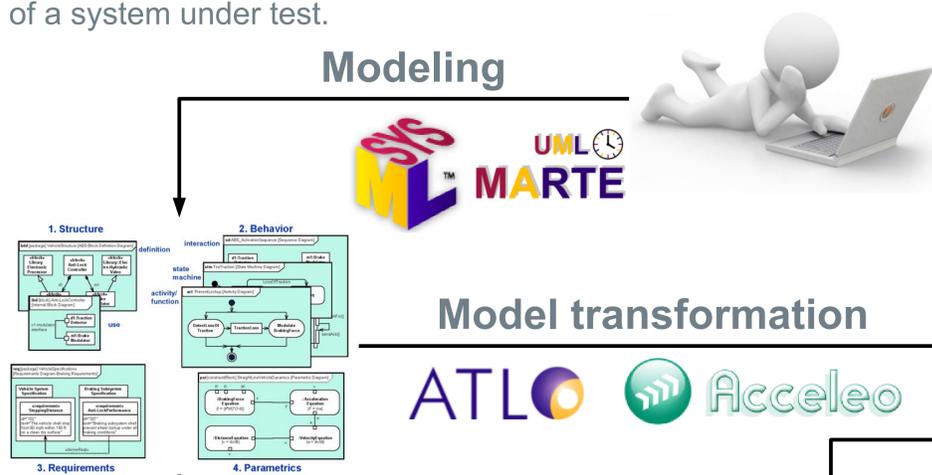




Test generation process for real-time and embedded systems

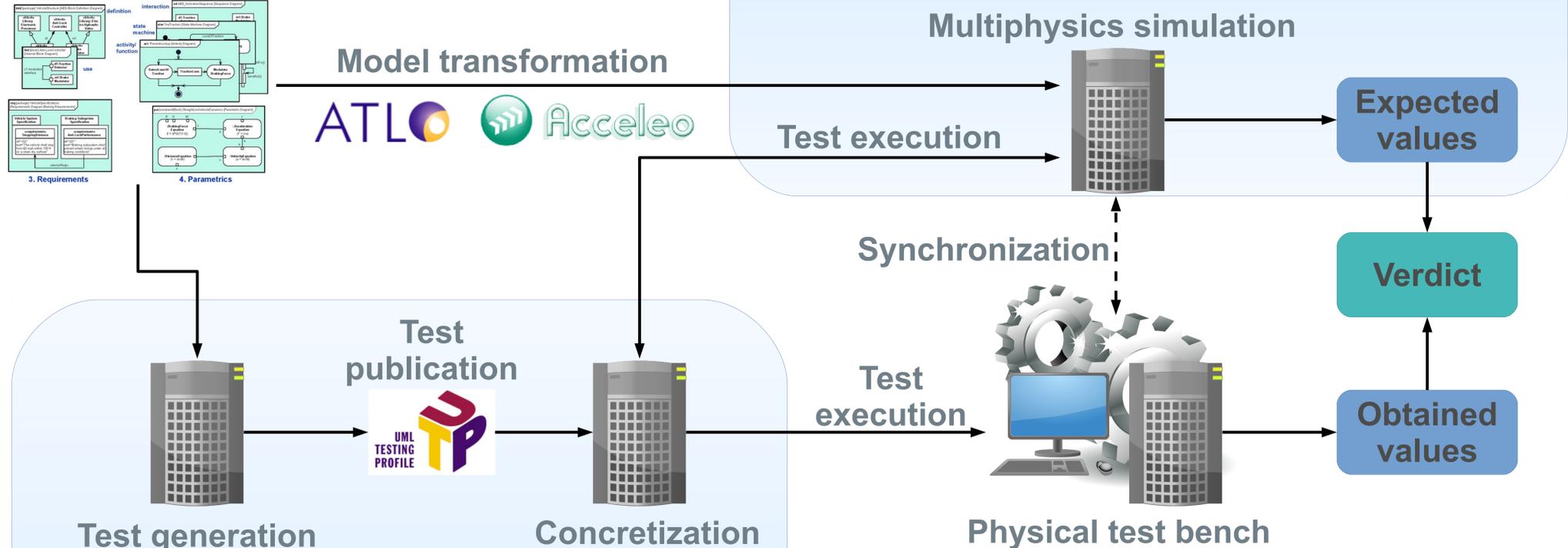
Introduction

This research and experimental work, in the field of MBT (Model Based Testing), enables to generate executable test scripts for real-time and embedded systems using SysML/MARTE models. SysML is a UML profile for modeling software and hardware components in an object-oriented paradigm. MARTE is a UML profile that enables to add time constraints in the SysML model of a system under test.



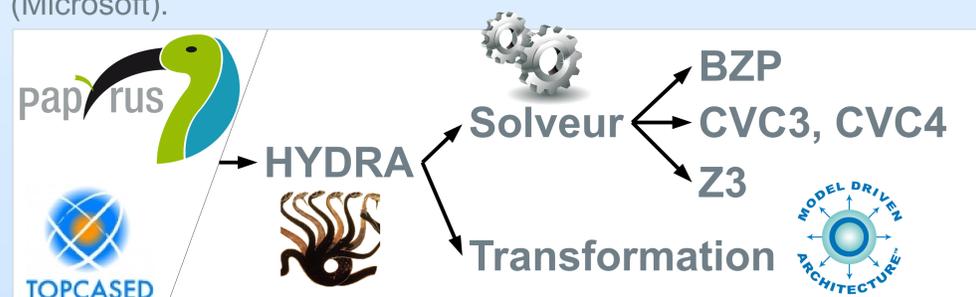
From SysML to Modelica

Modelica is an open language from the Modelica Association, which enables to model and simulate multi-physical systems (e.g. combining fluidics systems with electrical systems). We have implemented an automatic transformation process to generate Modelica code from SysML model that respects the OMG's SysML-Modelica standard. This transformation, implemented with ATL and Acceleo, permits to validate a SysML model and to simulate a system at the earliest in the test generation process. In this process, the simulation also has a test oracle role in order to obtain expected values. These values are compared with obtained values during execution of the real system in order to assign a test verdict. Finally, this process enables the validation engineer to manage only one modeling reference: the SysML model.



The Hydra platform

Hydra is a software that aggregates scientific knowledge of DISC department. It enables, among others, an automatic model transformation to perform test generation using different solvers: Phoenix BZP (our own constraint solver), CVC3, CVC4 and Z3 (Microsoft).



Hydra also enables to recover test sequences calculated by solvers in order to automatically translate them into the UTP standard (UML profile to represent test artifacts). Indeed, concretization step (replacing abstract values of the model by real values) is known to be costly in term of time. That is why, using the UTP standard as a pivot language, might improve the automation of the concretization step.

Conclusion

The above detailed model-based process enables the automatic test generation to validate real-time and embedded systems according to their functional and non-functional requirements.

The automatic model transformation from SysML to Modelica saves time through an early SysML model validation, a unique test model reference and a simulation as test oracle. Moreover, an implementation of the transformation was done with the OMG SysML-Modelica RTF and is available on a GitHub repository (<https://github.com/SysMLModelicaIntegration>).

The MARTE profile permits to bring new coverage criteria: worth case execution time, time testing, robustness time testing... In addition, simulation results are used by test generators to cover critical behaviors of the system.

Finally, on the one hand, the Hydra platform enables to automatically compare test generation time from the different solvers. On the other hand, it enables to benchmark the proposed process with complex SysML models in order to evaluate scalability. Scalability is indeed required to be adopted in an industrial context.

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