SSP 2.0 – taking the next step in the standardized exchange of composite system models and simulation architectures

The [System Structure & Parameterization (SSP) standard](#) has established itself as a format for the exchange of composite system simulation models and simulation model architectures. SSP version 2.0, now released by the [Modelica Association](#), is a major milestone for the standard with new features that enable the use of FMI 3.0 and Modelica components, and the exchange of abstract simulation model architectures, improving support for new use cases: advanced co-simulation, virtual Electronic Control Units (vECUs), the next generation of Digital Twins, artificial intelligence, and autonomous driving applications.

SSP 1.0 has established itself as a widely adopted format for the exchange of composite system simulation models incorporating interconnected component models in the widely adopted [FMI standard](#) for the exchange of individual models. The royalty-free nature of Modelica Association standards, as well as their harmonized development and availability of open-source and commercial solutions right from the first publication have contributed to their adoption across many industries: automotive, aerospace, industrial equipment, buildings, energy, manufacturing, and others.

The development of SSP 2.0 has been guided by the needs of new use cases, the experience from current end users and developers, as well as the parallel development of the FMI 3.0 standard. The rapid digitalization of the engineering development process, and the growing needs for collaboration between suppliers and OEMs require technical advances to both FMI and SSP to continue the success story over the next decades. The major advances are the following:

- **Architecture Exchange.** Where SSP 1.0 focused on the executable simulation system as the point of interchange, SSP 2.0 enhances support for the exchange of architectural specifications, and their incremental refinement in collaborative development processes.

- **Advanced Co-Simulation.** The success of FMI has made the demand for high-quality co-simulation much more obvious. New technical features in SSP 2.0, based on corresponding new features in FMI 3.0 enable high-quality, robust co-

simulation of complex systems of models. The realm of the possible with co-simulation has grown significantly with both SSP 2.0 and FMI 3.0.

- **Broader Component Support.** SSP 1.0 supported FMI-based components out of the box, with SSP 2.0 adding direct support for Modelica-based components, as well as support for both causal and acausal connection semantics, and mapping of structured interface types to binary connectors. This also broadens the range of additional components that SSP can support going forward.

- **Virtual Electronic Control Units.** Digitalization of the development process is the ultimate goal to improve efficiency in product development, especially with embedded software. Virtual Electronic Control Units (vECUs) help to achieve that for embedded software development. SSP 2.0 adds support for the interconnection of FMI 3.0-based full-fledged vECUs into overall cyber-physical systems.

- **Layered Standards and Meta Data.** The concept of "Layered Standards", introduced with SSP 1.0, and now more widely adopted in FMI 3.0, allows users to embed artifacts from other standards within the SSP container in a systematic way. SSP 2.0 widens this support, especially in the areas of meta data and digital signature standards, greatly improving standards interoperability in a meaningful way. In this way SSP 2.0 will also serve as the basis for an upcoming layered standard on simulation traceability.

- **Next Generation Digital Twins.** FMI is a great format for component and system-level digital twins, executed in the cloud or at the edge. SSP 2.0 brings this support to the level of systems within systems, with features that enable the embedding of additional content – like 3D models and materials – along-side the behavioral models.

- **Artificial Intelligence Applications.** Machine Learning and other artificial intelligence techniques are popular for calibrating parameters of the models contained in Functional Mock-up Units (FMUs), the models compliant to FMI. SSP 2.0 supports updating parameters much more efficiently than previous versions, leveraging dynamic array size and enhanced parameter file formats.

For those interested in the added technical features that SSP 2.0 offers over SSP 1.0, see the change description in the [SSP 2.0 specification](), and the [release notes]().

About the Modelica Association

The Modelica Association (MA) is a non-profit organization incorporated in Sweden with the mission to develop open-access, royalty-free, coordinated standards for the development and verification of cyber-physical systems. The open and royalty-free nature of the standards supports a rich eco-system of open-source and commercial solutions. The MA projects provide open-source assets, compliance checkers, and infrastructure to simplify the process of standards adoption, all publicly available under the Modelica GitHub organization, and organizes regular open-access conferences, with all papers available on the Modelica website. The Modelica Association standards are endorsed and recommended by many professional societies in the modeling and systems engineering domain: Prostep IVIP, PDES, NAFEMS, and INCOSE.

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