CIMdata

Digital Thread in Aerospace and Defense

Poised for Rapid Growth

Sponsored by Aras

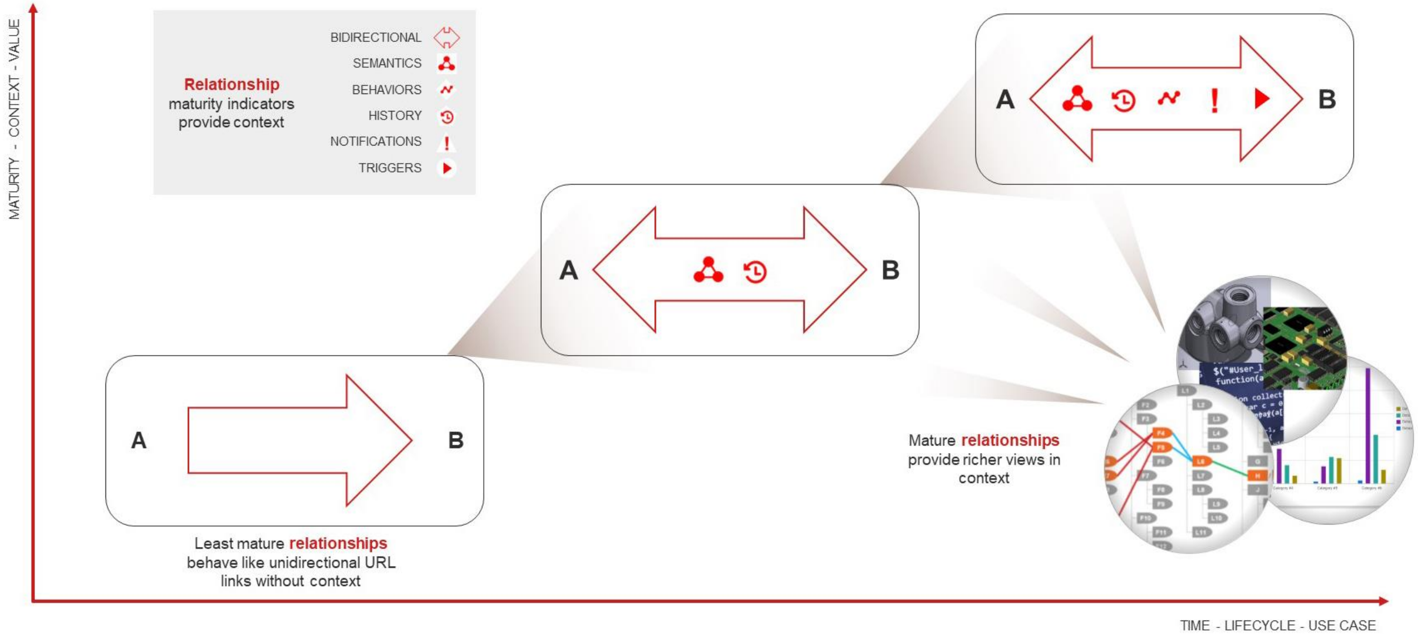
Topics

A&D Research

Recent CIMdata research on behalf of the Aerospace and Defense PLM Action Group member companies in collaboration with Aras clearly indicates that digital thread investment within the ecosystem of industrial users, their customers, suppliers, and solution providers is poised for rapid growth.

Initial implementations of targeted digital thread solutions have provided proof points of value and essential learnings. Now rounds of investment are ramping up, guided by these early achievements and with expectations driven by the value potential revealed.

Digital Thread Context Defined by the Maturity of Relationships



Courtesy of Aras

Aras' Perspective

- A digital thread is meant to connect all digital assets.
- Simple URL-like relationships are useful but lack context.
- Maturity of relationships evolves over time.
- Specific maturity of relationships sets the context for manufacturing.
- Relationships keep evolving with the assets in the field.
- Digital thread views must present information so that it makes sense to the user.

Digital Thread's Rise to Prominence

The concept of a digital thread providing automated linkage of multiple representations of a product, each tuned to the needs of various creators and consumers along the lifecycle, is very powerful. Until recently, tracing these linkages has been primarily a manual process, extracting product information from myriad heterogeneous systems and relating them in ad hoc reports. But now, with recent advances in commercial PLM solutions, the digital thread, with automated linkages and traceability, has become a practical possibility, even for industries with complex products, such as aerospace & defense.

In response, industry leaders have implemented targeted digital thread solutions and envision expanding these solutions throughout the product lifecycle. With the newness of this approach there is not much available in the way of lessons learned or value achieved. This lack of real data is a barrier to broader investment within industry. On the solution side, providers are constantly seeking additional insight into investment drivers within industry.

Recent research by CIMdata on behalf of the Aerospace and Defense PLM Action Group (AD PAG) in collaboration with Aras has provided critical insights, which inform the content that follows. Information was gathered through thought leader interviews and responses to an online survey. The majority of respondents were from A&D, but the results are relevant across all industries with complex and regulated products.

What is Driving Interest in Digital Thread?

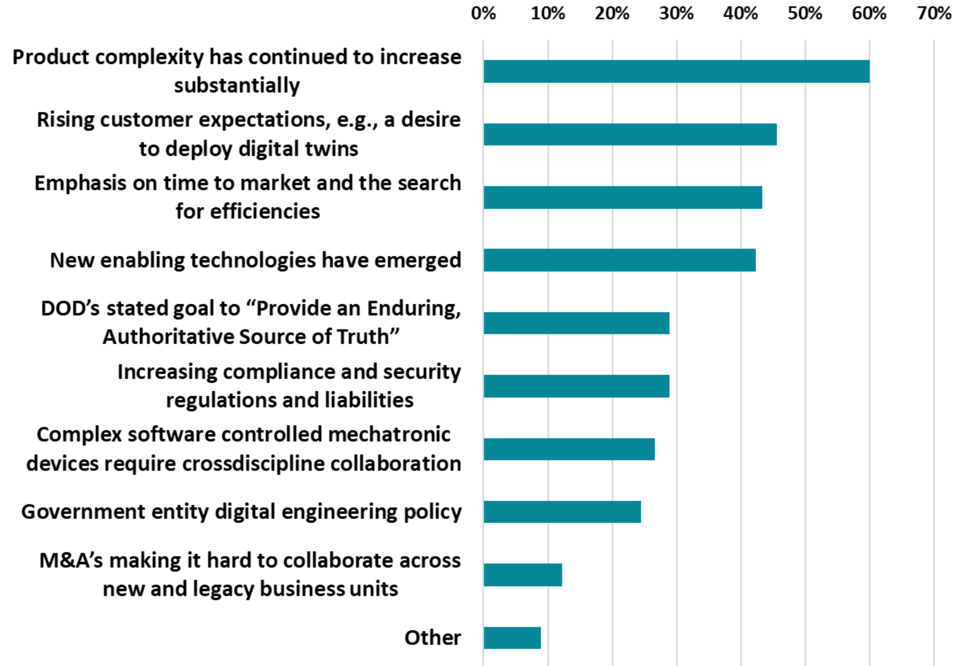


Figure 1—Reasons for Digital Thread's Rise to Prominence (% of respondents)

Aras Defines the Digital Thread

Digital thread maintains meaningful relationships among all of a product's digital assets—and their revisions over the lifecycle—across multiple domains throughout an enterprise and the supply chain. The digital thread is an attribute of an enterprise's information architecture that connects data elements in different tools and systems from a wide range of vendor providers.

Digital assets include specifications, requirements, design details for all domains, simulation & analysis data, verification & validation data, bills of material, technical data packs, quality & maintenance records, all related documents & process plans, and others.

What the Digital Thread Does

The conceptual understanding of digital thread within industry is very immature. Nearly half of the companies surveyed do not have a commonly accepted definition of digital thread. Less than 10% use a published definition. Interviews with 10 industry leaders yielded 10 definitions. Some were long, others brief. Only two were based on definitions published by respected external authorities.

Though there may not be a consistent and widely accepted definition of digital thread, there is a broadly shared perception of what a digital thread ***does*** and what a digital thread ***is***.

Combining the most prominent characteristics of what a digital thread ***does*** yields a reasonable definition of digital thread, i.e., "Establishes traceability of product information across multiple domains in the lifecycle (mechanical, E/E, software, and firmware) to provide meaningful relationship connections between a product's digital assets."

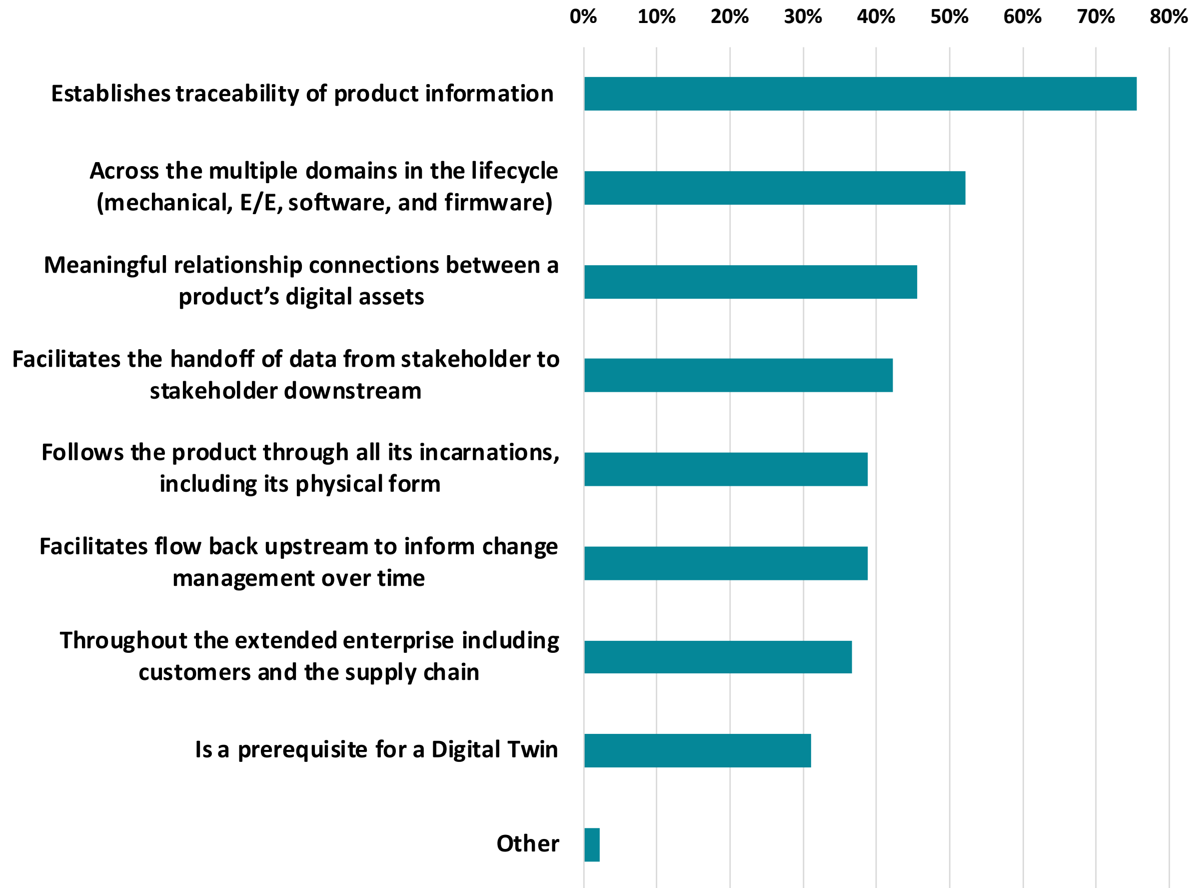


Figure 2—Most Significant Characteristics that Describe What a Digital Thread ***Does***

What the Digital Thread Is

The most prominent characteristics of what a digital thread ***is*** reveal a mature appreciation among specialists in industry of the required capabilities of enabling technologies and appropriate architectural approaches for implementation of a digital thread solution.

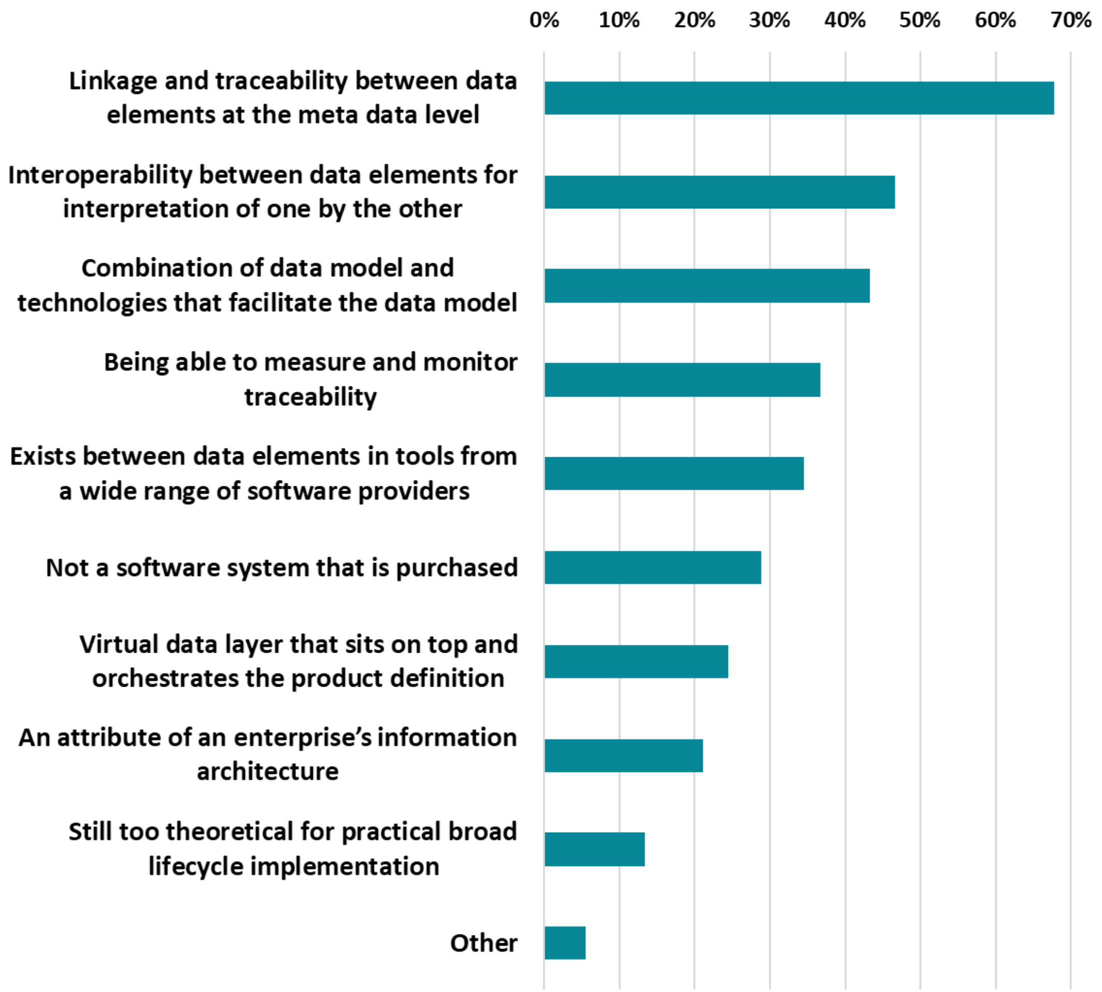


*Figure 3—Most Significant Characteristics that Describe What a Digital Thread **Is***

The Digital Thread Value Footprint—Program Stage

Industry leader interviews revealed a wide range of digital thread realities. All of these companies are motivated and moving with a sense of purpose. All have implementations supporting multiple use cases. Most of these use cases are in support of product development, providing some degree of requirements traceability and integration between engineering and production.

Referring to the lifecycle definition from ISO 15288 in Figure 4, survey respondents indicated where and when they were implementing their digital thread solutions.

Investment to date has been concentrated in the Concept and Development lifecycle stages and will shift in the near term to Development and Production, while ramping up in the later lifecycle stages. In the longer term, investment will shift substantially to the later lifecycle stages.

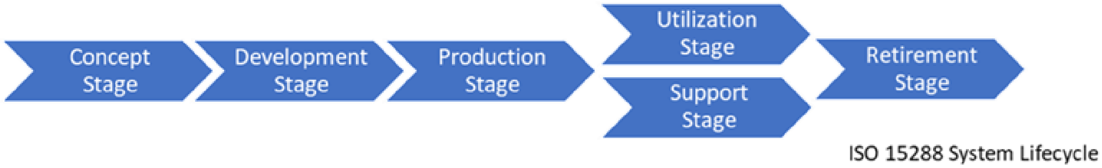


Figure 4—Lifecycle Definition from ISO 15288, "Systems and Software Engineering—System Life Cycle Processes"

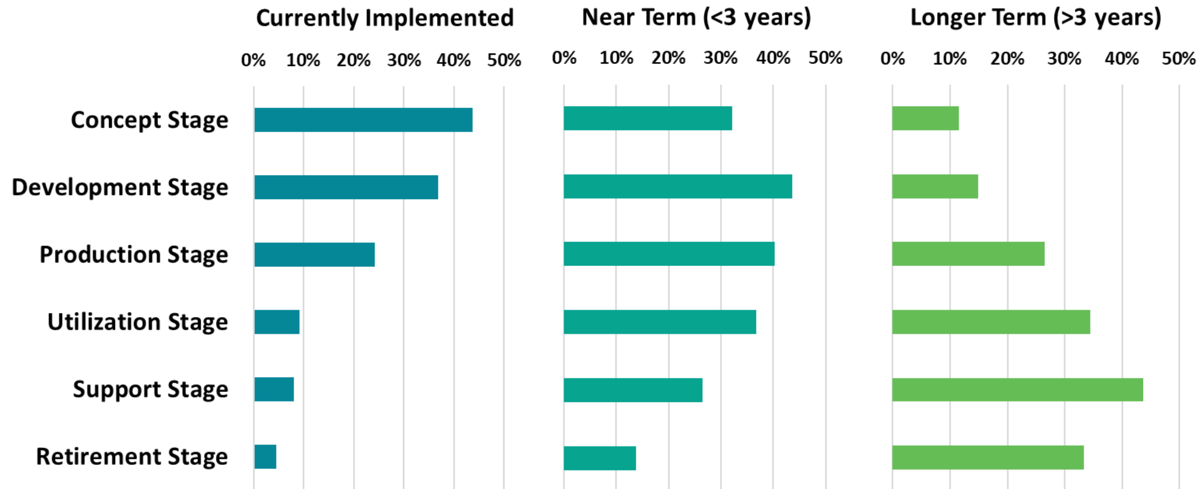


Figure 5—Plans to Expand Current Digital Thread Implementations Within and Across Lifecycle Phases Over Time

Aras' Perspective

The primary business value of a digital thread is an ability to quickly identify data in context. Context means that data is relevant to the task at hand, reflects the appropriate maturity of the relationships used to trace the data, and is presented in a view that allows the user to get the value that they are looking for.

For example, the business value of the data traceable via a digital thread at a given stage in the lifecycle will be different and will be presented differently depending on whether a company sells the aircraft engine to the customer versus delivering "Power by the Hour."

The Digital Thread Value Footprint—Data

Currently, the most prevalent digital thread linkages are between design-related data categories, i.e., needs and requirements data, mechanical design data, E/E design data, software design data, and engineering bill of materials data.

Going forward, investment in establishing linkages between design-related data categories will in the near term be more broadly dispersed across the product lifecycle. In the longer term, investment will shift toward linking data within and between categories associated with the later lifecycle stages.

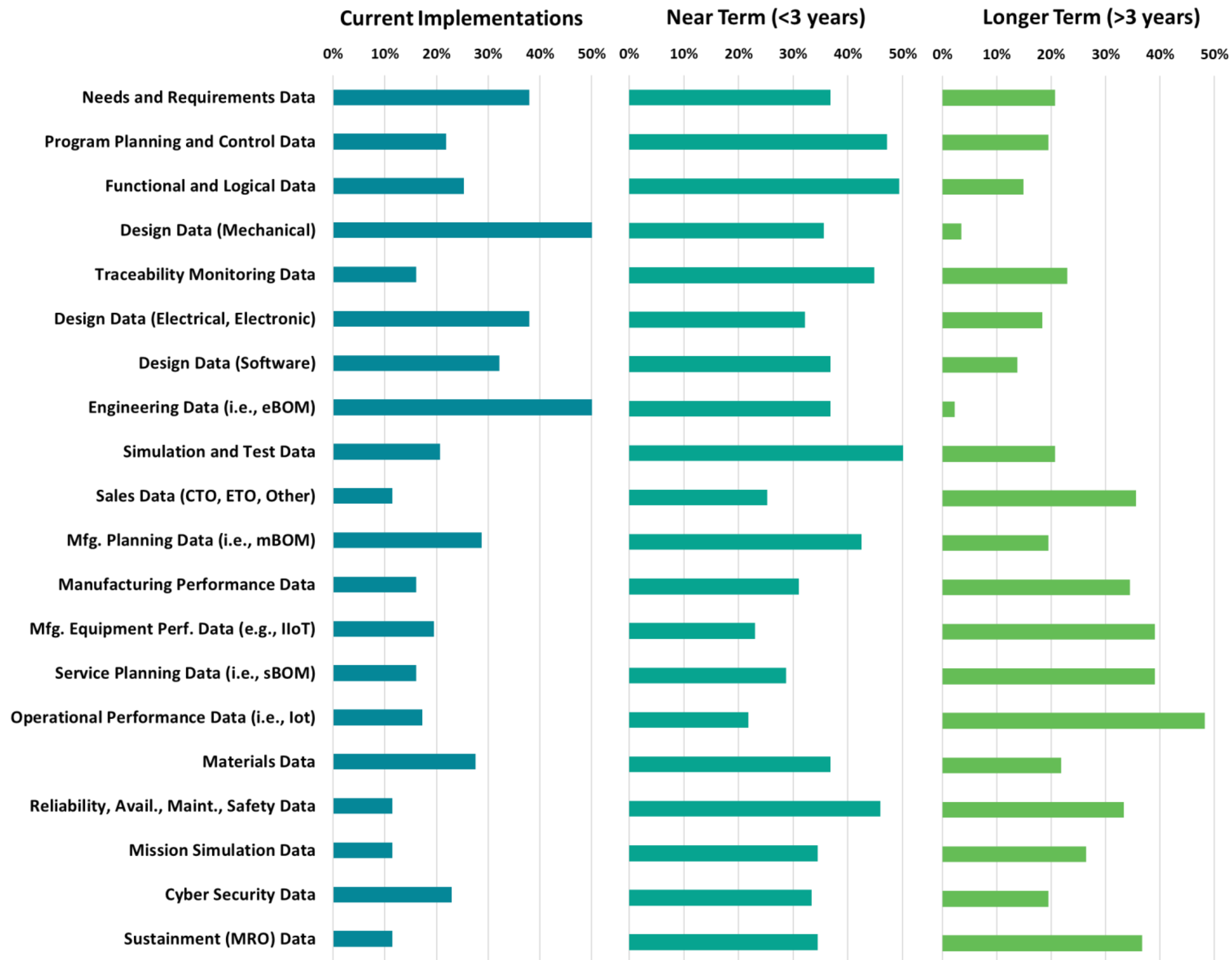


Figure 6—Plans to Expand Current Linkages Within and Across Product Lifecycle Data Categories Over Time

The Digital Thread Value Footprint—Use Cases

Our survey results highlight an inconsistency between the importance of the digital thread to our respondents and their progress to date. The importance assigned to digital thread use cases is surprisingly broad and high. The prevalence of current digital thread use case implementations is surprisingly low. The most striking indicator that digital thread investment is in very early days is the contrast between importance assigned to digital thread use cases and the prevalence of current implementations. For example, lifecycle BOM management is considered essential by 62% and important by 26% of respondents but is currently implemented within only 25% of respondents' companies.

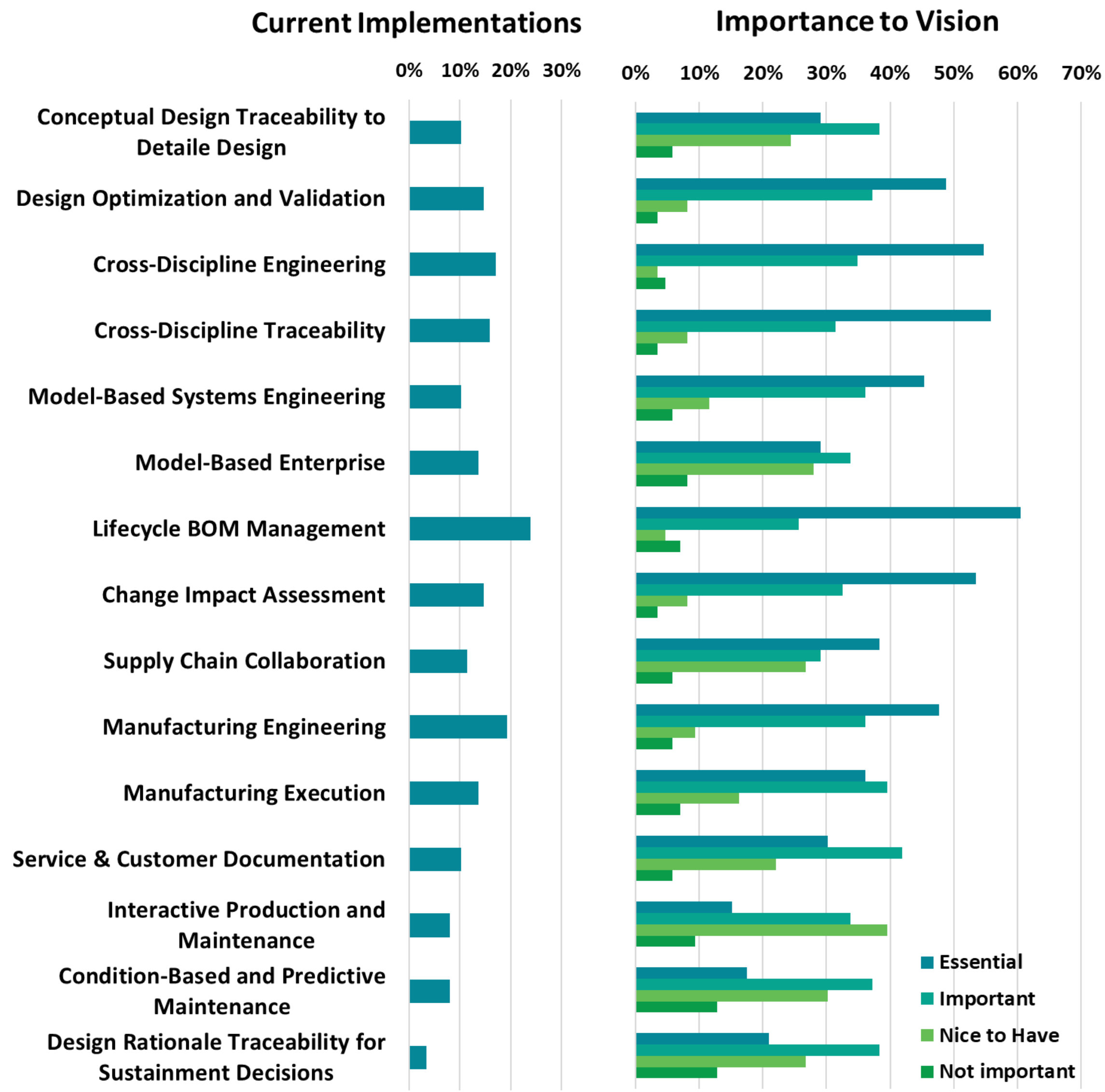


Figure 7—Digital Thread Use Cases Currently Implemented and Importance of Use Cases to Achieving the Digital Thread Vision

Digital Thread Realization

The digital thread is commonly presented as a sequential flow mapped to the product lifecycle. On the left in Figure 8 we show the four principal product structure configurations in lifecycle sequence. In this representation, threads would run left to right between the objects in one structure to the next in line. But if we look at the derivative relationships between these structures as shown on the right, we see that the dependencies are not sequential.

There are many other views of product structure that are relevant to various communities as they contribute their efforts throughout the product lifecycle. CIMdata believes that these product structure configurations are best depicted as a web.

As with all major endeavors, the key to success is to think big but focus on pieces of the total picture. Use cases are the pieces. They define scope and business value. Pick the piece, or use case, to work on next based on business problems to be solved or opportunities to be captured. And as you build out piece by piece, keep in view that bigger landscape so that the pieces fit together.

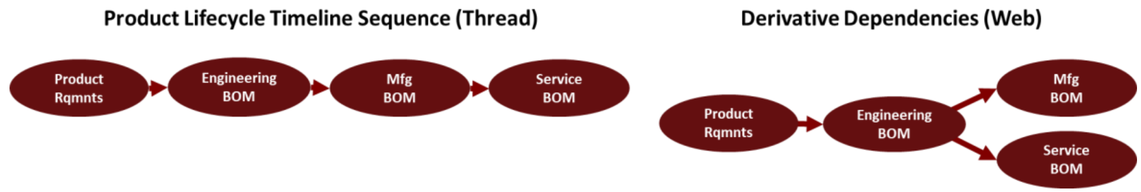


Figure 8—Two Perspectives of Digital Thread Dependencies—Timeline Sequence vs. Derivative Dependencies

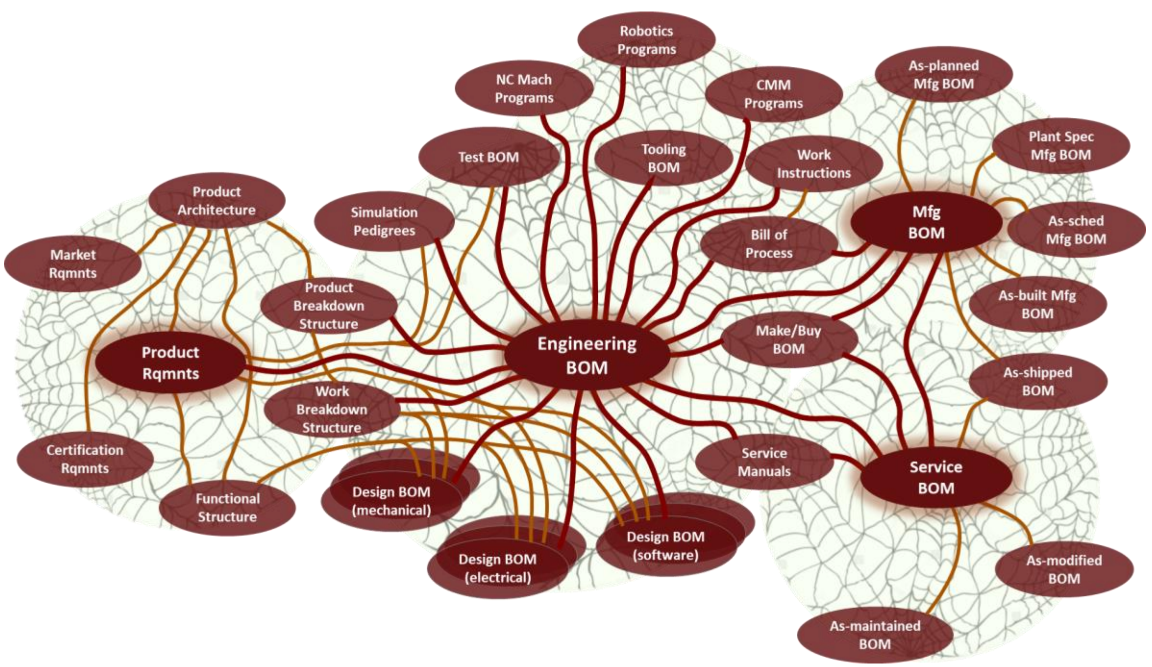


Figure 9—The Digital Thread is Really a Web

Case Study—Heavy Equipment Defense Contractor

CIMdata has assisted industrial clients from multiple industries in their journey to build out a digital thread, and we believe the following case study provides a good example of a use case with clearly defined scope and business value.

In this case study, the company engineers and manufactures heavy equipment. An order may be for moderate to large volumes of these items which may be of multiple configurations, and since the equipment is expensive and lasts for a long time, they also sell complex support packages. Preparing proposals was very slow, error prone, and with a high dependence on tribal knowledge. Also, they were leaving money on the table due to their inability to provide a proposal in a timely manner.

The focus for the initiative was the proposal BOM, but root cause analysis quickly focused attention on the engineering bill of material (eBOM). Proposal information came from many disconnected, redundant, and non-synchronized sources. But the eBOM was the original source from which all of the other views were derived. In the original state, the eBOM, manufacturing BOM (mBOM) and service BOM (sBOM) were in separate systems. Make/buy and costing were in spreadsheets.

In step 1 of the transformation, the eBOM, mBOM and sBOM were moved to a single PLM solution, using multi-view BOM capability for automated reconciliation and synchronization.

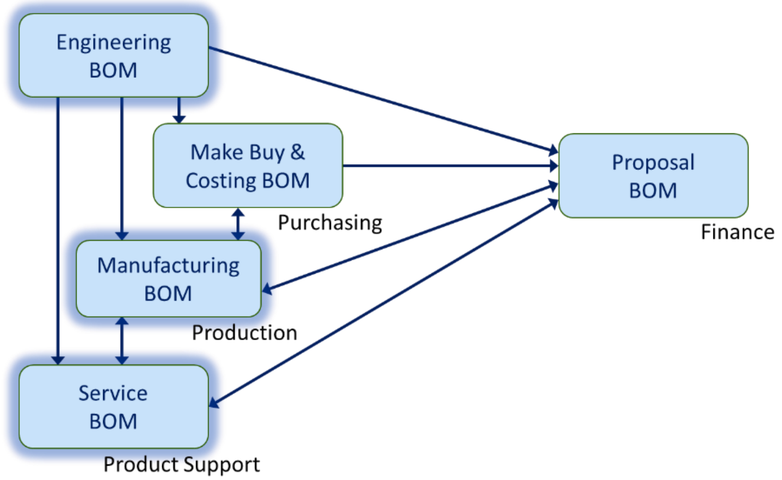


Figure 10—Heavy Equipment Manufacturer Case Study Scope

In step 2, make/buy, costing and proposals are generated on a low-code platform. The Consolidated BOM and the Proposal BOM are no longer Excel spreadsheets, but information mashups stored in the PLM.

Some business benefits identified from this transformation were:

- Reduced turnaround and increased accuracy of proposals
- Reduced level of effort and disruption of normal staff activity to verify product configurations for proposal pricing
- Ability to define service configurations more quickly and accurately

By focusing on a real business need, this company achieved significant payback and is now well positioned to build out more of their Digital Thread.

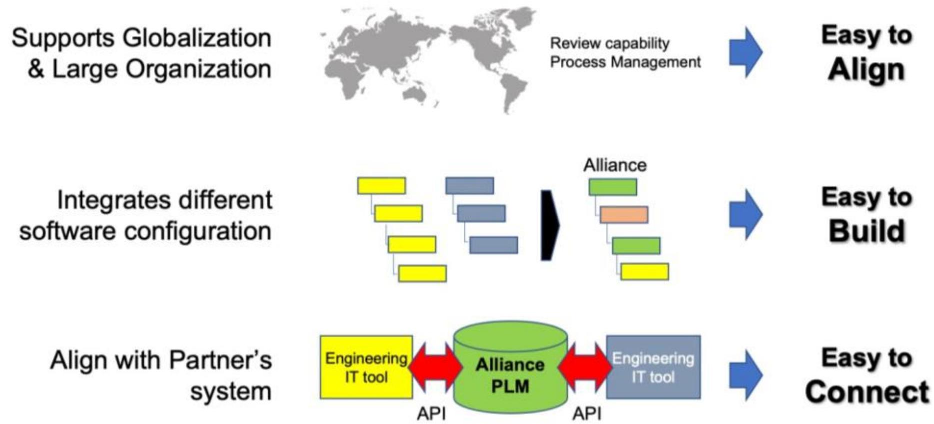
Case Study—Nissan Motor's In-Vehicle Software Variants Managed via Digital Thread

Nissan Motor was faced with significant process and cost challenges related to the configuration of in-vehicle software variants. This was due to the massive electrification of all cars and electrically powered vehicles (EV). The existing processes relied on manual manipulation of functional data that was spread among multiple systems and owned by multiple teams, including partners. This resulted in lack of traceability, poor reuse, duplicate development, human errors, and lack of trust between teams.

Nissan concluded that there were two core underlying issues:

- Absence of a single central library of the existing individual software functions accessible to Nissan and their partners. A library that would allow configuring software variants, identify missing functions, and eliminate duplication of development between Nissan and partners.
- Absence of an open and tool-agnostic digital thread across the entire Nissan global organization including their partners. A digital thread that meets today's software configuration needs but is resilient enough to evolve with changes in process, design data, human organization, and the digital transformation of the company.

Nissan understood that implementation of a digital thread must be based on a single company-wide PLM platform that supports Nissan's and partners' heterogenous application landscape. Aras Innovator was chosen because of Nissan's prior experience with the platform including its openness, low-code modeling, and low-cost upgrades.



Courtesy of Nissan

Figure 11—Nissan's Globally Aligned PLM Platform

Nissan worked very closely with partners to end-of-life all existing separate solutions, consolidate all data, unify all disconnected processes, develop a common in-vehicle software function library, provide a software variant configurator, and to integrate it all with the partners information systems.

Today Nissan can effectively manage complexities of the ever-increasing configurations of in-vehicle software variants while minimizing cost, improving quality, reducing development time, and optimizing development resources.

According to Mr. Hiroaki Nemoto, Engineering & Design Systems, Nissan Motor Co.

"Ten years ago, this idea was so grand and difficult that I couldn't find any capable solutions. Today, Aras Innovator allows step-by-step realization of these goals via its 'easy to build,' 'easy to align,' and 'easy to connect' characteristics."

See: https://www.aras.com/en/resources/all/cs-nissan

Future Digital Thread Investment Priorities

Looking to the future, industry leaders are taking a broader view of the digital thread's value potential, with more investment in production and service use cases. They view the next stage as more complex and transformative to their companies. Fortunately, several have been successful in establishing programs that enjoy strong support from a well-informed and motivated senior management. However, many others have not.

All Top 5 pain points being targeted in future implementations relate to accessibility and traceability across data elements, especially traceability of requirements throughout the product lifecycle. Systems engineering is featured prominently in many responses, including ranking as the top new value opportunity being targeted in future digital thread implementations, which aligns with CIMdata's view that systems engineering is a principal driver of the digital thread.

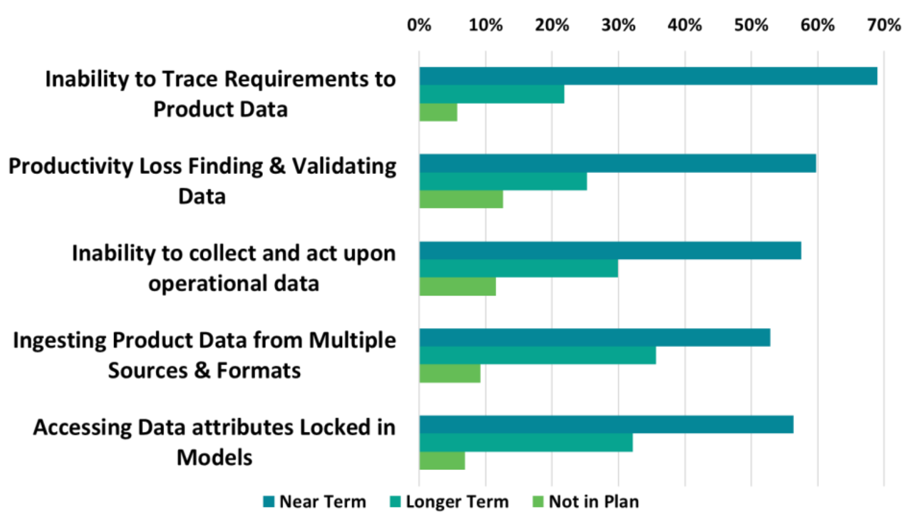


Figure 12—Top 5 Pain Points Being Targeted in Future Digital Thread Implementations

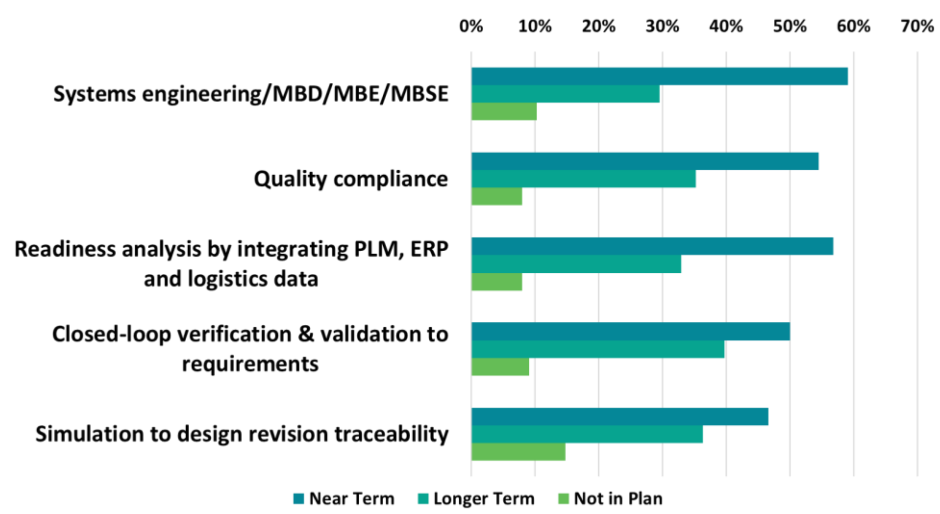


Figure 13—Top 5 New Value Opportunities Being Targeted in Future Digital Thread Implementations

Strategies for Success

An area of divergence between industry leaders is in the focus of their implementations. For some, the focus is providing interfaces to source applications to extract and associate product data artifacts and attributes. For others, the key is the association and traceability of dependencies between artifacts in support of a use case. And for a few, the focus is on data governance, which they believe is foundational for enabling a richer and more extensive set of product lifecycle use cases.

The number 1 inhibitor to formulating and executing a digital thread strategy is "lack of interoperability between different vendors' tools and systems." The number 1 proposed means for mitigation is to "increase support of standards."

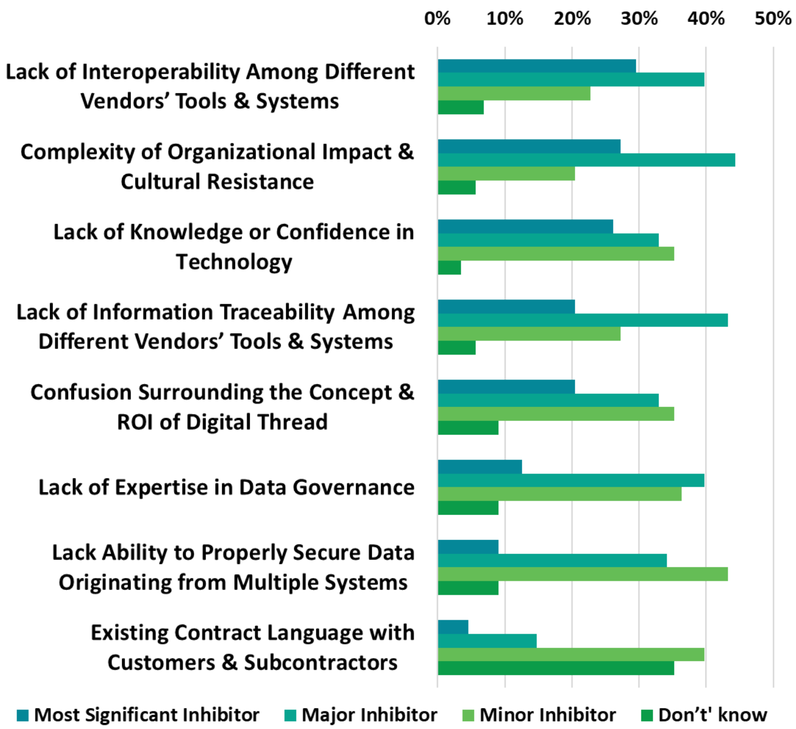


Figure 14—Principal Inhibitors to Formulating and Executing a Digital Strategy

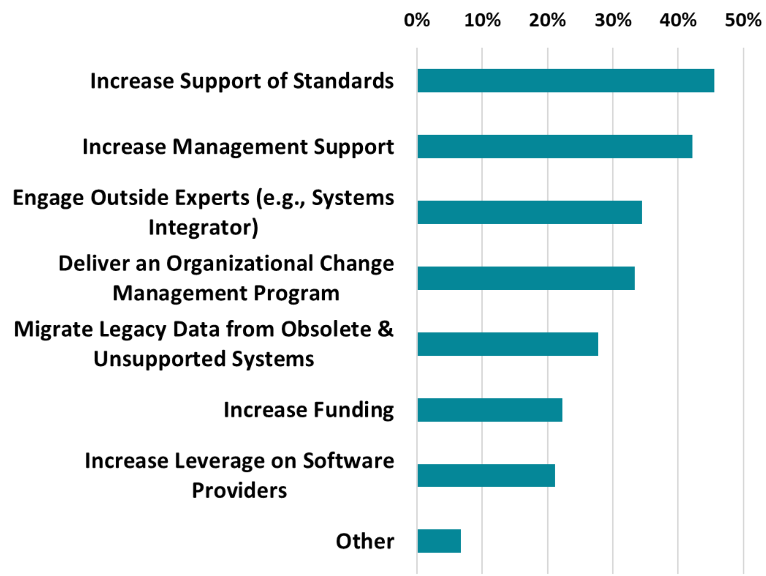


Figure 15—Proposed Means for Mitigation of Inhibitors to Formulating and Executing a Digital Strategy

Solution Technologies

Key Technical Considerations

Core to the value of digital thread is traceability across source and derivative product-related artifacts along the product lifecycle and throughout the extended enterprise.

The digital thread value landscape is distributed across a heterogeneous value chain from customer to OEM to partners and multiple tiers of suppliers. This reality drives the need for data interoperability and elevates the importance of standards and openness of enabling solution architectures.

Proven technical solutions exist for enabling the digital thread, and leading solution providers are investing heavily in research-guided strategies and roadmaps to further strengthen their offerings.

Data is the foundation of the digital thread. This reality elevates the importance of sound data governance and a cleansed repository, especially as use case implementations proliferate and must be interlinked into an extended thread.

Technologies in Use Today

The technologies used to link product lifecycle data segregate into three tiers as shown in Figure 16. The top tier, which has the longest history, includes PLM and PDM, followed by ERP, and custom applications. The middle tier consists of application and data integration tools. These are followed by the third tier of newer specialty technologies for combining data from multiple sources and establishing linkages and traceability. We can expect the ranking of these specialty technologies to rise significantly over the next few years.

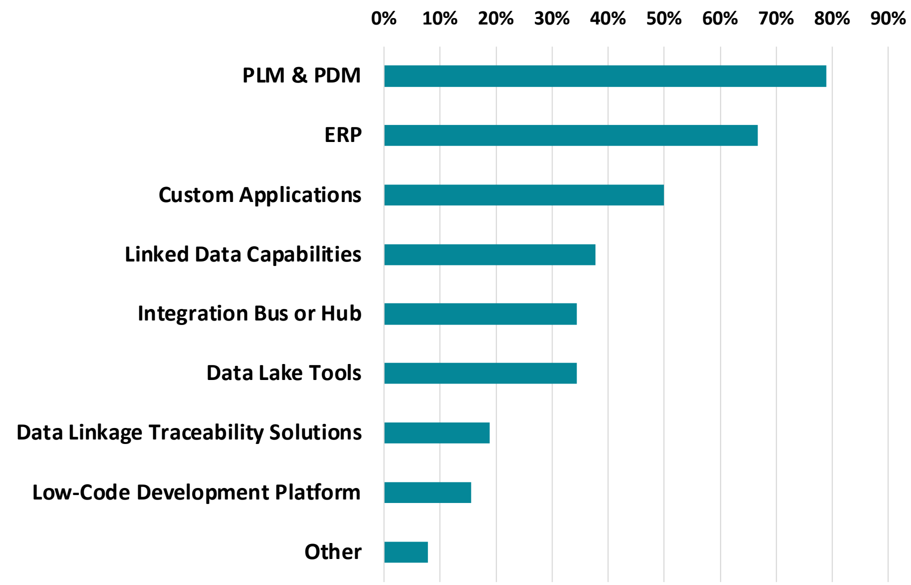


Figure 16—Technologies Currently Used to Link Product Lifecycle Data

Solution Capability and Provider Alignment

Attitudes on the topic of solution capability and provider alignment are mixed. Some industry leaders are quite critical, especially regarding data model accessibility and flexibility to comply with a corporate data governance strategy. Other interviewees are somewhat neutral or slightly positive. They feel that some providers are moving in the right direction; some are not. Several feel that solution capabilities have improved significantly overall in the last 5-10 years and that, despite some remaining gaps, are now fully capable. Some express satisfaction that “good partnering” is happening.

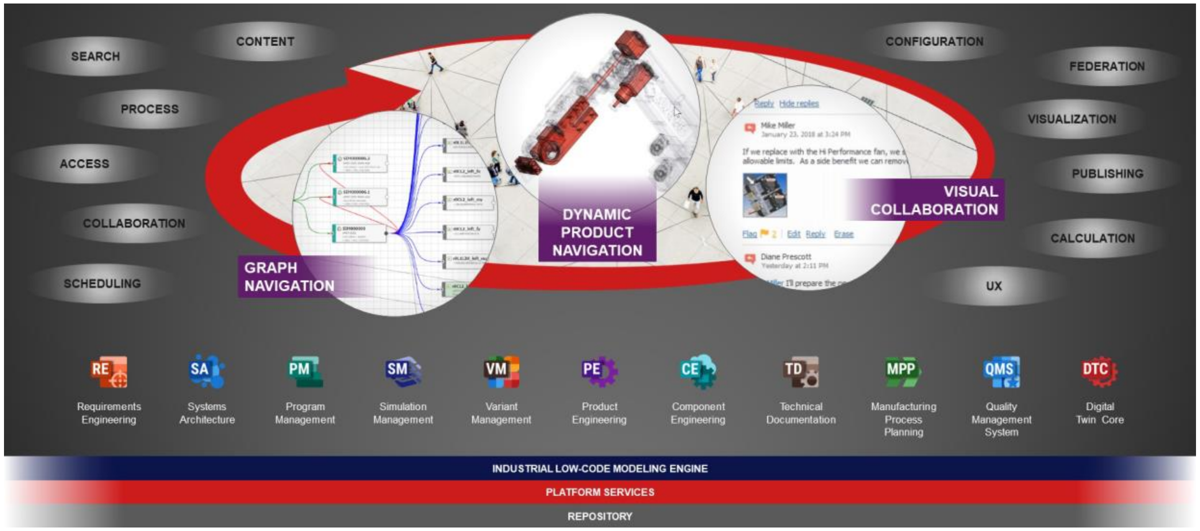
Aras Solutions

Aras equips the world's largest manufacturers with end-to-end PLM solutions that are fully capable, configurable, or customizable. Developed with agility and openness as a top priority, Aras' technology offers seamless interoperability across the enterprise. It includes applications shown along the bottom of the graphic below for engineering, manufacturing, quality, and maintenance.

Examples of Aras platform services include:

- Graphical Navigation is a visual representation that enables the user to traverse the digital thread across the product lifecycle.
- Dynamic Product Navigation enables anyone in the enterprise to use PLM queries to dynamically render a product, which could originate from multiple 3D CAD systems.
- Visual Collaboration enables users to collaborate securely in context across the enterprise, i.e., a user can drag a 3D model into a threaded discussion and collaborate across departments.

Yesterday's rigid technologies are no longer appropriate for today's businesses—modern businesses need an adaptable, open, and flexible platform. Aras Innovator is purpose-built to deliver impact wherever and however it's needed.



Courtesy of Aras

Figure 17—Digital Thread Platform Services Across the Lifecycle

About the Aerospace & Defense PLM Action Group

The Aerospace & Defense PLM Action Group is an association of aerospace OEMs and aircraft engine providers within CIMdata's globally recognized PLM Community Program, which functions as a PLM advocacy group to:

- Set the direction for the aerospace & defense industry on PLM-related topics that matter to members
- Promote common industry PLM processes and practices
- Define requirements for common interest PLM-related capabilities
- Communicate with a unified voice to PLM solution providers
- Sponsor collaborative PLM research on prioritized industry and technology topics

CIMdata administers Group operations, coordinates research, and manages the progression of policy formulation.

About Aras

Aras provides a powerful low-code platform with applications to design, build, and operate complex products. Its technology enables the rapid delivery of flexible, upgradeable solutions that build business resilience. Aras' platform and product lifecycle management applications connect users in all disciplines and functions to critical product data and processes across the lifecycle and throughout the extended supply chain. Airbus, Audi, DENSO, Honda, Kawasaki, Microsoft, Mitsubishi, and Nissan are using the platform to manage complex change and traceability. Visit www.aras.com to learn more and follow us on Twitter and LinkedIn.

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