Novel Approach for Modeling Very Dynamic and Flexible Real Time Applications

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Abstract

Modeling techniques are used to solve a variety of practical problems related to processing and scheduling in several domains like manufacturing and embedded systems. In such flexible and dynamic environments, there are complex constraints and a variety of unexpected disruptions. Hence, scheduling remains a complex and time-consuming process and the need for accurate models for optimizing this process is increasing. This paper deals with dynamically reconfigurable architectures which are designed to support complex and flexible applications. It focuses on defining a solution approach for modeling such applications where there is significant uncertainty in the duration, resource requirements and number of tasks to be executed.

Keywords: ***Dynamically Reconfigurable Architecture, uncertainty, scheduling, modeling methodologies, DFG.***

I. Introduction

Today, integrated silicon applications are more and more complex. Moreover, in spite of its performance, ASICs development is still long and very expensive, and provides inefficient solutions for many applications which are composed of several heterogeneous tasks with different characteristics. In addition, the growing complexity of real-time applications today presents important challenges, in great part due to their dynamic behavior and uncertainties which could happen at runtime [1]. To overcome these problems, designers tend to use dynamically reconfigurable architectures (DRA). The development of the latter opens new horizons in the field of architecture design. Indeed, the DRAs are well suited to deal with the dynamism of new applications and allow better compromise between cost, flexibility and performance [2]. In particular, fine grained dynamically reconfigurable architectures (FGDRA), as a kind of DRAs, can be adapted to any application more optimally than coarse grain DRAs. This feature makes them today an interesting solution when it comes to handle computational tasks in a highly constrained context. However, this type of architecture makes the applications design very complex [3], especially with the lack of suitable and efficient tools. This complexity could be abstracted at some level in two ways: at design time by providing design tools and at run time by providing an operating system that abstracts the lower level of the system [4]. Moreover, such architecture requires the presence of an appropriate operating system that could manage new tasks at run time and under different constraints. This operating system, and to effectively manage dynamic applications, has to be able to respond rapidly to events. This can be achieved by providing a suitable scheduling approach and dedicated services like hardware preemption that decreases configurations and contexts transfer times. To realize an efficient schedule of an application, this operating system needs to know the behavior of this application, in particular the part where the dynamicity can be exploited on a DRA.

In this paper, we are interested in the modeling of applications that could be executed on dynamically reconfigurable architecture. This kind of applications is characterized, in addition to its real-time constraints, by several types of flexibility. The purpose is to improve the performance of the modeling techniques which facilitates the job to design an efficient scheduling approach.

The remainder of this paper is structured as follows: ‘n Section 2, brief review is given about the context and the related work on modeling techniques used in different domains. Section 3 describes our new technique modeling applications targeted to DRA. The Section 4 reports a description of the proposed modeling method and comparisons with other models, while the last Section draws conclusions.

II. Context and problem definition

Today, embedded systems are more and more used in several domains: automobiles, robots, planes, satellites, boats, industrial control systems, etc. An important feature of these systems is to be reactive. A reactive system is a system that continuously reacts to its environment at a rate imposed by this environment itself. It receives inputs from the environment, responds to these stimuli by making a number of operations and produces the outputs used by the environment, known as reactions. Dynamically reconfigurable architectures are an interesting solution for this type of applications. Due to