Design Tools Session

Design Space Exploration for Embedded Parallel System-on-Chip Platforms using modeFRONTIER

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Abstract

A complete design space analysis of a System-on-Chip (SoC) architecture is practically prohibitive due to the large number of possible architectural configurations and the long time required to perform system simulations. The problem is usually more complex due to the existence of multiple and often conflicting objectives to optimize. In this type of problems, carefully chosen optimization algorithms which explore wisely the design space by considering all objectives at the same time need to be applied. These optimization algorithms do not produce a single solution, but a set of non-dominated solutions named Pareto front, which represent a good compromise between all conflicting objectives.

Many methods have been proposed in the literature to identify the Pareto front for SoC design problems. However, the use of powerful design exploration methods by itself does not guarantee that optimum solutions will be found in reasonable time with a reasonable use of resources. It is important for the SoC designer to have access to a design environment that provides the ability to express the design problem in clear terms, understanding the relevant characteristics of the problem, and allowing to discover how these characteristics change with the problem specification and parameter values. In this way, it is possible to avoid unrealistic combinations of parameters, choose representative points and prune the design space as much as possible.

The modeFRONTIER design environment is one of the most widely used tool for multi-objective optimization in complex engineering domains. In the EU MULTICUBE project, modeFRONTIER is being retargeted to the domain of Embedded Parallel SoC design. The interaction between modeFRONTIER and the high level simulators is performed by using an open XML specification, which allows the integration with various simulators (or models) for SoC platforms and architectures. During the optimization process, modeFRONTIER provides values for the system configuration parameters and expects back from the simulator the corresponding system metrics.

Initial optimization experiments have been performed using two high level simulators (IMEC-HLsim and MULTICUBE-SCoPE) running an MPEG4 encoder multimedia application. Configuration parameters considered till now are the number of CPUs, the instruction cache size and the processor frequency. System metrics like power consumption, latency and execution time are used as optimization objectives. The Design of Experiments (DOE) module helps to define the initial set of designs for the exploration and the set of points for reliable Response Surface Models (RSM). The RSM module allows users to save simulation time by creating statistically validated mathematical models that approximate the behavior of the simulator. Post-processing tools allow users to obtain information from the SoC system and determine correlations, extracting useful design features. The optimization experiments performed till now show promising results, suggesting that modeFRONTIER can provide an easy to use and flexible design environment for SoC platforms.