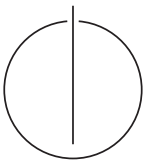

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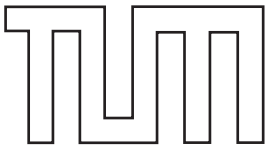

SPES 2020 Deliverable D1.1.B-2

Modeling Theory

Open Issues and Way Forward

Software Plattform Embedded Systems 2020

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1 Introduction

In Deliverable D1.1.A-1 [HHR09], we introduced a modeling theory for the SPES 2020 project. In Deliverable D1.1.B-1 a number of additional requirements on the theory and open issues were reported. In the following, these concerns are classified according to the scientific challenge they impose and first solutions are sketched how to overcome them. Please note, we only consider issues concerning the theoretical foundations of a model-based development in this document. Methodological aspects of our approach are not in the scope of this document.

We use the following classification:

- Concerns that are already solved in the available modeling theory (but have to be explained more carefully);
- Concerns that are easy to fix, but need some work;
- Concerns leading to open scientific questions, that need significant time to be worked out;
- Concerns that need deeper and more extensive scientific work and can be hardly solved in the first phase of SPES.

2 Classification

In the following, the comments and open issues from Deliverable D1.1.B-1 are classified in the four classes introduced above.

2.1 Already Solved Concerns

- *Global/Local Time:* A global time model is needed, in addition local clocks are possible. Each FOCUS-component in a network might have a local clock and different time granularity. The global model is needed for the synchronization between components.
- *Assumption/Guarantee Specifications:* The behavior of a system might be specified by means of an assumption/guarantee notation, which consists of two predicates, namely, an assumption and a guarantee. The assumption specifies the domain of the system. The guarantee characterizes the reaction of the system to its inputs if the inputs are in accordance with the assumption. Assumption/guarantee specification have been part of our research for many years, see for example [Bro98, Bro05, HH08b].

2.2 Easy to Fix Concerns

- *Continuous Time:* Continuous time can be added to discrete time. FOCUS includes an abstract model of discrete time that can be related to physical time (by giving a concrete time granularity (such as 10 μsec) with every time slot. Time can be refined (see paper on time refinement [Bro97]) by changing the time granularity (physical time changes accordingly).

2.3 Open Scientific Questions

- *Hybrid models:* So far FOCUS components interact by discrete values. However, to describe the environment of the system, continuous values have to be concerned. In order to deal with hybrid systems, FOCUS streams and the composition operators have to be extended by the combination of discrete changes of the system mode and continuous descriptions of the I/O behavior within single modes.
- *Rich models:* Functional models might be enriched by quality attributes. This is an area of research. Some existing results of the SPEEDS project [Spe08] might be probably used.
- *Performance for usage:* The definition and composition of the performance for usage in modular architectures is considered as an important quality attribute. Again, the results of the SPEEDS project [Spe08] might provide first solutions that should be used.
- *Modeling variance:* Product lines is an open area of research. Some first results of TUM projects can be used (e. g., VEIA[1], see also [HH08a, HH08b]). However, product lines have been explicitly excluded from the scope of the first phase of the SPES project.

2.4 Hardly Solved Concerns

- *Dynamic systems:* A dynamic system or a non-static architecture is one where the connections between its components and also the set of components chances over time. Special dedicated calculi and theories have been worked out to model dynamic systems such as Ambient Calculus or π-calculus. Such languages and calculi need sophisticated theories. A possibility to deal with dynamic systems is not to use dedicated calculi but to reflect the dynamics by specific components (busses, component families etc.) Some ideas to this open area of research can be found in [BS01], where the behavior on a bunch of indexed channels is specified.
- *Probabilistic models:* Probabilistic models are associated with random physical systems, in which a given type of event tends to occur at a persistent rate. Probabilistic models are invoked to explain these stable frequencies of the occurrences. Even if some attempts exist, to the best of our knowledge none of them is satisfying for modeling the probabilistic aspects of systems with a well-formed and trunctable theory.
- *Integrated models of mechanics/electronics/software:* This is an open area of research. Some first results of TUM projects can be used (e. g., EntAut, VDW/MES, NX2PSC, AutoVIBN[2]).
- *Non-functional composition:* The definition and especially the composition of non-functional properties in modular architectures is still an open area of research. Examples of non-functional properties are typical quality attributes like safety, maintainability or usability but also aspects like energy, temperature or the flow of material.

[1] http://veia.isst.fraunhofer.de/
[2] http://autovibn.in.tum.de

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