Multicube Explorer - A Design Space Exploration Framework for Embedded Systems-on-Chip

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Multicube Explorer is a design space exploration tool for supporting platform-based design. It allows a fast optimization of parameterized system architecture towards a set of objective functions (e.g., energy, delay and area), by interacting with a system-level simulator. Multicube Explorer provides a set of innovative sampling and optimization techniques to help finding the best objective-function trade-offs. It also provides an open XML interface for supporting new platforms/architectures.

Overview
Multicube Explorer is an interactive program that lets the designer explore a design space of configurations for a parameterized architecture for which an executable model (use case simulator) exists. Multicube explorer is an advanced multi-objective optimization framework which is entirely command-line/script driven and can be retargeted to any configurable platform by writing a suitable XML design space definition file and providing a configurable simulator.

Interaction with the simulator
The design space exploration is performed by using the simulation abstraction layer exported by the XML driver to the optimizer plug-ins. The optimizer instantiates a set of architectural configurations by means of the design space iterators, and passes the corresponding representation to the XML driver which will execute the simulator. Information about simulator runs will be displayed directly in the Multicube Explorer shell.

Goals of Multicube Explorer
The overall goal of the open source design space exploration framework aims at providing a retargetable tool to drive the designer towards near-optimal solutions to the architectural exploration problem, with the given multiple constraints. The final product of the framework is a Pareto set of configurations within the design evaluation space of the given architecture. Besides, the following goals have been identified:

Automatic design space exploration
One of the goals of the open source tool is to provide a command line interface to the exploration kernel that allows the construction of automated exploration strategies.

Portability
Another goal of the open source tool is to be portable across a wide range of systems by using the standard ANSI C++ programming language.

Modular composition
Simulator, optimization algorithms and other design space exploration components are dynamically linked at run-time, without the need of recompiling the entire code base.

Architecture of the tool
The tool is basically composed by an exploration kernel which orchestrates the functional behavior of the design of experiments and optimization algorithms.

The kernel module is responsible for reading in the design space definition file (in XML format) and accepting commands from the shell interface (or the corresponding script). It then exposes the parameters of the design space to all the modules involved in the optimization process (DoE, Optimization Algorithms) by means of a core design space representation (CDSR).

The CDSR provides a set of abstract operations that are mapped on the specific use case under analysis. The abstract operations are represented by iterators over the feasible design space, among which we can find full search, random search, factorial iterators.

This work is part of the ICT-FP7 EU project MULTICUBE: www.multicube.eu