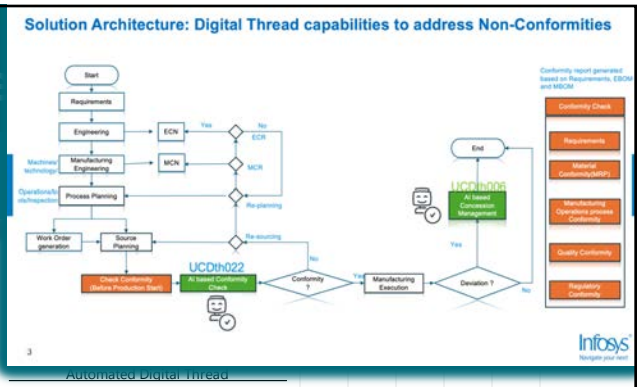


Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Design of Axial Compressor for Gas Turbine Engine						
Collaborative System Engineering						
Cross System/Domain Impact Analysis						
Cameo PLM Integration						
Cross-Discipline Engineering						
Model-Based Systems Engineering and Associated Topics						
End2End Additive Manufacturing						
Virtual Quality Assurance						
Solution Architecture Model						
Integrated Enterprise Configuration Lifecycle Management and Baselining						
Automated Digital Thread						
Long-Term Data Archival and Retrieval						
Generation, Configuration Management, and Impact Assessment of the Digital						
Virtual Assembly						
Production and Support						
Concession Management						
Technical Documentation in the Digital Thread						
Interactive Production and Maintenance						

19

Demonstration Use Case

19 Digital Thread Use Cases—spanning the lifecycle



Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Design of Axial Compressor for Gas Turbine Engine						
Collaborative System Engineering						
Cross System/Domain Impact Analysis						
Cameo PLM Integration						
Cross-Discipline Engineering						
Model-Based Systems Engineering and Associated Topics						
End2End Additive Manufacturing						
Virtual Quality Assurance						
Solution Architecture Model						
Integrated Enterprise Configuration Lifecycle Management and Baselining						
Automated Digital Thread						
Long-Term Data Archival and Retrieval						
Generation, Configuration Management, and Impact Assessment of the Digital						
Virtual Assembly						
Production and Support						
Concession Management						
Technical Documentation in the Digital Thread						
Interactive Production and Maintenance						

20

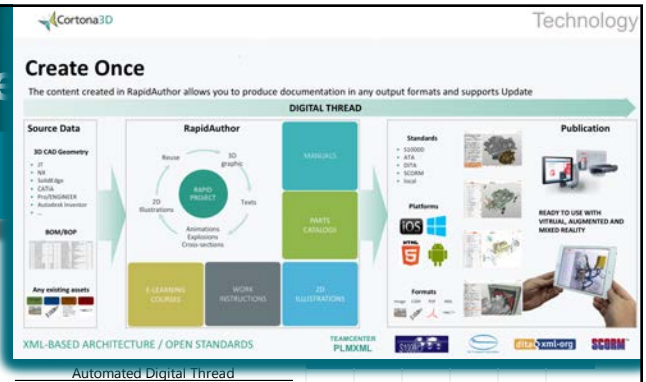
Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Demonstration Use Case

19 Digital Thread Use Cases—spanning the lifecycle

Digital Thread Use Case	Lifecycle Stage A	B	C	D	E	F
Design of Axial Compressor for Gas Turbine Engine						
Collaborative System Engineering						
Cross System/Domain Impact Analysis						
Cameo PLM Integration						
Cross-Discipline Engineering						
Model-Based Systems Engineering and Associated Topics						
End2End Additive Manufacturing						
Virtual Quality Assurance						
Solution Architecture Model						
Integrated Enterprise Configuration Lifecycle Management and Baselining						
Automated Digital Thread						
Long-Term Data Archival and Retrieval						
Generation, Configuration Management, and Impact Assessment of the Digital						
Virtual Assembly						
Production and Support						
Concession Management						
Technical Documentation in the Digital Thread						
Interactive Production and Maintenance						



21

Agenda

CIMdata

- Introduction
- Benchmark Plan
- Use Cases
- Demonstration Results
- Concluding Remarks
- Q & A

22

Use Case Demonstrations

CIMdata

Evaluation dimensions and rating scale

Evaluation Dimensions

Use Case Goal
The intended outcomes and business value

Use Case Actions
The standard sequence of actions and their corresponding outcomes

Robustness
The ability of a system or solution to consistently perform well under various conditions

Ease of Use
The simplicity and intuitiveness of the system or solution

Adaptability
The ability to adjust in response to changing requirements, environments, or user needs

Rating Scale

0-Not shown

1-Minimally meets requirement

2-Mostly meets requirement

3-Meets requirement

4-Exceeds requirement

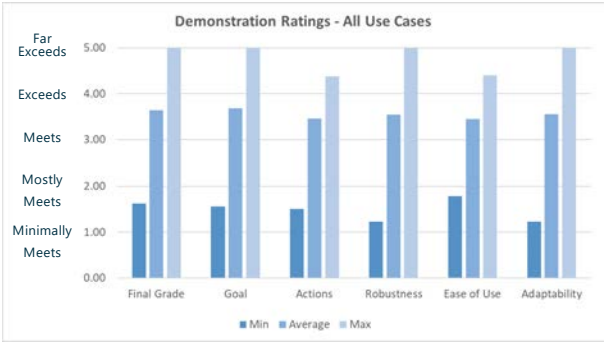
5-Far exceeds requirement

23

Use Case Demonstrations

CIMdata

Results – All use cases



- The demonstration ratings show an overall positive outcome
- Average scores above 3.0, indicate that most use case demonstrations met or exceeded expectations in all evaluation categories
- Minimum scores between 1.0 and 2.0 suggests that a few demonstrations fell short of expectations
- Most solution demonstrations were viewed as mature and strategically aligned
- Some solution demonstrations prompted concerns regarding their practical readiness and quality of execution

24

Use Case Demonstrations

CIMdata

Summary assessment of value (1 of 2)*

- Evaluator ratings
  - Overall, demonstrations were rated as exceeding requirements
  - Individual provider demonstrations rated from meets to far exceeds
- Participants emphasized that
  - The collective learning experience and cross-industry exposure were invaluable
  - Providing insights that could only be gained through a collaborative benchmark of this kind
- The sessions fostered a clearer understanding of where the industry stands today revealing both technical progress and conceptual divergence

*Twelve senior domain experts from AD PAG member companies served as demonstration evaluators

25

Use Case Demonstrations

CIMdata

Summary assessment of value (2 of 2)

- Across all sessions, the collective experience offered exceptional educational value and industry insight
  - Evaluators described the demonstrations as "impressive" and "convincing," though not all were at the same level of maturity or completeness
- While no single provider offered a complete Dtw-Dth platform, the collective demonstrations
  - Provided critical comparative insights
  - Revealed emerging best practices
  - Reaffirmed the collaborative benchmark's value as a unique industry learning experience

26

Agenda

- Introduction
- Benchmark Plan
- Use Cases
- Demonstration Results
- Concluding Remarks
- Q & A

27

Concluding Remarks

Key findings (1 of 2)

- Divergent strategies
  - Focused Solutions – These providers offer deep, mature capabilities in a specific domain (e.g., simulation-led design, technical publications, or metrology)
  - General Solutions – These providers focus on the broader challenge of connecting disparate enterprise systems (PLM, ALM, MES, ERP) to create a cohesive data thread
- Architectural evolution from connectors to virtual-data-landscape
  - Move from point-to-point integrations towards more sophisticated architectural patterns
  - Concept of a federated digital fabric, tapestry or web

28

Concluding Remarks

CIMdata

Key findings (2 of 2)

- Role of the major PLM platform solutions
  - Foundational but evolving within the broader Dth and Dtw ecosystem
  - Continues to serve as the authoritative source for 'as-designed' product data and the backbone for configuration and change management
  - Its position as the central program hub is increasingly being challenged and redefined by more open, federated, and data-centric architectures
- Pragmatic integration of AI
  - AI and ML have transitioned from conceptual ideas to practical enablers for advanced Dtw-Dth functionalities. Applications are concrete and focused on delivering specific business value

29

Concluding Remarks

CIMdata

Critical prerequisites for success (1 of 2)

- Integrated multi-domain models
  - The ability to connect models from various domains (e.g., design, cost, supply chain, physics-based simulation) is essential for holistic analysis
- PLM-MES integration
  - A seamless, bidirectional link between the PLM system ('as-designed/as-architected') and the MES ('as-manufactured/as-built') is fundamental
- Open standards and interoperability
  - A reliance on open, neutral standards (e.g., STEP, JT, OpenUSD) is crucial for avoiding vendor lock-in and ensuring long-term data exchangeability and collaboration across the ecosystem

30

Concluding Remarks

CIMdata

Critical prerequisites for success (2 of 2)

- Robust data governance and archival
  - For industries like A&D, a strategy for archiving and accessing data for decades is a non-negotiable requirement
  - The long-term effort required to maintain a complex web of connected data sources and data models as underlying systems evolve is substantial and must be sustained
- Organizational Readiness
  - The technology is often more mature than the organization's ability to adopt it
  - The A&D industry's readiness, while growing, is still in its early stages

31

What is the Business Opportunity?

CIMdata

How the PLM Economy can best support these requirements

- Technology providers' future competitive edge
  - Move from point-to-point integrations for importing data to enablement of a virtual-data-landscape
  - Enable expansive implementations of threads, twins and AI with open architectures
- Service providers' future competitive edge
  - Advanced methods for planning, designing, building, deploying and reskilling
  - Advanced methods for integrating multi-domain models and heterogeneous data sources

32

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026

Thank You to Those Who Worked With Us

For contributing their knowledge and effort to this important work

Partnering Organizations

AIAA

prostep ivip

SAE INTERNATIONAL

Participating Solution Providers

Ansys part of SYNOPSYS

Capgemini

Cortona3D

eQ Technologic

HEXAGON

Infosys

PROSTEP integrate the future

33

To Learn More...

- Access A&D PLM Action Group resources at QR code below
  - Digital Twin-Digital Thread Use Case Catalog, Mar 2026
  - Digital Twin-Digital Thread Solution Evaluation Benchmark Report of Findings, Dec 2025
  - Model-Based Systems Engineering Research, report, Dec 2024
  - Digital Twin-Thread: Phase 4 – A&D Industry Digital Twin/ Thread Standards, position paper, Nov 2023
  - 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
  - Digital Threads and Twins In Theory and In Practice: Benchmarked Industry Use Cases, webinar, 9 Apr 2026
  - The What and Why of Digital Threads and Twins - A Report from the Field, webinar, Mar 2025
  - How to Build Out an Enterprise Digital Web, webinar, Mar 2024
  - 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 BoM at Its Center, webinar, Sep 2021

34

Questions & Answers

CIMdata

What's on your mind?

35

Thank You

CIMdata

36

Value Potential of Digital Twins and Digital Threads

2026 Market & Industry Forum—9 April 2026