From UML/MARTE Models of Multiprocessor Real-time Embedded Systems to Early Schedulability Analysis based on SimSo Tool

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Abstract: The increasing complexity of Real-Time Embedded Systems (RTES) should be met with equally sophisticated design methods. The recent Unified Modeling Language (UML) profile for Modeling and Analysis of Real-Time Embedded systems (MARTE) is well adapted for systems modeling. However along with the variety of schedulability analysis tools, bridging the gap between design models and meta-models of the documented scheduling analysis tools becomes an important issue.
In this paper, we discuss a Model To Text (M2T) transformation for enabling the derivation of schedulability analysis models from UML/MARTE models. The generated model for schedulability analysis represents an input for an analysis tool. As a proof of concepts, we present the implemented code and experimental results.

1 INTRODUCTION

The spread of technology and the industry requirements have pushed designers to switch from simple monoprocessor architectures to more complex parallel multiprocessor architectures. Considering multiprocessor systems leads to an increasing trend of RTES design, which requires rigorous methodologies to reduce the designer's effort and avoid systems failures. A prominent effort has been focused on the use of Model Driven Engineering (MDE) (Schmidt, 2006) and high-level modeling languages such as UML/MARTE profile (OMG, 2008) to automate the design flows and raise the abstraction level.
On the other hand, designers are interested in verifying the temporal correctness of their studied systems at early design stages to be reassured that no deadline may be missed. In this context, the schedulability analysis is used to validate the temporal behavior of systems scheduled using monoprocessor or multiprocessor scheduling approaches.
Regarding multiprocessor scheduling, three approaches are available in the literature; the partitioned scheduling approach, the global scheduling approach and the semi-partitioned one (Dorin et al., 2010).
The partitioned scheduling approach consists on statically assigning each task to be executed on only one processor. Using this strategy comes to using monoprocessor scheduling approach, since each task may be allocated to only one processor. In a partitioned scheduling context, tasks are not allowed to migrate inter-processors.
While adopting a global scheduling approach, tasks are dynamically allocated to processors and they are allowed to migrate inter-processors improving then Central Processing Units (CPUs) occupation. While using this approach, a full migration of tasks is allowed. Consequently, an attention must be given to the cost of preemption and context switching as well as the number of cache misses due to the transferring of tasks from one computing resource to another one.
Under the semi-partitioned scheduling approach, most tasks are assigned to be executed on specified processors like in the partitioned scheduling approach. Nevertheless, tasks that may not be assigned to a single processor are allowed to migrate inter-processors. This approach enables a restricted task migration to maximize CPU occupation and reduce context switching costs.
Regardless the used scheduling approach, the schedulability analysis has always been an important issue that has been widely studied during the last years. Nevertheless, there are still many open issues regarding this context. In fact, due to the variety of schedulability analysis tools coupled with the ever growing complexity of RTES, there is still a need to automate the early schedulability analysis step to reduce designers' effort. Researchers' attention has been then focused on the transformation of systems models into analysis tools meta-models to analyze

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