Towards a Credible System Simulation Architecture applicable to Heat Pump Systems using Modelica, FMI and SSP

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Abstract

This paper presents a conceptual framework for developing a credible system simulation architecture for heat pump systems, using Modelica, FMI, and SSP.

Modern heat pumps, though seemingly simple, present classic systems engineering challenges like cross-domain development, interdisciplinary collaboration, configuration management, piece-to-piece variation, traceability, and simulation credibility. Model-based design and virtualized release are identified as suitable approaches.

The paper addresses the competitive market's demand for reduced costs and shorter innovation cycles by highlighting the need for increased virtualization in the engineering process. Simulation is a key technology, but technological advancements are needed to further enhance its impact. Challenges include ensuring robust and efficient computation, managing model variance and variability, and coping with heterogeneous tool environments.

The proposed approach leverages the System Structure and Parameterization (SSP) standard, an open standard by the Modelica Association, for tool-independent definition and simulation of hierarchical system structures. SSP enables abstract component interfaces, parameterization, and interconnection, facilitating integration and evaluation in simulation or co-simulation environments. SSP also supports managing variability through configuration-specific parameter sets and offers SSP Traceability for credible simulation processes.

The paper describes current user experiences, including the use of Functional Mockup Interface (FMI) for tool interoperability. The authors highlight how SSP can be leveraged to address these challenges by providing a standardized, tool-agnostic approach that minimizes manual rework and fosters better integration.

For heat pump systems, the conceptual SSP structure is modeled in easySSP and represented as System Structure Description (SSD), preserving the semantics of connections. Subsystem simulation models are implemented in Dymola using Modelica, and the concrete realizations are provided as Modelica models and FMUs for integration into the SSP model, enabling co-simulation.

In conclusion, the paper emphasizes the advantages of the SSP-based approach for heat pump system simulation, while acknowledging practical challenges. It also hints at ongoing efforts within the ITEA4 22013 OpenSCALING project to further enhance available solutions and standards.

Keywords: SSP, FMI, Modelica, model-based systems engineering, system simulation, co-simulation, credible simulation

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