

# Rodin Multi-Simulation Plug-in

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In this work we introduce a plug-in extension to Rodin that enables co-simulation of Event-B models and continuous-time models in the Functional Mock-up Unit (FMU) format. The plug-in aims at overcoming the lack of continuous time modelling capabilities in the current version of Event-B by leveraging the Functional Mock-up Interface (FMI) standard for tool-independent physical model exchange and co-simulation [1]. That makes it possible to carry out a standard formal development of discrete-event subsystems in Event-B and compose them for the simulation-based analysis with continuous-time models of environment, which can be designed in any FMI-compliant modelling tool<sup>1</sup>.

The simulation semantics is loosely based on the concept of a simulation master algorithm from the FMI standard that splits the simulation time interval  $[t_{start}, t_{stop}]$  into discrete communication steps  $[tc_i, tc_{i+1}]$ , where  $0 < i \leq N$ ,  $tc_i \leq tc_{i+1}$ ,  $tc_0 = t_{start}$ ,  $tc_N = t_{stop}$ , at which the data exchange between the co-simulated interacting components is performed. The simulation of individual component is performed in steps of the size  $hc_i = tc_{i+1} - tc_i$ . Our implementation of the master algorithm is generic, i.e. allows any number and composition configuration of the simulated components, and uses a fixed size communication step  $hc_i$ . The simulation of FMU components is performed by the master via the FMI interface, while the Event-B components are executed using an experimental version of the ProB animator [2].

The Rodin Multi-Simulation plug-in provides a component diagram editor (see Figure 1) that allows to import and configure Event-B machines and

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<sup>1</sup>According to <https://www.fmi-standard.org>, over 35 tools have some support of the FMI standard.

FMUs as components with input and output ports, which can be composed on the diagram via connectors. The simulation is performed on the diagram model, and the values of variables can be either plotted in real-time using a special Display component, or analysed later from a generated .csv file.

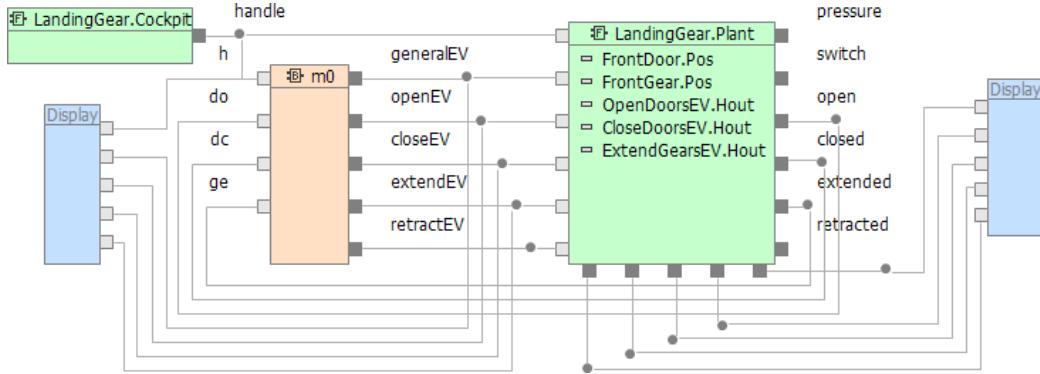


Figure 1: RMS component diagram in Rodin (co-simulates an Event-B machine  $m0$  and FMUs *LandingGear.Cockpit* and *LandingGear.Plant*)

As a work in progress we consider implementing an adaptive (variable step size) master algorithm, optimising tool's performance and validating it against the existing simulation-based approaches on a real-scale case study.

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## References

- [1] Torsten Blochwitz, M Otter, M Arnold, C Bausch, C Clauß, H Elmquist, A Junghanns, J Mauss, M Monteiro, T Neidhold, et al. The Functional Mockup Interface for tool independent exchange of simulation models. In *Modelica'2011 Conference, March*, pages 20–22, 2011.
- [2] Michael Leuschel and Michael Butler. ProB: an automated analysis toolset for the B method. *International Journal on Software Tools for Technology Transfer*, 10(2):185–203, 2008.