Smart Systems Engineering - SmartSE

Executive Summary

Project Phase VI

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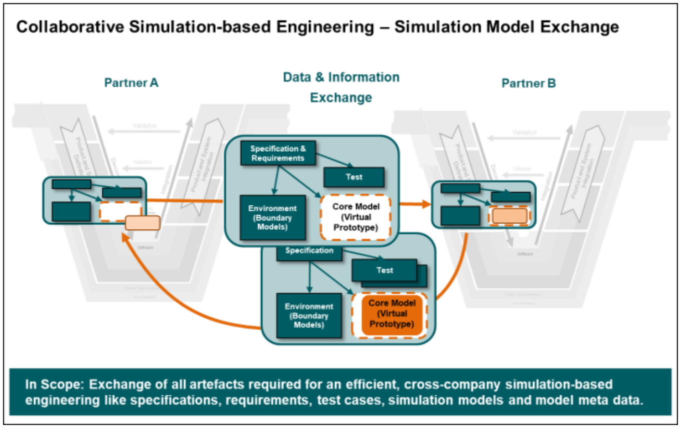
In order to accelerate the development of complex mechatronic systems, such as those used in the automotive or aerospace industries, and to save costs, these systems are increasingly being developed using systems engineering approaches and validated virtually. Since development activities are typically spread across a long supply chain, simulation processes and data formats must be standardized so that simulation models and other simulation-related data and information can be exchanged between different partners and used in different applications.

The SmartSE project group

The Smart Systems Engineering – SmartSE - project group of the prostep ivip Association aims to develop application-oriented concepts for cross-company collaboration in simulation-based systems engineering. To this end, SmartSE develops approaches and solutions for distributed, collaborative system development between partners, with a focus on model- and simulation-based development and validation. SmartSE formulates and combines the requirements of manufacturers and suppliers in the manufacturing industry, for example in the aerospace industry and particularly in the automotive industry. For this purpose, the SmartSE project group defines working methods, best practices, as well as standards and interfaces. In addition, it provides IT vendors with a forum to improve the interoperability of different IT solutions.



A special feature of the SmartSE project is its strong practical orientation: the results are application-oriented concepts for addressing the shared challenges of systems engineering and model-based development. SmartSE formulates recommendations for process design, promotes technical standards for the collaborative development of complex mechatronic systems, and ensures improved transparency of systems engineering objects.

The SmartSE project group consists of a group of around 25 companies and research institutions, including both user companies and IT vendors.

Core scenario „Simulation Model Exchange“

The SmartSE project focuses on the exchange of simulation and model-based development objects that are required for efficient collaboration between the involved partners, such as an OEM and a supplier. These include artifacts such as specifications, requirements, test cases, simulation models and their parameters, as well as associated metadata that are necessary for efficient, cross-company simulation-based development.

As a result, SmartSE provides answers, solutions, and recommendations for typical questions and problems in distributed development scenarios between partners, such as:

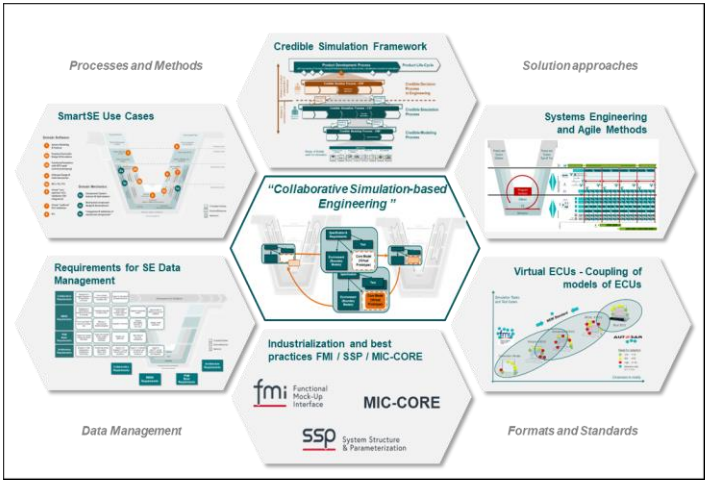
- *What needs to be exchanged between the partners involved in the development of a system or a component for a specific MBSE application?*

- *How can the process of performing a simulation task across companies be optimized?*
- *What approaches are there for exchanging the necessary simulation models and accompanying information for this type of use case?*

Selection of SmartSE project results and approaches

In addition to the core scenario "Simulation Model Exchange," the SmartSE project group has devoted itself to various aspects and challenges of cross-company simulation and model-based development over the past 15 years and has developed these solutions.

- *Detailed collection and description of **SmartSE use cases** for the creation, exchange, and use of simulation models in collaborative development processes between system manufacturers and their suppliers*
- *Collection and description of **simulation tasks** as concrete, differentiated activities with a specific purpose in the area of cross-company and cross-domain development and virtual validation*
- *Detailed analysis and description of the simulation tasks "**coupling of control unit models (V-ECUs)** with each other and with environment/plant/vehicle models" and derivation of requirements for optimal support by standards such as FMI or AUTOSAR*
- *Enabling the **traceability and reproducibility of simulation tasks** within the collaborative product development process through a generalized process framework, the "Glue Particle Approach", as well as through the "SSP Traceability Format" and formats such as the MIC Core Standard*
- *Detailed description of the **"Credible Process Framework for Simulation"** as a structured approach for using numerical simulation to support decision-making and simulation-based release in the product development process*
- *Concept of how **systems engineering and agile methods** complement each other and how the advantages of both approaches can be exploited*



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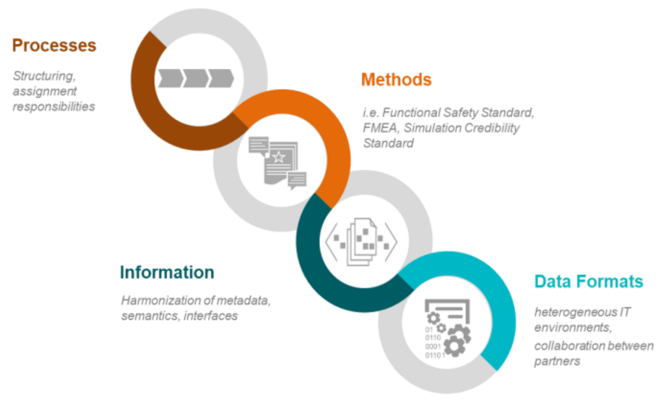
Mission statement and building blocks for targeted standardization

The “building blocks for targeted standardization” represent a central approach and mission statement for numerous standardization activities of the SmartSE project group. In line with the philosophy of the SmartSE project, standardization should never be an “end in itself,” but rather support industrial use cases in order to achieve a high level of acceptance. The main source for deriving relevant information and data for describing standards is a detailed analysis of the processes and methods associated with industrial use cases. The four building blocks - processes, methods, information, and data formats - must be considered holistically in terms of their interaction.

Guiding principle and building blocks for a targeted standardization



The “building blocks for targeted standardization” approach is used in particular in connection with supporting the traceability and reproducibility of simulation tasks through standards.

Intended benefits and business value of the SmartSE project

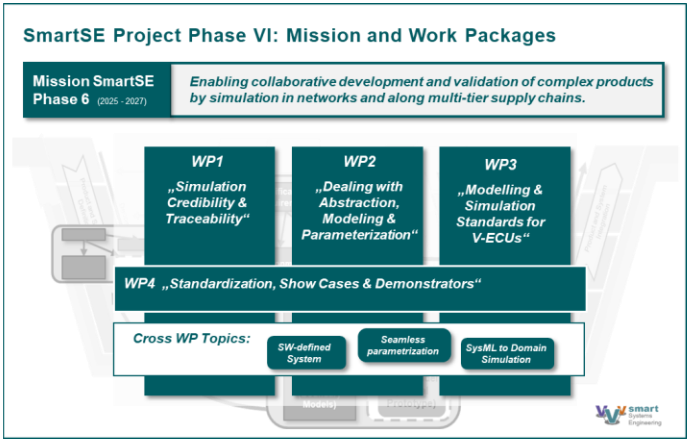
The SmartSE project aims to deliver significant benefits by promoting efficiency, quality, collaboration, and innovation in the development and validation of increasingly complex products and systems. Clear standards, simulation-based methods, and the optimization of distributed development processes enable companies to develop complex products faster, more cost-effectively, and more reliably.

SmartSE's solutions and approaches offer a clear competitive advantage, particularly in industries such as the automotive, aerospace, and medical technology sectors, by addressing the challenges of modern product development.

- ***Increased efficiency in product development*** *by reducing hardware testing, shortening development times, and harmonizing processes and standards in collaborative, simulation-based development*
- ***Improved quality and precision of numerical simulations****, as well as their traceability and reproducibility, for transparent and comprehensible product development*
- ***Optimization of collaboration*** *in distributed development networks through the use of clear interfaces and standards*
- ***Risk minimization*** *in the development and validation of complex systems*

Current SmartSE project phase VI (2025 – 2027)

The results available so far show that SmartSE's practical approach contributes significantly to its success. Our publications, such as the SmartSE Recommendation, white papers, and best practices, are always up to date and cover current topics. It is only logical to continue along this path, to further advance current topics, and to provide a discussion platform for them. In particular, topics such as “simulation Credibility and Traceability” and “Use and Exchange of Virtual Electronic Control Units (V-ECUs)” from the more recent project phases, which have already achieved excellent results, offer potential for further research.



With the increasing demands on the validation of complex systems and products, both the model exchange between two partners and the entire supply chain must be considered. Each of the partners involved uses different methods for validation, as they all work at different levels of abstraction. This increases the difficulty of ensuring traceability and simulation quality in the collaboration network. With the focus on autonomous systems, there are now additional aspects that need to be taken into account. These can only be realized through a good symbiosis of classic mechatronic elements and software. Looking at the development of these two areas, it becomes clear that the development cycles and thus the development methods are fundamentally different. This means that even the classic V-model must be viewed from the perspective of constantly evolving products.

Focus of the current project phaseVI (2025–2027)

Enabling collaborative development and validation of complex products by simulation in networks and along multi-tier supply chains.

With project phase VI, which started in 2025, the SmartSE project group offers a platform for further discussion and the development of solutions.

In detail, the SmartSE project addresses the following topics in project phase VI:

- *Development of **best practices** for the use of simulation in networks and along multi-level supply chains with a focus on simulation credibility and traceability*
- *Development of approaches for **dealing with different levels of modeling and abstraction** when simulations are used at different levels by suppliers; this requires the development of different modeling and collaboration approaches*
- *Analysis of challenges in the use and **exchange of virtual electronic control units (V-ECUs)** and definition of specific requirements for standard extensions*

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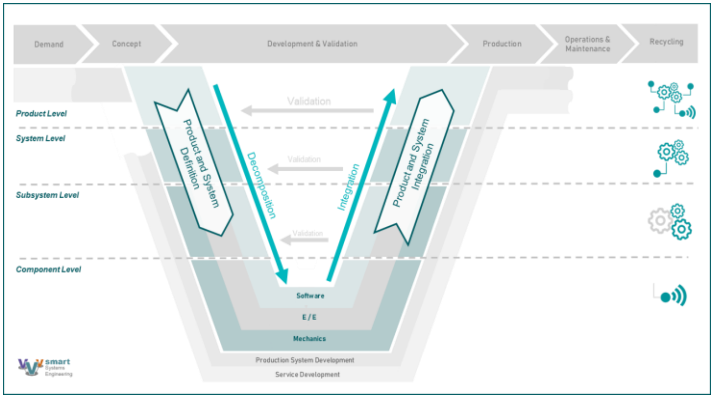
- *Establishment of a **central contact point for SmartSE-relevant standards** such as FMI, SSP, SSP Traceability, and SysML*
- *Creation of **demonstrators and show cases** for the collaborative simulation- and model-based development of use cases using SmartSE-relevant standards*
- *Identification of **potential for AI** in simulation- and model-based development*



Summary

SmartSE promotes harmonization and standardization in model- and simulation-based systems engineering. With its practical focus, the project continuously integrates new trends from the automotive and aviation industries. For 15 years, SmartSE has been publishing white papers and best practices that are used across industries. An important milestone was the establishment of the FMI standard as the leading exchange format for simulation models. SmartSE continuously updates recommendations for FMI users.

The project coined terms such as core and boundary models and develops strategies for protecting intellectual property in simulation. Another focus is virtual validation, especially for autonomous systems. SmartSE developed the Credible Process Framework for Simulation and is investigating the SSP standard and virtual ECUs (VECUs). The project also analyzes the integration of classic systems engineering methods with agile development approaches to enable seamless collaboration.

Key success factors of the SmartSE project are its broad focus with work priorities at various levels, its focus on pre-competitive future topics, the composition and continuity of the consortium of business partners, IT providers, and SE specialists, and the mentoring model used to coordinate the work packages.

„SmartSE offers a holistic vision for the use of simulation in decision-making processes, including in collaboration with partners. In addition, concrete results that can be implemented in companies are continuously being produced, supported by demonstrators..“

Read also:

A selection of our publications ...

SmartSE Recommendation V4

SE Data Management for Simulation Model Exchange

pubished 05/2025

White Paper

Guard Rails for „Simulation Credibility Standards and Recommendation“

pubished 3/2024

White Paper

System Engineering and Agile Methods

pubished 3/2024

White Paper

System Structure and Parameterization

pubished 1/2022

White Paper

Virtual Electronic Control Units – vECUs

pubished 3/2020

White Paper

Simulation-based Decision Making and Release

pubished 6/2021

Contact

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Further information on the SmartSE project can be found here: