Implementing stabilized co-simulation of strongly coupled systems using the Functional Mock-up Interface 2.0

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This paper addresses the main issue encountered with the co-simulation of coupled systems that exchange energy, i.e. the trade-off between computational performances and numerical stability. The possible loss of stability is explained by the discretization of the coupling variables and can be analyzed by considering such co-simulated systems as closed-loop sampled-time systems, as shown on figure 1.

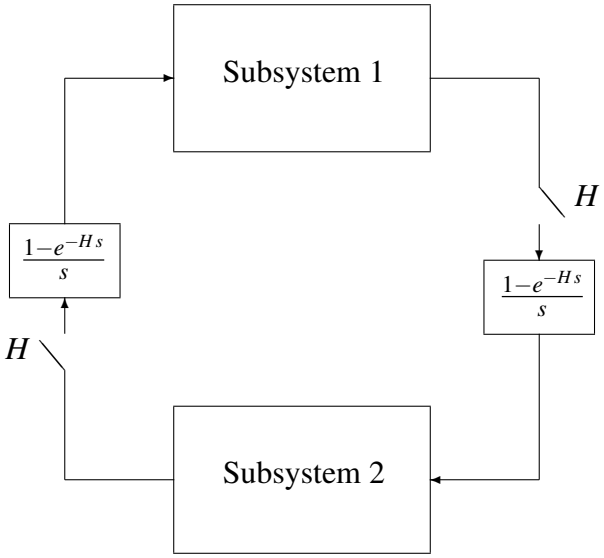

Figure 1: Bloc diagram of a two-subsystems co-simulation process.

This property is first explained in details with the help of a simple generic test system for which a large oversampling with respect to the Nyquist frequency is required in order to keep a good level of accuracy. The linearly implicit stabilization method from [1] is then implemented and tested thanks to the directional directives computation capability of the FMI for Co-simulation 2.0 standard [2]. Some minor extensions to the standard are proposed to efficiently implement the method. When applied to the test system, it is shown that large co-simulation steps can be taken, and hence significant computation time speed-ups are observed.

References

[1] Arnold M., Numerical stabilization of co-simulation techniques, the ODE case, Working document MODELISAR, sWP 200-203, September 5, 2011.

[2] Modelica Association Project "FMI", Functional Mock-up Interface for Model Exchange and Co-simulation 2.0 Release Candidate 1, October 18, 2013.