A Model Driven-Based Approach For Global Scheduling of Real-Time Embedded Systems

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***Abstract*—The choice of the appropriate scheduling approach and algorithm for a Real-Time Embedded Systems (RTES) is a challenging step, which requires a vast knowledge and expertise about the scheduling field. Some approaches were proposed to support automatic choice of scheduling algorithms, but there are few studied using high-level scheduling approaches and supporting multiprocessor scheduling allowing task migration. The aim of this study is to use high-level techniques to guide designers while choosing the appropriate scheduling algorithm for a studied system while supporting task migration. In this context, this paper proposes a model-based approach for an automatic choice of scheduling algorithm while supporting the global scheduling approach, which supports task migrations.**

Keywords-Automatic scheduling; MDE; UML/MARTE; RTES; Global Scheduling.

I. INTRODUCTION

The ever growing complexity in Real-Time applications requires the utilization of more powerful resources to implement the various functions that meet users' requirements. Such increasing complexity needs to be managed properly while respecting the system requirements regarding performance, power, cost and time-to-market.

In this context, the main key issue in Real-Time development that must be addressed carefully is the scheduling step. In fact, various research works proposed approaches to support Real-Time Systems scheduling [2,5,16]. Nevertheless, no attention has been given to the use of high-level methodologies that overcome the complexity of the scheduling step mainly while considering multiprocessor architectures.

With regard to this issue, some research works used high-level methodologies to deal with RTES scheduling [9,20]. However, along with the variety of scheduling algorithms, the use of high-level methodologies is not sufficient to overcome the ever growing complexity of RTES scheduling and help designers to properly schedule their studied systems. In fact, there is still a need to assist designers during the scheduling algorithm choice. With this regard, much research work proposed methodologies to guide designers while choosing the appropriate scheduling algorithm [15,21].

These research studies addressed properly the automatic scheduling of multiprocessor systems to assist designers during the design process and avoid failure risks. However, only the partitioned scheduling approach that prohibits task migration was supported. Moreover, no attention was given to the use of high-level methods that facilitate the modeling step and support the whole life cycle of systems development. Hence, an attempt to use Model-Driven Engineering (MDE) [19] while supporting automatic scheduling was addressed in various research studies [4,6]. Authors of these papers used also design patterns to support the high-level modeling and automatic scheduling.

The proposed approaches [4,6] seem to be an adequate solution that uses high-level techniques to help designers overcoming the scheduling step complexity. However, only the partitioned scheduling was supported. Moreover, no attention was given to the optimization of tasks allocation on processors.

With regard to these issues, we propose a model-based approach for automatic choice of scheduling algorithm regarding the global scheduling approach that supports tasks migration. While allocating tasks on processors, an attempt to maximize Central Processing Units (CPU) occupation and minimize the energy consumption is considered while using Tabu search [17].

The remainder of this paper starts with section 2 in which we define the various concepts used in this proposal. Section 3 highlights the proposed approach with its major steps. Experimental results are given in section 4 to validate our proposal. We discuss in section 5 the advantages of our approach compared to existing ones. Finally, section 6 gives a summary of the paper.

II. TECHNICAL BACKGROUND

Before describing the proposed approach we used in conducting this research, we first present the scheduling theory and the used techniques and languages.

A. *Scheduling theory:*

The scheduling theory [10] represents a solution to deal with the allocation of tasks on the available computing resources while respecting temporal requirements. Two major types of scheduling strategies are documented in the literature; the monoprocessor and the multiprocessor scheduling.

In fact, RTES are subject of a lot of constraints that necessitate the use of a multiprocessor architecture, which offers powerful execution hosts. In this context, we provide a brief overview of the three commonly used scheduling approaches for RTES multiprocessor scheduling [3]; the partitioned, the semi-partitioned and the global approaches.

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