Binding Design and Analysis by Viewpoints for Heterogenous Real-Time systems

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1 Introduction

Recently, Model-Driven Engineering (MDE) has been more and more in use by software architects in order to insure the correctness of real-time systems. For this extent, design models are established to verify the schedulability of the system through different methods. The analysis of the system under-design can be done with several analysis tools such as Cheddar [4] or MAST [3]. The design of real-time systems is often done through off-the-shelf design models such as UML-MARTE or AADL. Often, design model and analysis model differ and a transformation from design model to analysis model is necessary, either by hand or automatically.

Y. Ouhammou proposed a framework, called MoSaRT (Modeling oriented Scheduling Analysis of Real-time systems) [2], to ease temporal verification with MDE. MoSaRT intends to be a bridge between design model and analysis model by offering a pivot meta-model for schedulability analysis.

As industrial embedded systems become more and more complex, the MoSaRT meta-model becomes as complex as the system. A way to overcome systems' complexity is to analyze systems through different viewpoints of the main model. Viewpoints can be the point of view of the processor, of the network, of the end-to-end response time, etc.

2 Different task models for analysis

One of the first real-time task model proposed in the literature was the Liu & Layland periodic and independent task model. As this task model was basic, and as architects used more and more complex task activation schemes, hundreds of task models and variations have been proposed (Sporadic model, generalized multiframe model or digraph model [5], etc.), most of them with means to analyze them. With so many task models existing for real-time systems, the set of input parameters needed to conduct an analysis (computation time, relative deadline, suspension, mutual exclusion, etc.) is different for each task model.

Because of the amount of explicit and implicit hypotheses needed for a design to be accurately represented by a task model, as well as the hypotheses required by the related analysis method, an analysis expert is needed at the design of real-time systems to determine the best suited analysis model and method for the system. Modeling a system with the MoSaRT framework is then difficult as the meta-model is not oriented towards a specific analysis tool. Therefore, the meta-model explores all possibilities to analyze real-time systems.

The utilization of viewpoints may reduce this difficulty. Indeed a viewpoint reduces the parameters to the selected task model, hiding unessential parameters (e.g. network related artifacts are not needed if the system is centralized).

3 Viewpoints in MoSaRT

We propose to enrich MoSaRT framework by adding several viewpoints to reduce the available parameters. The extension intends to be developed with EMF Views [1]. From the global meta-model, and depending on end-user purposes, the meta-model is reduced to minimal classes: each specialist can model the necessary taskset fitting his needs.

The composition of viewpoints can also be considered to get a global one. In other words, a model would be constituted of several submodels, each submodel being the subject of a different viewpoint. We aim to propose several viewpoints to model, design and analyze systems. The submodels can be considered independently from each other for analysis. The different submodels can be interconnected to reconstitute the

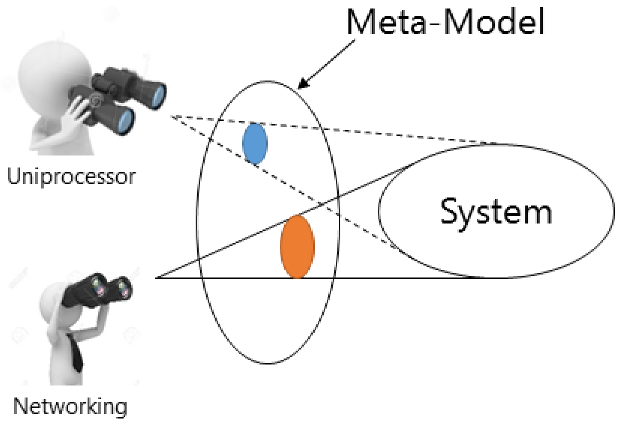

Figure 1: Principle of viewpoints of a system

heterogeneous global system and conduct, for example, an holistic analysis. Figure 1 presents schematically two sub-meta-models, in blue and orange on the figure, representing two aspects of a system under-study.

4 Open problems & Conclusion

The pivot meta-model is large because of heterogeneity of analysis models. Thus, viewpoints of the meta-model would reduce the elements available to the user. Viewpoints ease analysis and help in the design of more complex real-time systems but open questions remain in viewpoints. Several types of viewpoints are possible. For example, there are independent tasks system, centralized system, or distributed system. An open question is the number, and the characteristics, of the viewpoints to propose in MoSaRT.

For model composition, we consider an ethernet network with several end-systems, each end-system represented with a given submodel: is it possible to find an ideal configuration to optimize the execution on the system and the transmission time on the network? In model composition, the consistency of the composed system has to be checked: for example, verify the message sent by a task is received somewhere in the system, or check that OCL rules verified in submodel are still verified in the whole model. Moreover, if some viewpoints share common properties, how to compose submodels to avoid properties in double?

Finally, should the framework integrate tools to reduce the quantity of software used and then reduce the time of training on analysis software?

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