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THE IMPORTANCE OF DATA IN THE SPACECRAFT PROJECT LIFECYCLE AND THE CREATION OF THE FIRST DIGITAL DATA ECOSYSTEM FOR THE SPACE DOMAIN: COOPERANTS.

Abstract

The importance of data throughout the spacecraft project lifecycle is undeniable, acting as both a foundational element and a crucial product. Data, serving various roles such as design, configuration, and results data, underpins the success of spacecraft projects and ultimately mission outcomes. Efficiently collecting, storing, processing, analyzing, visualizing, and sharing data lies at the heart of data spaces. This paper will investigate how, in the space domain, data spaces might play a vital role in propelling spacecraft engineering and collaboration forward.

The paper examines the roles of data and their impact on shaping the inaugural digital ecosystem for the space domain: COOPERANTS. Highlighting the latest advancements and achievements, COOPERANTS stands as a pioneering initiative leveraging data space technology, rooted in the GAIA-X conceptual framework. This includes, but is not limited to dataspace infrastructural services (i.e. cloud services), federation services, i.e. services which facilitate the operation of the dataspace (identity, trust, contracting, data exchange) and advanced smart services. In the Gaia-X framework, an advanced smart service refers to a highly integrated and secure digital offering which provides novel solutions tailored to specific use cases while ensuring data protection and privacy.

By establishing virtual collaborative environments based on said smart services, COOPERANTS facilitates smooth data sharing, analysis, and collaboration among spacecraft engineering stakeholders. The paper will delve into key milestones, challenges overcome, and lessons learned from the project's demonstration phase, showcasing their transformative influence and ability to accelerate the progress in the digitization of spacecraft engineering. For this we will show key use cases for the data ecosystem in different stages and tasks throughout the project lifecycle, considering (Model-Based) Systems Engineering ((MB)SE), Domain Engineering, Manufacturing, Integration, Assembly, and Test (MAIT). These use cases comprise collaborative programm management, customer-prime collaboration in (Model-Based) Systems Engineering, functional digital twins and many more.

In the realm of digital twins for example, data serves as the linchpin, enabling seamless communication between physical assets and their virtual counterparts. Here, real-time monitoring, analysis, and simulation are indispensable for predictive maintenance, optimization, and innovation across the industry. The symbiotic relationship between MBSE and data is evident, deeply intertwined with spacecraft lifecycle business processes. From data inputs to representation in models, and from data-driven analysis to decision-making, MBSE is closely connected to data management and outputs. The paper will scrutinize

these various functions of data and explore how data spaces can enhance them, drawing insights from the project's demonstrators and pilots.