



# Enterprise Digital Thread

## Interlacing Product Data

### Abstract

Organizations today are going through a rapid transformation led by highly purpose-driven products, services, and business model innovations. Their commitments to bring sustainable, safe, economical products and services are stronger than ever before. Delivering features faster and continuously to eliminate friction in the customer value chain has become the success mantra for sustainable organizations.

Products and services, while becoming smart and connected, are becoming complex. This is due to the complexity of multiple domains and multiple functions such as engineering, manufacturing, sourcing, service, and the extended ecosystem are facing challenges in accessing accurate product data due to disconnected processes and systems.

To ensure agility, all the entities must work collaboratively. Digital connectivity and product data analytics are key to orchestrating the lifecycle processes.

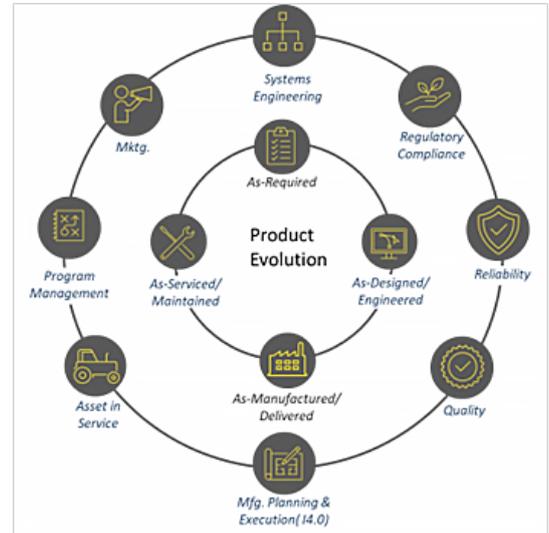
Digital thread interconnects all these product data entities and enables the data continuity that is needed to address various business scenarios in the product lifecycle.

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# 1 Interlacing Product Data and the Inherent Challenges

Products evolve and attain certain milestones as they mature from the Requirements phase until becoming an asset functioning in the field. The STEP Lifecycle Model defines the product lifecycle in four stages, as shown in the figure 1. As a product progresses through these lifecycle stages, various enterprise functions and extended enterprise entities collaborate and generate product data which needs to be connected to ensure data flow across functions

However, organizations face various challenges while trying to make this happen.



**Data silos getting created across the product lifecycle:** Data that is generated by the various functions reside in disconnected systems which limits data flow.

**Ever increasing product complexity:** The heterogenous data types and formats from various domains (hardware, software, and mechanical) increase the product data complexity.

**Data traceability across the lifecycle:** Due to process and data disconnects, tracing accurate product configuration from engineering through service and maintenance of the asset is extremely challenging, reducing the confidence of the stakeholders to carry out impact analysis, or to respond faster.

**Diversified data semantics and ontologies:** Data interoperability discipline is achieved by following industry standard ontologies. However due to the growing number of standards to address the heterogenous nature of product data, this becomes a challenge.

**Fragmented IT landscape and data sources (IT in silos):** Today's IT landscape is an amalgam of several IT architectures, from legacy mainframe systems to open system architecture and to microservices-driven cloud components, making it difficult to establish product data flow.

**Continuous mergers, acquisitions, and divestitures:** Mergers & acquisitions (M&As) and divestitures introduce complexities in the process and in the IT landscapes making it challenging to deliver connected data views.

## 2 Addressing the Challenges with Digital Thread – Key Characteristics for Value Realization

To address the challenges, organizations have started various digital transformation journeys, one of which is to establish an Enterprise Digital Thread.

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**Digital Thread is a transformation approach to interlink considerable product data generated by various operating entities of an enterprise and its extended enterprise as the product evolves from the concept stage till it is maintained as an asset in the field and to its end of life.**

Digital Thread enables seamless flow and visibility of information across the operating entities and extended entities with accurate contextual data required to make timely and informed decisions.

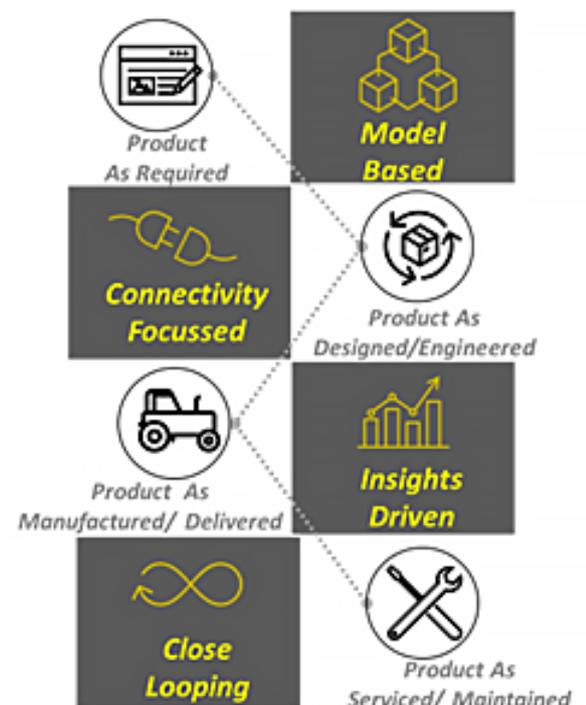
**Digital thread must have the following four characteristics to realize the complete benefits.**

**EModel based:** High-fidelity models with parametrized information to understand/simulate the functioning of systems comprising the product.

**Connectivity focused:** Contextual information from enterprise IT systems available to all stakeholders across various operating functions

**Insights driven:** Intelligent insights to identify existing issues or innovate new possibilities

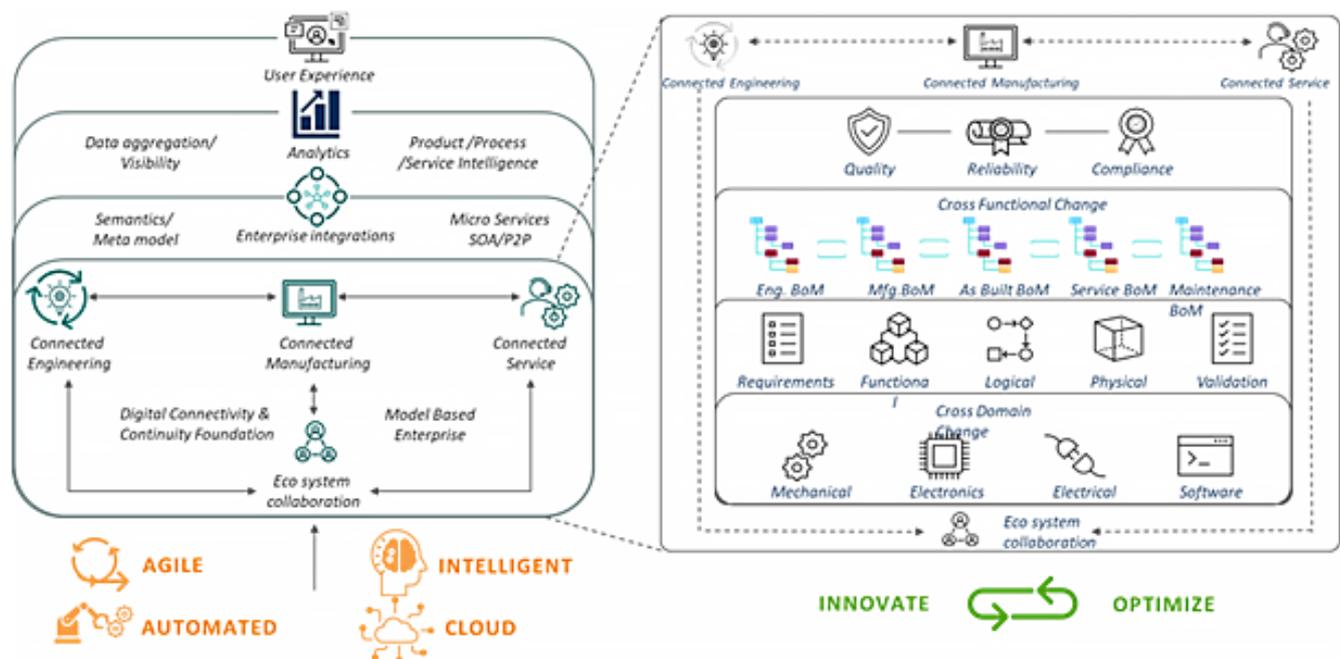
**Close looping and traceability:** 'Right to Left' connectivity for feedback that enables corrective/improvement actions.



### 3 Digital Thread Platform Architecture

Implementing digital thread requires a platform-centric approach as the capabilities required to address the lifecycle of a product are distributed across multiple systems, such as PLM, MES, ERP, EAM, and legacy systems. In addition, technologies such as automation, cloud, analytics, and AI/ML need to be leveraged.

**Figure 3: Digital Thread Architecture**



**A framework to build the platform needs a five-layered model as follows:**

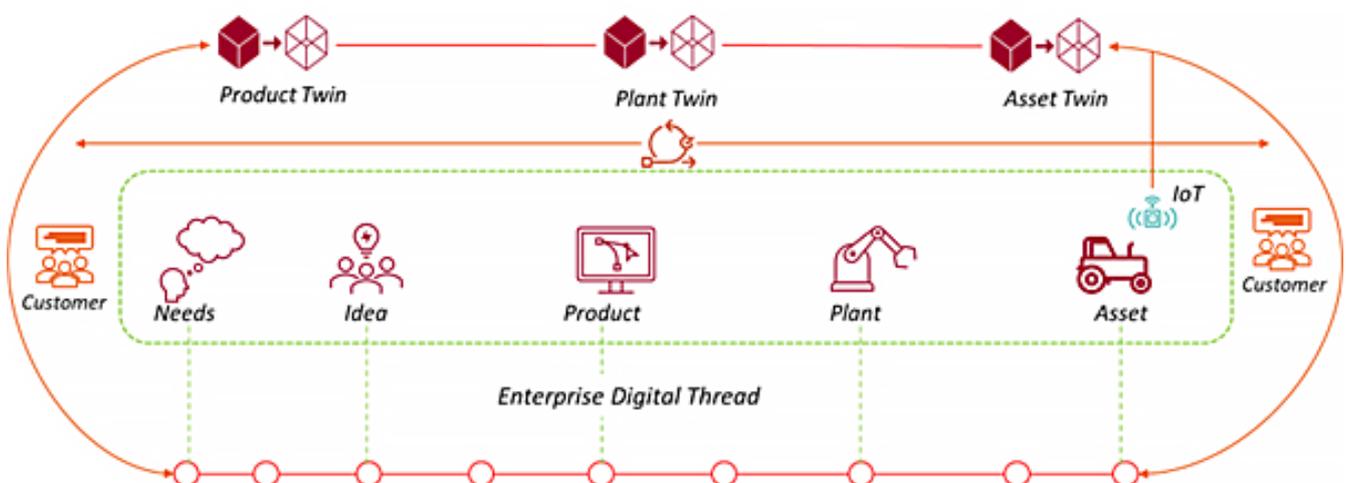
- **Functional capabilities layer:** All the capabilities required to orchestrate the product lifecycle.
  - PLM/PDM foundation
  - Multi-domain product development
  - Model-based systems engineering
  - Manufacturing / Supply chain integration
  - Asset / Service life cycle integration

- **Enterprise integration layer:** A service-based orchestration layer, built on industry standard semantics for data interoperability and exchanges, such as OSLC, FMI and STEP, and for technologies such as microservices, knowledge graph navigation, data streaming to provide a resilient and scalable integration capability.
- **Analytics and insights layer:** A data aggregation and data science layer powered by AI/ML capabilities to establish intelligence across the evolution of product, monitor and track metrics and KPIs, and provide persona-based insights to enable faster and more informed decision making.
- **User experience layer:** To render the product lifecycle data in the form of persona-based dynamic views using knowledge graph, mixed reality, augmented reality or virtual reality capabilities.
- **Cloud infrastructure:** To improve collaboration among different stakeholders, connecting lifecycle processes, improving data availability and visibility to take informed decisions and reduce operational and setup cost.

## 4 Convergence of Digital Thread and Digital Twin

Digital thread, by virtue of being the orchestrating platform of all product lifecycle data, is essential for constructing Digital twins. The data flow that it provides helps in defining the twin and keeping it up to date in real-time during the design/manufacturing phase or operational phase of the asset.

**Figure 4: Digital Thread enabling the Digital Twin**



# 5 Digital Thread Business Value



Increased visibility and control of product data and processes required to manage product evolution complexities



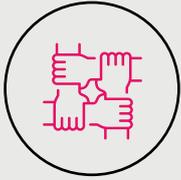
Agility in decision-making enabling faster responses to market requirements



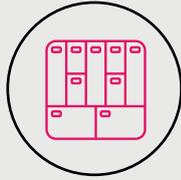
Connected Digital and Physical World by constructing Digital Twins to provide closed loop feedback



Improved Insights and Actions through enterprise connectivity and model-driven data

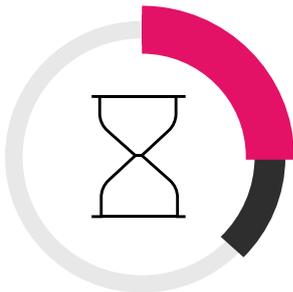


Foster deep collaboration across the ecosystem to deliver complex products faster

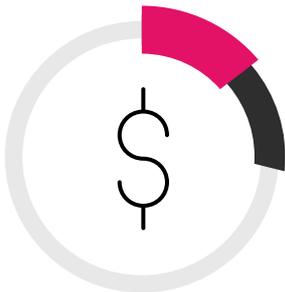


Foster new business models leveraging the data and orchestration capabilities

Time to Market  
**30% to 40%**



Product Development Cost  
**20% to 30%**



Product & Service Quality  
**40% to 50%**

