SIEMENS DIGITAL INDUSTRIES SOFTWARE

Updating **MBSE with SysML v2**

Executive brief

Siemens is dedicated to helping customers create the next generation of products, when delivering innovation and performance comes from finding the optimal concept designs among thousands of possibilities. Equally important is our ability to seamlessly connect with product engineering for executing the design, development and verification during product engineering.

Companies face many challenges – a concept could be perfect but impossible to produce or a product could meet every engineering goal but is so costly it would never be successful. For the complex products of today, balancing these extremes requires next generation Model Based System Engineering (MBSE) solutions to help set the scope of the program with robust requirements engineering and optimized product architectures. It also requires establishing a verification plan that leverages continuous virtual verification to reduce program risk and stay on schedule. The goal of MBSE practices is to deliver a feasible concept to product engineering while enabling all necessary stakeholders' access to the product requirements whether those are representing physical needs, business needs or integrations of the many systems.

All of this is underpinned by Systems Modeling Language (SysML), and though it has provided ample room to grow designs, the breadth of today's products has become far too wide for the original implementation. An upgrade is required to meet the challenge of today's complex products and the ever-increasing complex products of the future. Because of this we are an active partner in shaping this future for system modeling within the comprehensive digital twin. When an individual aircraft can contain millions of lines of code, miles of wiring, hundreds of mechanical systems, hundreds of electronic boxes and must work flawlessly every time, it is essential that your system modeling solution can handle every piece of information. Highly assisted driving, electrification, and the progress for full autonomy in automobiles has dramatically increased the sensors, software, controllers, wiring, and system of systems growth for the industry. This pattern repeats across almost every industry, including heavy equipment and medical technology. The first iteration of SysML was originally meant for software, so adding in every

other engineering domain for aerospace and automotive development proved to be unsustainable. The evolution of SysML v2 is critical to enable a truly comprehensive MBSE process that retains a single source of truth and can freely communicate information in and out of the enterprise.

SysML v1 – An aging standard

To understand model-based systems engineering, it can be helpful to split the term in half. Model-based refers to using informed data on market needs like cost, time and quality, but also technical studies on feasibility, risk and performance. Decisions are made earlier with this information in the concept design phase and communicated through the models to product engineering. System engineering is the method for making these decisions, often through the reuse of existing models, to ensure the complex integrations are wholly defined for product engineering. SysML v1's greatest limitations are that:

- The standard was built for software development, while it is an important feature of many products today, it is far from the only discipline being engaged
- The limited number of models forces systems to be consolidated, reducing the ability to reuse them in later development tasks
- The definitions themselves are imprecise, which makes complex systems of systems a greater challenge when coordinating separate teams
- The limits of a graphical modeling language have forced most users to extend the language leading to obstacles of exchange and interoperability across a broad supply chain

The discrepancy between the goals of SysML v1 tools and reality are highlighted in a recent SERC survey on the maturity of MBSE. Aside from the facts that modeling provides measurable improvement to designs and that it is secure, engineers disagreed with the benefits managers and executives understood the tools provided. To the engineers, the process is valuable to development quality but without a mature solution it is very difficult to implement effectively. And most of these issues came down to accuracy and communicability of the models.

Some vendors and OEMs have expanded the abilities of SysML v1 solutions to work around the limitations, but these are often proprietary in their implementation which goes against the reason for using a standardized backbone. Poor information transfer is still a dramatic disadvantage for programs involving many different suppliers, whether in-house or third-party firms with SysML v1 based MBSE tools.

Customers require MBSE solutions that scale with the large, complex systems of systems that define today's products, provide interoperability between applications and tools, and enable effective collaboration within their teams and value chain. Implementing the new, SysML v2 standard and next generation MBSE solutions within the Xcelerator portfolio will correct these limitations while providing an open environment to share information between customers and suppliers in development within the comprehensive digital twin.

Architectural definitions drive development

Much like the progression CAD software saw from wireframes to 3D photorealistic modeling, system modeling is primed for a major evolution. The updates of a SysML v2 platform provide the necessary process for today's complex product development from concept through engineering. A greatly increased number of models enables product definitions on a per-system basis and even more granular if required that are usable by developers and consumers. The interoperability with other engineering models and tools enables a much wider architecture definition, from safety to in-depth performance balancing. And by extending the focus beyond software development, SysML v2 based solutions can break down the silos between engineering domains while maintaining the connection to requirements in domain specific applications. The multi-domain architecture then drives downstream development practices throughout the enterprise.

Each of these improvements on their own is a valuable addition to complex development, but all of them together provide a way to make better decisions faster than ever. Informed models can uncover correlations that would not otherwise be identified through an expanded design space, delivering the best product. The models can even include more abstract or statistical evaluations to remove risk and improve the quality of the product architecture. By integrating these models across engineering domains and the development process, information can be verified continuously.

A standardized process for this work is one of the most requested features of MBSE solutions in the SERC survey referenced earlier, providing a common understanding between teams. This furthers the similarities between CAD and system modeling tools. Siemens has always been a proponent of an open ecosystem across the digital enterprise. Just as Siemens was committed to developing the JT standard for CAD, we are leading and supporting development of the SysML v2 standard. And with continued work we strive to make the engineering view of MBSE solutions meet that of the management and executive positions working to implement them.

Not all solutions are created equal

A stable architecture plots the course for all of development and SysML v2 will benefit every user, with the greatest value gained by those that reuse model data across their enterprise with the comprehensive digital twin. This can come in many forms depending on the application, possibly as whole-sale reuse of specific models between products where an individual system remains the same. It may involve using a model throughout the development cycle, starting in the concept phase to define the product and progressing through product engineering, production and even service to guide these processes. Imagine selecting a subsystem from a previous product and bringing all the development information with it – that might be software to integrate it and the tooling information for manufacture.

The reason for adopting an open standard is all about communication, internally and externally. If a supplier or customer is utilizing a different solution, reliance on the standard means information and work are not lost in translation. This extends to those still using SysML v1, with hundreds of suppliers in a project it is very likely to have some suppliers still using the older language standard. By consuming this legacy data and integrating it into regular processes, the business can retain a single source of truth. A model, is a model, is a model, no matter the software tool – CAD, EE, Software Development or business process.

A bright future

When modern products can include mechanical, electronic, electrical and software domains, it is difficult to imagine using a modeling tool that can only account for a limited set of diagrams to express verifiable solution intent. Especially when each of these domains will likely contain multitudes of systems that integrate into the larger system of systems. Our commitment to SysML v2 is critical to the future of complex development – combining it with a comprehensive MBSE solution provides better decisions faster by shifting left. It removes risk and improves quality through optimizing and verifying a wider definition of the product architecture. And it breaks down the silos between development tasks to achieve seamless interoperability and exchange across the value chain. We will continue our work as an active partner in developing the next generation modeling language standard and a compliant MBSE solution to revolutionize how companies create, share and optimize systems across the enterprise with the digital twin.

Siemens Digital Industries Software
siemens.com/software

Americas 1 800 498 5351

Europe 00 800 70002222

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