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WHITEPAPER

DEVELOPING PRODUCTS MORE EFFICIENTLY WITH THE DIGITAL THREAD

A digital thread is a digital backbone, that links information from different data sources. It is a prerequisite for the traceability of development processes across domain boundaries. Without a digital thread, complex mechatronic products with a lot of software and electronics can no longer be developed efficiently. This whitepaper explains how to set up a digital thread and the advantages it offers.

Introduction

The digital thread is the key to the efficient development of complex mechatronic products, which usually involve different disciplines and domains. This is precisely why it is so difficult to weave the digital thread, because it has to relate information from a variety of different domain systems, for example, to be able to analyze the effects of changes. To do this, companies need tools that allow them to easily access domain systems and make the information relationships transparent. PROSTEP's white paper describes what such a solution might look like and which requirements and use cases it should support.

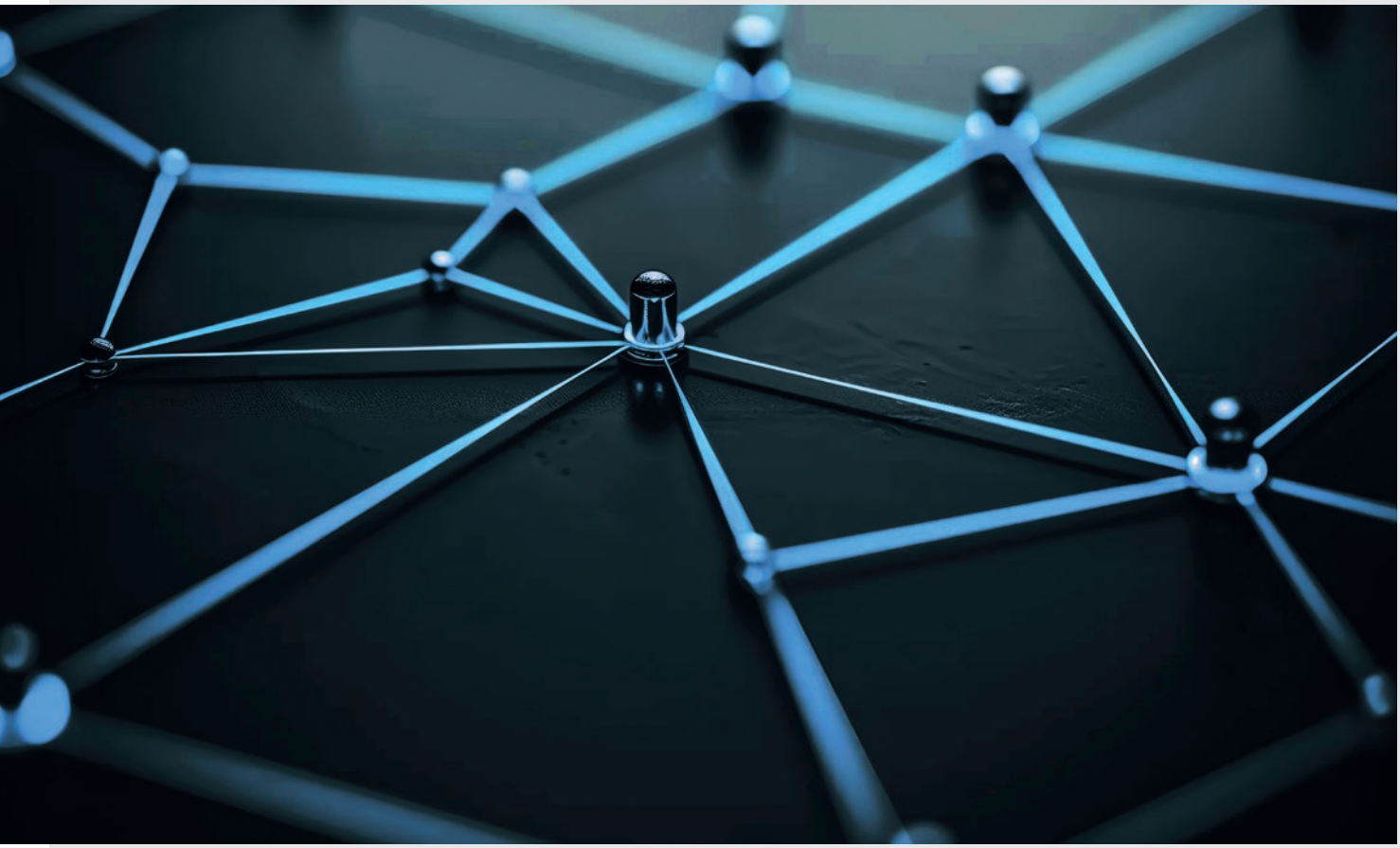
The Digital Thread Connects What Belongs Together

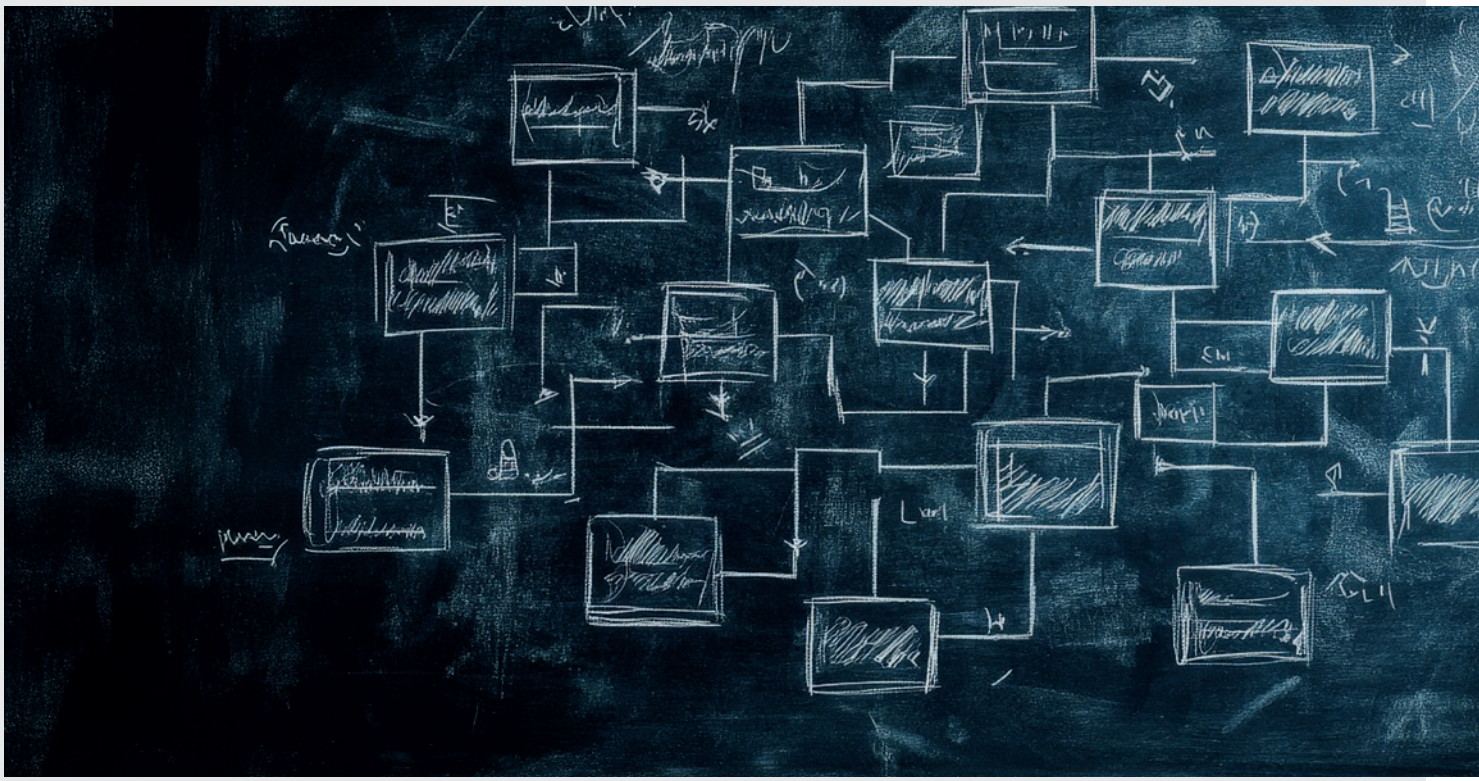
Connecting what belongs together – that is the task of the digital thread. It is essential for traceability, in other words the ability to understand how a product was created, why it was created in this way or what could be the causes of possible defects that occur during use. A typical use case is the change management of mechatronic products. In order to be able to predict the effects and influences, you need the digital thread, which maps the dependencies across domains.

In the past, when products essentially consisted of mechanical assemblies, it was much easier to create the digital thread. The product data was usually created with an authoring system and managed in a PDM or PLM system. In the meantime, mechanical products have become networked systems with a lot of electrics/electronics (E/E) and software, which can be updated over the air during the operating phase or perhaps even offered as a complete service. Various disciplines and domains are involved in development, production and operation, which generate and manage their mechanical, E/E and software artefacts with different IT systems.

The problem is that these artefacts do not exist independently of each other, but fulfil certain functions together. However, what interacts and how, and how it can influence each other in the event of changes, is not precisely documented anywhere. It only becomes clear through dialog between the disciplines and domains involved. However, their development statuses are usually only compiled at certain milestones because this is very time-consuming.

Companies could save an enormous amount of time if they were able to link the information about the related artifacts once and maintain these links throughout the entire life cycle of the product. Time that they could use to speed up the market launch of new products, but also to incorporate user feedback from the field more quickly into changes and improvements. The digital thread would also open up enormous potential benefits for them in terms of documentation. In order to build it, various challenges have to be overcome.





Product Complexity – A Challenge in Product Development

Companies today are faced with a dilemma: the increasing complexity of product development is literally crying out for a digital thread in order to manage it more efficiently and make it easier to understand. However, it is precisely this complexity that makes it difficult to set up the digital thread because more and more disciplines and domains are involved in the product development process. They all use their own authoring tools and data management systems, which are generally not particularly well integrated. And even if they are, it makes little sense to bring the relevant information together in a domain-specific application.

Requirements management alone is complex. When developing systems, the various domains not only have to meet increasingly demanding requirements in terms of functionality and connectivity, but also comply with ever stricter standards and guidelines regarding product safety and environmental compatibility. And they must also be able to check and fully demonstrate compliance with these requirements and the applicable regulations.

This is no easy task when some of the requirements are still recorded in documents and companies do not actually have a standardized system with which they can manage them across domains and over the entire life cycle- with the possible exception of Excel. In addition to dedicated requirements management systems, the requirements are partly in the ALM systems and partly in the PLM systems. This “patchwork” is propagated throughout the entire development process, which usually follows the V-model. Although each domain can create its own domain-specific digital thread, there is no cross-domain view of the data and the process.

This fragmented digital thread makes it difficult to understand whether the specified systems and subsystems will ultimately meet the requirements of the overall system, especially as these requirements can change during the course of development. There is no reliable basis of information. Companies need a solution that connects the domain-specific digital threads and enables them to gain a holistic view of the product. To do this, it must be able to support the cross-domain processes.

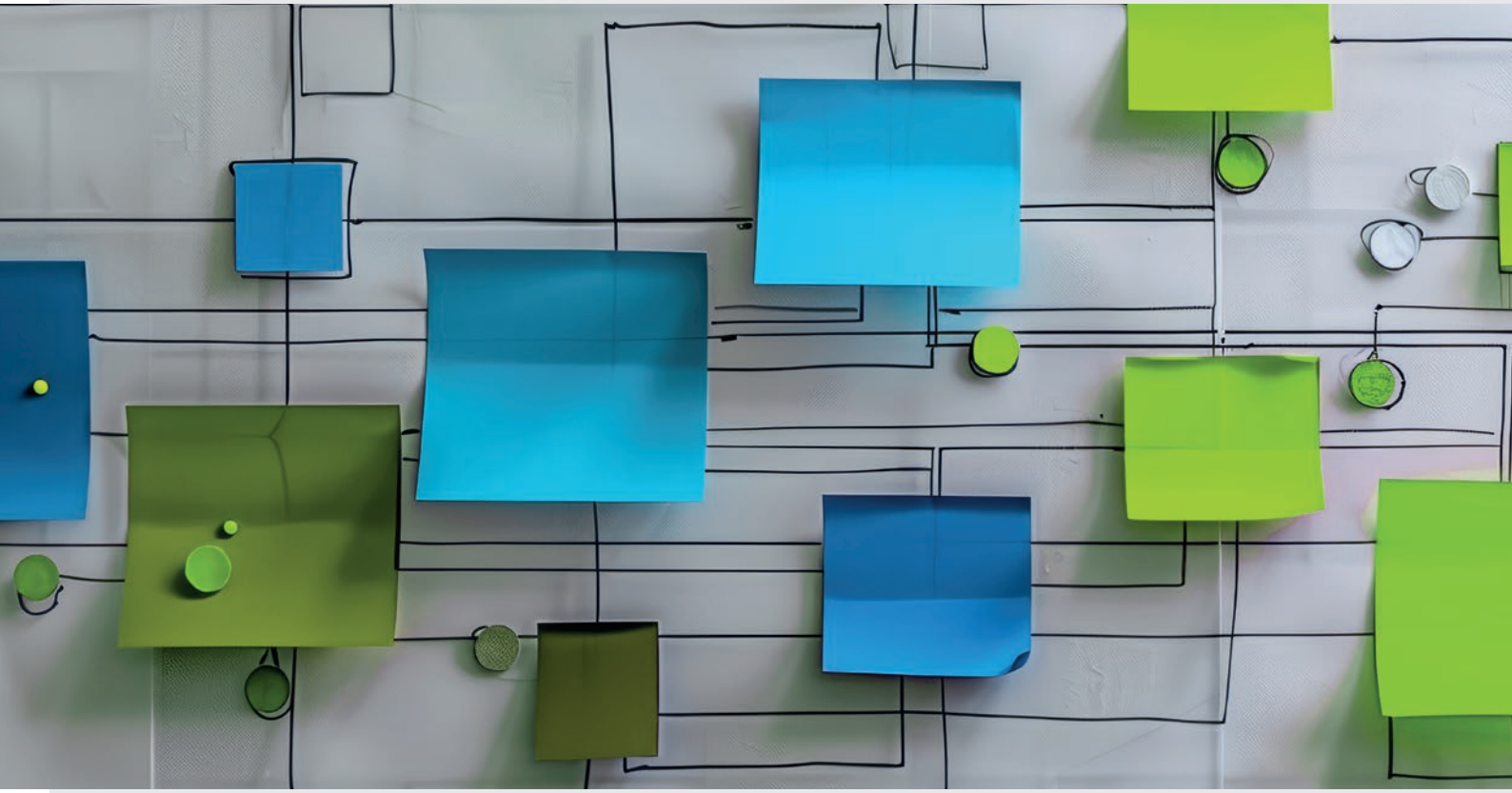
Applying Cross-Domain Processes

Development processes differ from industry to industry because they have to meet different industry-specific standards. This applies not only to the automotive industry, which usually uses the A-SPICE reference process model for the development of electronics and mechatronics, but also to highly regulated industries such as aerospace or medical technology. In addition, every company has a slightly different interpretation of these general process specifications, which must be taken into account when setting up a digital thread.

A digital thread solution must be able to map the process in such a way that it is compliant with industry-specific standards and at the same time corresponds to the company's practices. And it must also be able to provide evidence of this. Ideally, this is done using templates provided by an appropriate solution. And the whole thing can of course be adapted to the company's specific processes and procedures so that, for example, an intermediate stage can be built into the process or two phases can be merged.

The mapping of processes across domains thus corresponds to horizontal integration. If the explicit artifacts in the domain systems are now referenced, vertical integration can also be achieved. Only the combination of horizontal and vertical integration makes it possible to create a digital thread that makes the development status traceable at any point in the process and also documents it reliably in the form of so-called baselines.

The processes are described in the form of workflows, which not only contain the individual steps but also reflect the status of the information objects. Ideally, a digital thread solution can track the overarching process on the one hand and trigger the individual processes in the domain-specific systems on the other, retrieve the status information and display it as a whole. This can be done, for example, by using a template for cross-domain change processes that orchestrates the individual domain processes and supports industry specifics such as A-SPICE. This template should be configurable so that customers can bring it to life by adding tasks for the components to be developed.



Global Change Management Connects the Domains

There are a variety of use cases that require cross-domain collaboration, starting with systems engineering and requirements management in the early phase of product development. Once the product is in the utilization phase, change management gains in importance. This may be defined for a specific industry, such as the change process according to VDA or A-SPICE. Furthermore, the creation of a robust and reliable documentation is a relevant use case.

The origin of changes can vary greatly. Depending on the industry, they can be triggered by changes in legislation or new scientific findings. A classic case is certainly feedback from customers that something is not working as expected. And this issue is also the starting point for a change. For this purpose, the requirements are first specified and alternative solutions developed. Once an alternative has been chosen, it is specified in the change request. Various departments use the relevant domain tools for their change processes, both for the specification and for the execution of the change request. However, the changes from the other domains are synchronized in meetings or by means of agreements via email or chat.

The complexity of today's mechatronic products requires an option that allows the change process to be mapped digitally as a cross-domain process, while at the same time linking it to the corresponding artifacts in the domain systems. In other words, to create the digital thread in the context of the change. This then enables dependencies to be brought together and mapped in terms of both context and process. In short, the engineers need a change cockpit that allows them to visualize the information in context and see their work progress.

In this cockpit a digital change thread is created, linking the process and data view. This orchestrates the individual domain-specific change processes and brings them together centrally. In addition, the maturity level of the changes is aggregated and the domains' position in the change process is reliably documented. This is achieved via the references that retrieve the status from the connected IT systems.

Cross-Domain Documentation of Processes and Deliverables

If several departments are involved in product development, the work progress and deliverables are usually documented in the domain-specific authoring and management systems. But not in their entirety because coordination between the departments often takes place in meetings and telephone conferences and subsequently only documented in emails or chat histories. This makes it challenging for project managers to keep track of the current development status and makes the decisions made by the departments during the development process difficult to understand.

In industries like the aerospace and medical engineering industries, the requirements relating to the obligation to provide proof of compliance are very stringent. Cross-domain documentation provides the basis for traceability. The documentation must be seamlessly integrated across all domains to ensure that the deliverables provided by the individual domains fit together and meet the requirements of the overall system. This is the only way, for example, to keep track the impact of changes throughout the entire system and to clearly identify the subsystems impacted by a change.

However, most companies do not have centralized digital documentation that allows for traceability. In order to be able to create audit-capable documentation, they need a central system in which all information comes together, is placed in a chronological/process-related context and is recorded unalterably. This does not mean that this system has to contain all the information relevant to documentation. It only needs to know the domain-specific systems in which this information is located and what version or status it had at a certain point in time.

One of the key questions that the documentation must answer is when which decisions were made and on what information basis. This only works if the information can be assigned to a timeline. Baselines, for example, which record the status of a project/process including the associated objects at a specific point in time, are helpful in this context. Cross-domain documentation is therefore the basis for traceability, which is becoming increasingly important for companies.

Traceability is Key for All Companies

Traceability is a must in strictly regulated industries such as aerospace or medical technology in order to obtain market approval. In principle, however, all industries with complex mechatronic products can benefit from traceability. Among other things, it makes possible to trace and eliminate any errors that occur more quickly.

The increasingly stringent requirements in terms of environmental compatibility and sustainability apply not only to large, global companies but also to the small and medium-sized companies in their global supply chains. If these companies do not meet these requirements, they lose the trust of their customers and ultimately their orders. It is therefore advantageous for companies of all sizes and from all industries make an investment in ensuring traceability.

A key component of traceability is cross-domain requirements management, which enables customer requirements and legal requirements to be assigned to specific functions and then broken down to subsystems, assemblies and components. At the same time, it must enable companies to assess the impact of changes and ultimately provide evidence, for example in an audit, that the developed product meets all requirements.

Ensuring traceability today involves a considerable amount of time and effort. There is no central system that keeps all (digital) threads between requirements, development artifacts and the test cases for verification and validation in hand and makes their temporal states transparent throughout the entire development process along the famous V-model. In order to ensure efficient traceability, the domain-specific IT systems must therefore be linked and the data linked in such a way that it can be made available across domains and, if necessary, across companies. Ensuring cross-domain traceability is one of the key tasks of the software OpenCLM, which is an integral part of PROSTEP's Digital Thread platform.

OpenCLM – A Lightweight Traceability Solution

The digital thread of complex mechatronic products lives in different company applications. These systems already provide traceability functions, but not across domain boundaries, especially in heterogenous IT landscapes. One way to ensure end-to-end traceability is to consolidate all the data in a single system. If consistency is to be ensured, large volumes of data would have to be continuously exchanged and synchronized between different IT systems, which would not be compatible with the dynamic nature of the development process.

The alternative to data replication is a lightweight, web-based application that lays over the existing IT systems and links the information objects stored in them in a process-oriented manner (vertical integration). This way, the application does not manage the data and documents themselves, but only the relationships between them and uses them to create a cross-domain information model. The digital thread is nothing else. However, the application is also capable of mapping processes with their stage gates or milestones (horizontal integration) and recording the maturity level of the data for a specific milestone, i.e. generating so-called baselines.

An essential prerequisite for the use of linked data technology is powerful connectivity. PROSTEP's traceability solution OpenCLM uses standard connectors to access the data in common PLM, ALM, ERP systems or other enterprise applications. In addition, an OSLC adapter allows communication with OSLC-capable source systems and thus also links to these systems. For all other cases, there is a connector template that can be configured to connect legacy systems to OpenCLM. This makes OpenCLM system-agnostic and flexible to use. A further advantage is the possibility to adapt the names of the objects in OpenCLM to the terminology of the respective company.

OpenCLM is web-based and can be used both on-premises and as Software-as-a-Service (SaaS). However, the application can also be used in hybrid cloud-on-premises scenarios. One of the key advantages of the solution is that it makes the digital thread independent of the domain IT systems. The links between the information objects are mapped independently of the domain IT systems used and are retained even if a system is changed.

Efficient, Dynamic, Integrative, and Reliable

Organizations have a number of advantages by using OpenCLM. One of the unique selling points that the solution supports both the horizontal integration of cross-domain processes and the vertical linking into the respective domain systems. Unlike other systems, the object statuses are orchestrated in the digital thread solution and not in the domain systems. There is a common baseline for all referenced objects and there is centralized and immutable cross-domain documentation.

OpenCLM can be easily customized to the requirements of the respective company thanks to the corresponding process templates, while also enabling a high degree of automation through appropriate workflows. Tried and tested standard connectors, which are regularly updated, and an OSLC interface ensure an easy connection of common PLM, ERP and ALM systems, as well as other enterprise applications, to the digital thread. Because OpenCLM only orchestrates the data and does not replicate it, the Digital Thread solution is very efficient. The effort required to search for relevant information in the connected domain systems is significantly reduced thanks to cross-system and cross-domain traceability. At the same time, it is ensured that users have access to precise object versions.

OpenCLM ensures a high degree of reliability in cross-domain processes through centralized documentation and baselining. The information is presented in a clear cockpit according to the need-to-know principle and serves as a jumping-off point to the respective domain systems. Cross-system traceability is maintained even if individual domain systems are replaced, giving companies a high degree of flexibility.

If you would like to know more about OpenCLM and the supported use cases, please contact us.

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Do you have any comments or questions?

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