

Digital Thread: Why Should We Care

PLM Road Map™ & PDT Europe 2023—15 November 2023

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PLM Road Map™ EMEA & PDT Europe 2023
The Digital Thread in a Heterogeneous, Extended Enterprise Reality
A call for PLM Professionals to share their knowledge & experience
15 & 16 November **eurostep**

**Digital Thread:
Why Should We Care?**
PLM Road Map™ &
PDT Europe 2023

15 November 2023—Paris, FRANCE

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Maximizing clients' ability to design, acquire, deliver,
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CIMdata's Services

Strategic advice & counsel through a comprehensive & integrated set of services

- RESEARCH**
Foresight
 - Research & analysis
 - Technology evaluations
 - Market-specific insights
 - Industry news & trends
- EDUCATION**
Leadership
 - Industry conferences
 - Seminars & webinars
 - Certificate programs
 - Best practices
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Success • Invest • Transformation
 - Strategic guidance
 - Aligning solutions with needs
 - Program management advisement
 - Market positioning

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Peter A. Bilello, President & CEO


Professional background

- More than 35 years of experience in the development of IT solutions for research, engineering, and manufacturing organizations worldwide
- Led numerous projects in PLM analysis, selection, implementation & management, synchronous and lean manufacturing consulting & software engineering, as well as general data management & governance strategy development and support
- Authored many papers & research reports on PLM and related topics, as well as numerous articles, commentaries, and perspectives that have appeared in publications throughout the NA, EMEA & Asia
- Holds a B.S. in Computer Science (minor in Physics) & M.S.E. in Manufacturing Systems Engineering


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Key Takeaways


 Digital Thread: Why Should We Care (1 of 2)

- The digital thread is one of CIMdata's Critical Dozen Digital Transformation trends & enablers
- Digital threads sew together disciplines, as well as the end-to-end product lifecycle—its processes, technologies & organizations
- The digital thread is best represented as a network of decisions & data nodes—these threads define a digital web/network
- An organization's Digital Network must have a purpose—it is not linear
- Understanding the human factor in digital network enablement is critical, along with data governance

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Key Takeaways

 Digital Thread: Why Should We Care (2 of 2)

- Digital network implementations are never straightforward
- A sound plan to maintain & enhance the organization's digital network throughout its useful life must be defined & maintained
- The value of the digital thread lies in the myriad of links to data that feed & validate decision-making from concept through life
- A digital network is required to support an organization's digital twins—their creation & end-to-end management
- A digital network and its potentially countless digital threads helps us see into every product- or service-related decision

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Agenda

- What is the Digital Thread
- How to Create the Digital Thread
- The Human Side of the Digital Thread
- Why Should We Care
- Concluding Remarks

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CIMdata's Critical Dozen

01
End-to-end connectivity

02
Data & process management

03
Configuration management


04
Bills of information

05
Model-based structures

06
Digital thread

CIMdata's Critical Dozen
The Top 12 Trends and Enablers of Digital Transformation

12 familiar, evolving trends & key enablers of digital transformation that you cannot, or should not, live without.




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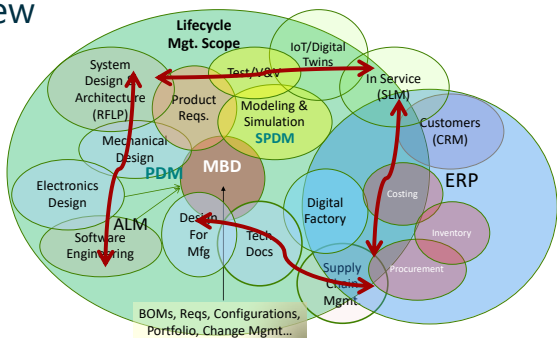


Digital Thread I


CIMdata's preferred definition

- Digital Thread refers to the communication framework that allows a connected data flow and integrated view of an asset's data (i.e., its Digital Twin) throughout its lifecycle across traditionally siloed functional perspectives

Digital thread is enabled and supported by a robust end-to-end and connected systems model and MBSE processes



Extracted from: https://www.dodmantech.com/ManTechPrograms/Files/AirForce/Cleared_DT_for_Website.pdf
 Also see: <http://www.manufacturing-operations-management.com/manufacturing/2016/04/what-is-the-digital-thread-and-digital-twin-definition.html>

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Digital Thread II


Managing the product lifecycle demands end-to-end connectivity



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E2E: Lifecycle Product Structures

Connections between the four principal structure configurations – Thread vs. Web

Product Lifecycle Timeline Sequence (Thread)

Product Rqmnts → Engineering BOM → Mfg BOM → Service BOM

Derivative Dependencies (Web)

Product Rqmnts → Engineering BOM → Mfg BOM → Service BOM

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Digital Thread: In Summary

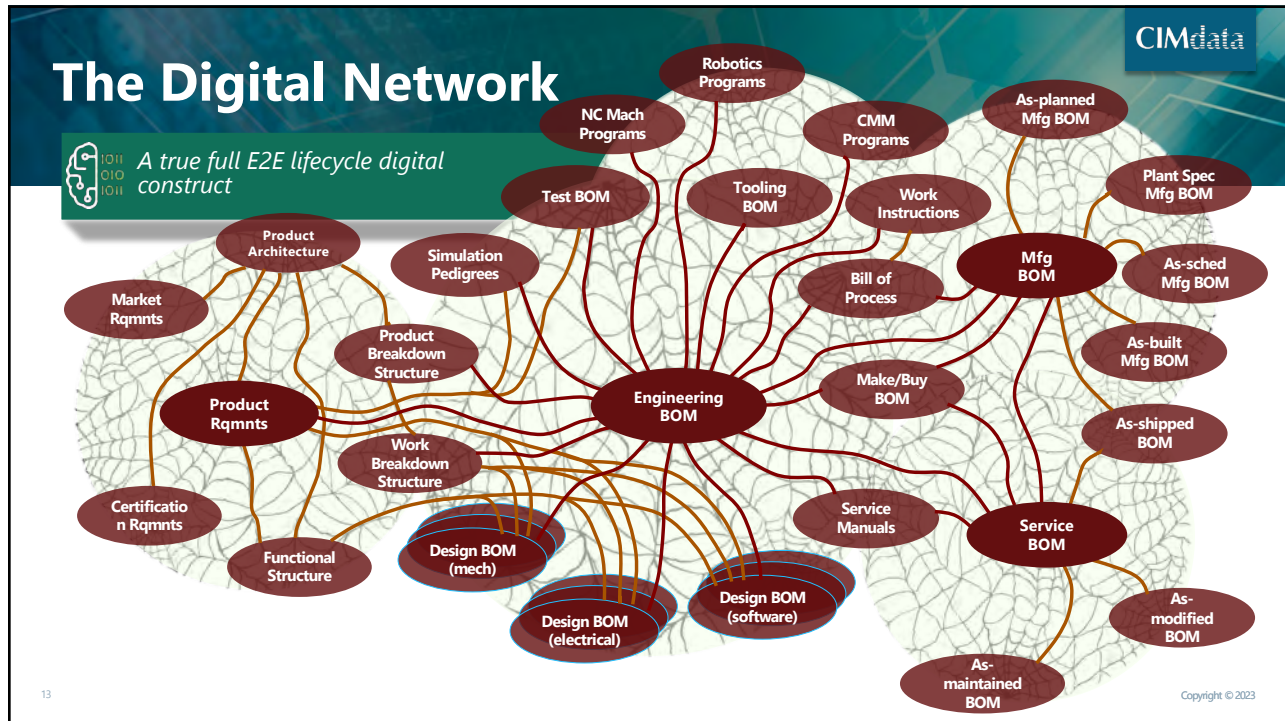
In essence, what is a digital thread

- A digital thread/web is a chart, or network, of decisions
- A digital thread must effectively connect data and processes so that digital twins can be created, maintained, and leveraged
- A network is a more realistic representation of how data and processes are interconnected in enterprises
- Each of these networks connects hundreds of informational nodes and data repositories
 - These range from simple flat files to model-based structures, each packed with info critical for making sound process decisions

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Creating a Digital Network: A Starting Point


 *This means choosing and connecting to the many data repositories relevant for any given process*

- Unfortunately, no two business units or departments organize their information in the same way, so establishing these connections can be tedious—but they are crucial
- One should start at the beginning of product conceptualization:
 - Marketplace information on what sells and what does not
 - Add to this any related competitive analyses that try to predict which product features and capabilities will be snapped up and which may be ignored
- With marketplace requirements clearly understood, the organization can more on to building out its digital network

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Creating a Digital Network: What's Next


 *A digital network can & should be systematically defined to maximize benefits (1 of 3)*

- Examine regulatory requirements databases—these hold countless must-have requirements
- Examine industry standards, every industrial market has “do” & “don’t” data that must not be overlooked
- Find repositories that aggregate customer wants & needs
- Connect with systems & tools used by developers & design engineers to do the primary geometric configurations of new products
 - CAD/CAE, EDA/MDA, PDM/PLM, and simulation & analysis


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Creating a Digital Network: What's Next


 A digital network can & should be systematically defined to maximize benefits (2 of 3)

- Identify additional configuration refinements for which developers and designers use, e.g., CAM, MES/MOM, M&S, and MRP/ERP
- Build connections to the engineering bill of materials (eBOM) and other BOMs in production, and to the systems that generate BOMs for downstream & upstream use, such as sales, marketing & service
- Identify key repositories in the MBSE domain that the business unit or enterprise implemented in its move away from paper & 2D drawings
- Reach deeper into downstream data repositories where modifications are generated in every new product's later development stages

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Creating a Digital Network: What's Next

 A digital network can & should be systematically defined to maximize benefits (3 of 3)

- Don't forget a vital connection—engineering change process, a consistent approach to managing & tracking network changes
- Developers & maintainers of digital networks should always be on the lookout for feedback loops
 - Even simple processes may have dozens of loops feeding changes and decisions back "upstream" to the beginnings of processes
 - These loops keep processes up-to-date, playing a major role in the organization's drive for continuous improvement


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Creating a Digital Network: Closing the Loop

 *The final two connections that must be considered for the digital network enablement*

- The databases in design engineering that track fast-moving developments in mCAD, CAE, EDA, CAM, MES/MOM, and of course PDM/PLM
 - Monitoring these developments helps digital network users keep up with developers' and designers' new techniques
- The databases that monitor the impacts of technology & economics on customer expectations
 - Tracking these impacts can help users of digital networks anticipate decisions that developers and designers are likely to face near-term
- Both can help keep complexity from being overwhelming

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Considering the Human Factor



Understanding the human factor in digital network enablement is critical

- In the development, production, and service of any product, there is a very human tendency to underestimate the range of factors impacting each decision
- Also commonly underestimated is:
 - The vast amount of information available
 - The variety of repositories & other sources
 - The likelihood of unexpected change
 - The complexity of other parts of any process when compared to one's own role
- These result in short-sightedness, and all can be averted or overcome with the appropriate digital network

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A Few Additional Considerations



Some of the common challenges


- Digital network implementations are never straightforward, and changes to connections to any one repository may affect feedback loops and links to other data stores
- Not all the repositories are to be found in your business unit or even in your enterprise
 - Almost every organization is part of another organization's digital network
- A significant amount of coding & testing is inevitable

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A Few Final Points


 *Some practical advice (1 of 2)*

- Any process can be enabled with a digital network in different ways for different purposes—thereby defining different digital constructs
 - An organization needs to reach agreements with all users on what its digital threads should achieve—their purpose & expected value, why they are needed and by whom—what its digital network must support
- To assure access to the internal technical expertise & outside resources
 - Actively promote the benefits of the digital network & its multiple threads
- Data Governance must be implemented to ensure that all extended enterprise participants have access to clear, concise & valid data
 - i.e., ensure that all information assets are trustworthy

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A Few Final Points

 *Some practical advice (2 of 2)*

- Delve deeply into the tools available in your PLM-enabling solution(s), as well as the supported & necessary data standards
 - They are numerous and powerful, but many require significant experience to use effectively
- Enlist help with technical issues, especially connectivity to the variety of repositories and data formats (old & new) that will be encountered
- Develop a sound plan to maintain and enhance the organization's digital network throughout its useful life, just as the underlying processes & threads must be maintained

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Finding the Digital Network's Value

 *The value of an organization's digital network lies in what it is designed to represent (1 of 2)*

- The value lies in the myriad of links to data & information that feed & validate decision-making from concept through life
- It must enable digital twins of its associated physical assets—an exact, up-to-date digital representation of the enterprise's physical products or services, or even its manufacturing system
- It must capture & represent all the decisions made throughout the lifecycle of a product or service, and the impacts of those decisions
- Building the digital network is about choosing which data nodes & repositories to link in any given process & how to best digitalize


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Finding the Digital Network's Value

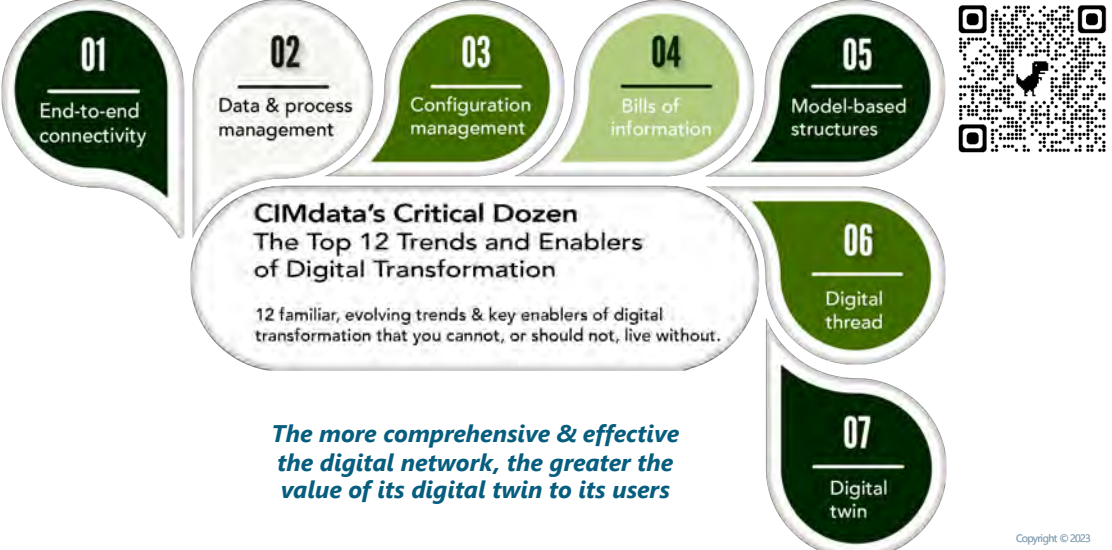
 The value of an organization's digital network lies in what it is designed to represent (2 of 2)

- Once the effort needed to build a digital network is understood, it is more than reasonable to ask, "Why go to all this trouble?"
- Fundamentally, a digital network, and its potentially countless digital threads, helps us see into every product- or service-related decision, and better understand how & why each decision was made
 - If we fail to remember why a decision was made and what we considered in reaching it, we will fail to learn from our past mistakes and risk repeating them
 - Worse, we will be unable to build on our prior successes
- Remember: a digital thread is required to support a digital twin's creation & management

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CIMdata's Critical Dozen: What's Next



01
End-to-end connectivity

02
Data & process management

03
Configuration management

04
Bills of information

05
Model-based structures

06
Digital thread

07
Digital twin

CIMdata's Critical Dozen
The Top 12 Trends and Enablers of Digital Transformation


12 familiar, evolving trends & key enablers of digital transformation that you cannot, or should not, live without.

The more comprehensive & effective the digital network, the greater the value of its digital twin to its users


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Digital Twin

 A digital representation of products and/or services at any point throughout the lifecycle


- A **virtual representation** (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to/from the associated physical asset(s).



Digital Twin of the Product



Digital Twin of Production




Digital Twin of Service


Digital twin is enabled and supported by a robust end-to-end and connected systems model and MBSE processes

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*Adapted from input from ASSESS (see www.assessinitiative.com)



Digital Twins

 Key characteristics


- There are multiple Digital Twins for different purposes, each has specific characteristics
 - For example, Data Analytics Digital Twins, MRO Digital Twins, Financial Digital Twins, Engineering Digital Twins, and Engineering Simulation Digital Twins
- Each Digital Twin must have a physical twin (i.e., a physical asset)
 - A virtual representation can and should exist prior to its physical twin
 - The physical asset can be a plant, a ship, infrastructure, a car, etc.
- Each Digital Twin must communication with its Physical Twin
 - It does not have to be real time or electronic

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Adapted from input from ASSESS (see www.assessinitiative.com)

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Engineering Simulation Digital Twin


CIMdata's preferred definition

- A **physics-based virtual representation** of a physical asset or collection of physical assets (physical twin) that allows simulations of the associated physical asset(s)



DIGITAL EXPLORATION
DIGITAL PROTOTYPE
DIGITAL TWIN

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Creating & Maintaining the Digital Twins


Digital Twin vision cannot be achieved without a full product/process model

Digital Twin – From Design to Operation

Physical Asset



Physics-based analytics

CAD Courtesy of Volvo Cars
<http://www.ansys-blog.com/digital-twin-pump/>

Virtual Prototype



<https://community.plm.automation.siemens.com/t5/Tecnomatix-News/Digital-Twin-Blurring-the-lines-between-reality-and-simulation/ba-p/333483>

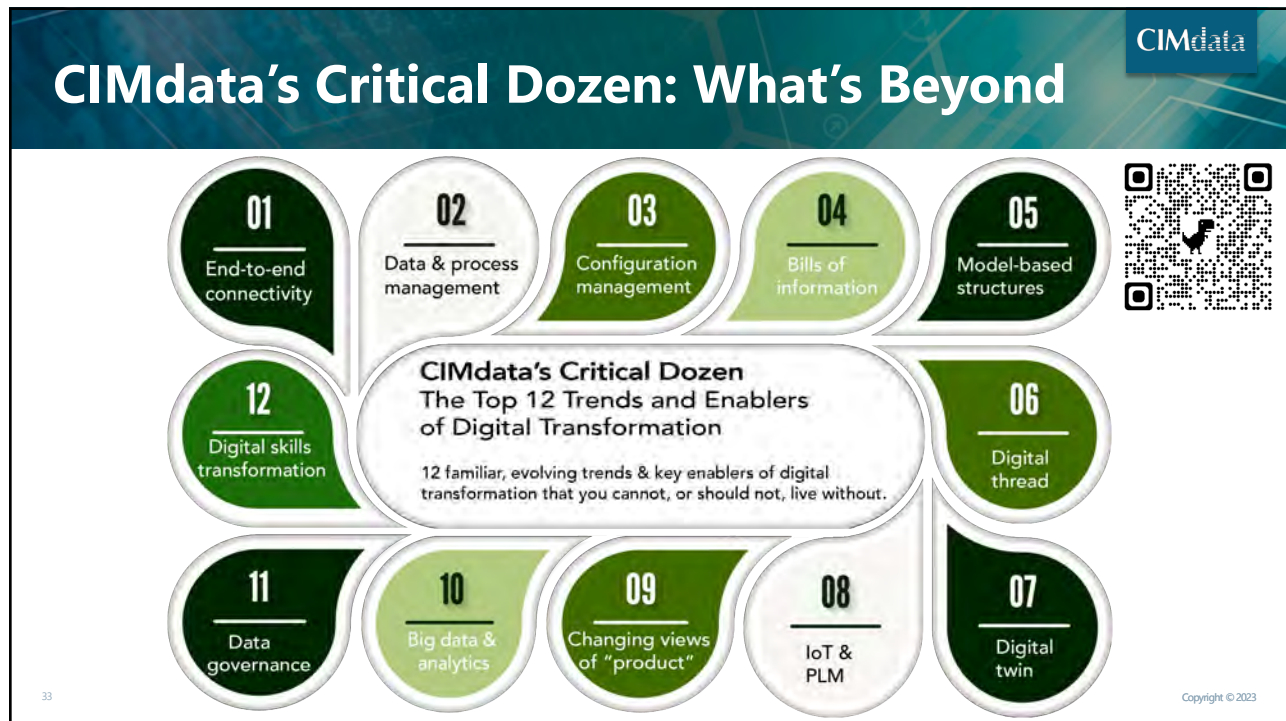


<https://www.ansys.com/software/2016/04/ansys-digital-twin-technology>

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Concluding Remarks

Digital Thread: Why Should We Care (1 of 2)

- Every digital process is precious to its users & vulnerable to a host of detrimental changes
- Incorporating processes into a digital network maximizes the value of its information to its users
- It must have a purpose—it is no linear, it can have countless threads
- A digital network's potential countless digital threads helps us see into every product- or service-related decision
- Its value lies in its myriad of links to data and information that feed & validate decision-making

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Concluding Remarks

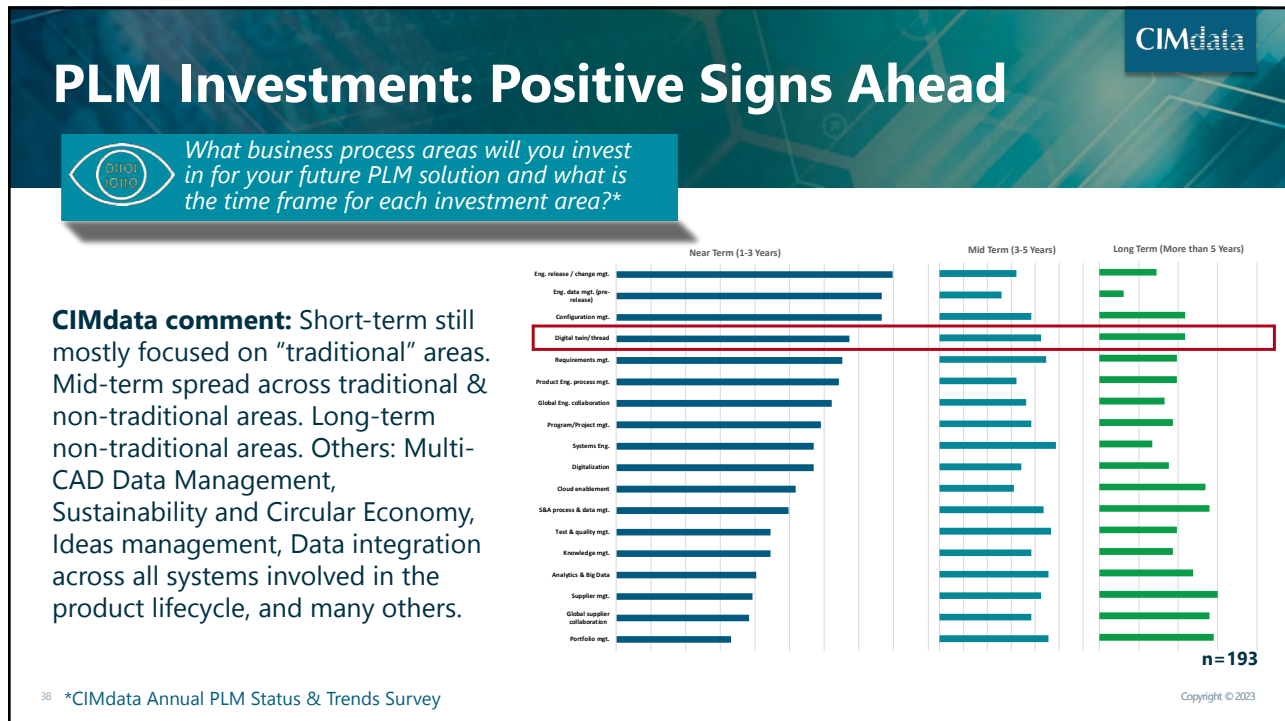
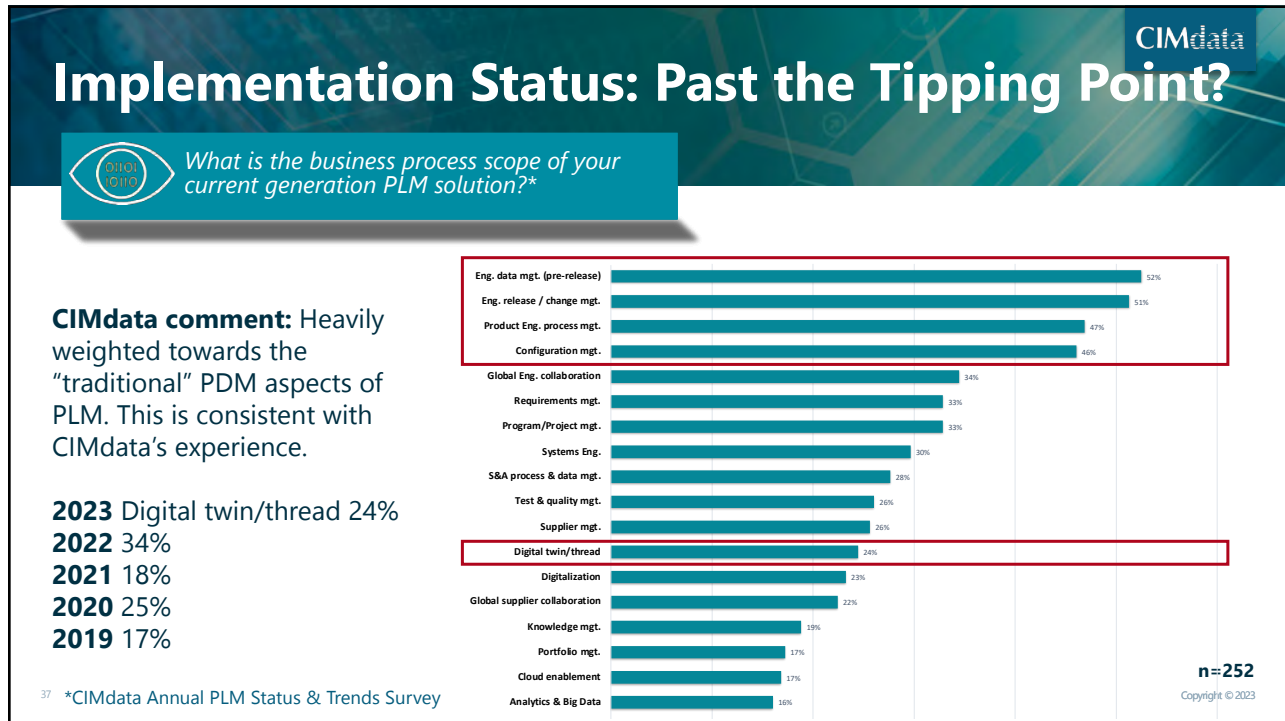
Digital Thread: Why Should We Care (2 of 2)

- The digital thread is one of CIMdata's Critical Dozen Digital Transformation trends & enablers—it sews together disciplines & the end-to-end product lifecycle
- Remember: a digital network is required to support a digital twin's creation & management
- Digital network implementations are never straightforward
- Develop a sound plan to maintain and enhance the organization's digital network throughout its useful life

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Questions & Answers CIMdata

 *What's on your mind?*



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