Multicube Explorer - A Design Space Exploration Framework for Embedded Systems-on-Chip
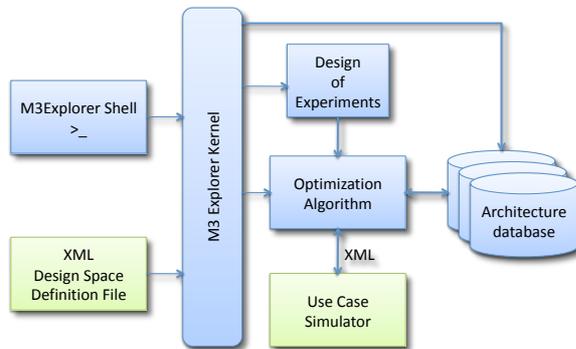
Gianluca Palermo   Cristina Silvano   Vittorio Zaccaria

Politecnico di Milano - Dipartimento di Elettronica e Informazione
{gpalermo, silvano, zaccaria}@elet.polimi.it

Giovanni Mariani

ALaRI - Universita' della Svizzera Italiana
giovanni.mariani@lu.unisi.ch

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.

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:

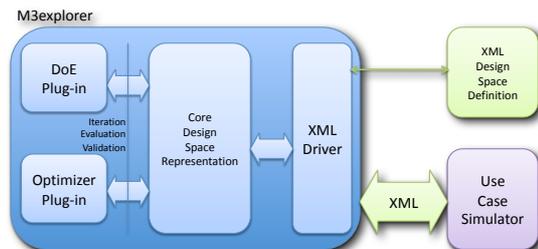*Automatic design space exploration*

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.

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.
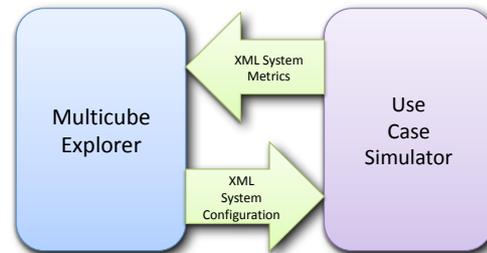
Architecture of the tool

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.