Testing Power Plant Control Systems in Modelica

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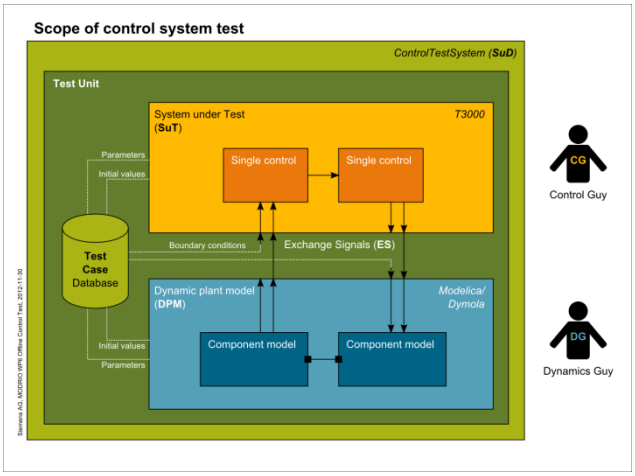
The control test application shown in this paper demonstrates the usability of Modelica to run comprehensive tests for plant controllers involving large parts of the physical plant and the control system. The goal is to allow the easy testing of controllers for power plants developed in a distributed control systems (DCS) such as SPPA-T3000 at every control engineer's desk. Due to the urgent need for control testing in a running project, this fully Modelica based prototype developed in the MODRIO project [2] has then be applied to a real life example. Similar to the approach of [1], the behavior of control blocks has been re-implemented in Modelica. A customized T3000-Modelica parser has been developed which enables the control engineer to translate a set of functional block diagrams from SPPA-T3000 into a Modelica package. This package contains all functional block diagrams which are to be tested and a top-level class containing all open controller inputs.

As a first application, the control of a district heating system of a combined cycle plant (CCPP) was investigated. The district heating system uses steam from steam turbine extractions in order to heat the water that will be supplied for district heating. The main function of the controller is to control the supply temperature of the water by means of several valves in the plant. A district heating system has long piping connections which are modeled as transmission-line pipe models with spatial distribution for the enthalpy.



The controller model (System under Test) and the plant model are connected in one Modelica model, called Test Unit. The Figure on the left shows the current approach for signal handling. Besides connecting controller and plant model, the Test Unit is used for adding boundary conditions. Test Cases are then created by extending the Test Unit and adding disturbances and changing parameters.

This paper shows that the simulation based test of control systems in Modelica is possible for industrial use cases. One of the identified benefits of the self-contained simulation setup was that absolutely no changes to the authoring tool (SPPA-T3000) were necessary. Nevertheless, we are reaching the limits of what current Modelica tools can handle in terms of number of signals and simulation performance of hybrid systems.

References

[1] Marco Bonvini, Alberto Leva (2012). A Modelica Library for Industrial Control Systems, Proceedings of the 9th International MODELICA Conference, September 3-5, 2012, Munich, Germany

[2] MODRIO - Model Driven Physical Systems Operation, http://www.modrio.org