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

Carlos Kavka
ESTECO SRL, Italy
carlos.kavka@esteco.com

Prabhat Avasare, Geert Vanmeerbeeck, Maryse Wouters
IMEC vzw, Belgium
{avasare, vanmeerb, woutersm}@imec.be

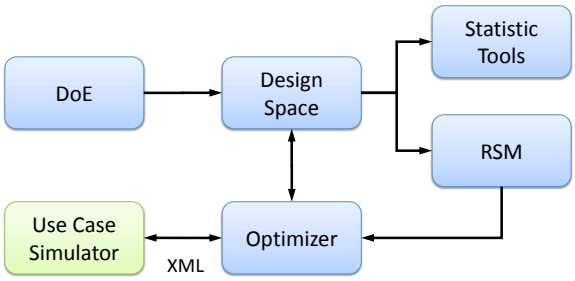
Hector Posadas
University of Cantabria, Spain
posadash@teisa.unican.es

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 System-on-Chip (SoC) design. The use of an open XML interface allows integration with various simulators (or models) for SoC platforms and architectures. Initial experiments using two high level simulators (IMEC-HLsim and MULTICUBE-SCoPE) running a multimedia application (MPEG4 encoder) show promising optimization results.

1. Overview

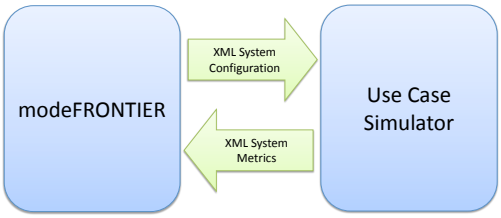
modeFRONTIER is a process integration and design optimization tool that allows to:

- Formalize and manage the design workflow in a flexible and dynamic way, by allowing the design architect to specify the optimization problem using a graphical user interface, selecting input and output variables, objectives and restrictions.
- Perform the link with the specific simulator platform using open standards.
- Perform the Design of Experiments (DoE) based on the properties of the experimental design space.
- Identify the important parameters that contribute to the global performance using statistical tools.
- Perform multi-objective optimization using up-to-date methods, technologies and strategies.
- Reduce the number of simulations by creating response surface models (RSM).
- Visualize results using appropriate charts and multivariate analysis tools.



2. Simulator interaction

The interaction between modeFRONTIER and the high level simulators is performed by using an **open XML specification**. modeFRONTIER provides values for the system configuration parameters and expects back from the simulator the corresponding system metrics.



In current experiments with **IMEC-HLsim** and **MULTICUBE-SCoPE**, the following parameters and metrics have been used:

Configuration parameters:

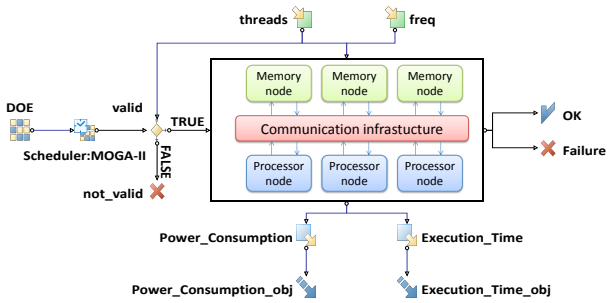
- Number of CPUs
- Instruction cache size
- Processor frequency

System metrics:

- Power consumption
- Latency
- Execution time

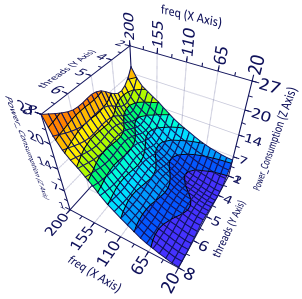
3. Optimization workflow

The optimization workflow is built graphically by specifying inputs, outputs, constraints and objectives. As an example, the following workflow represents a design optimization problem using **IMEC-HLsim**, where the objective is to minimize both the power consumption and the execution time, based on the number of CPUs (threads) and the processors frequency.

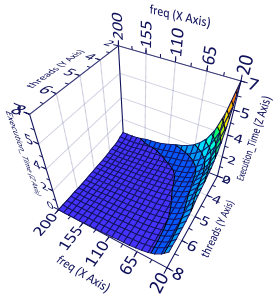


4. Optimization process

The Design Of Experiments module is used to provide an adequate initial population of designs to the optimization algorithm, and an appropriate set of support points in order to build the Response Surface Models (RSM).

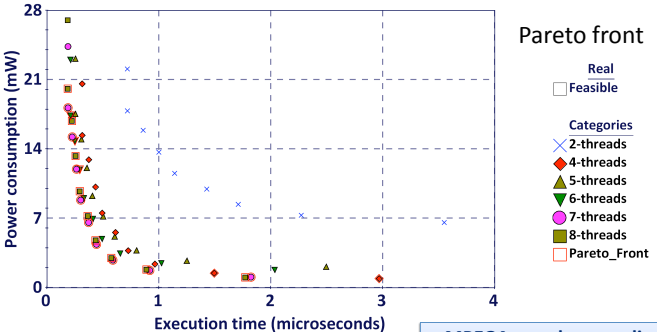


RSM - Power consumption



RSM – Execution time

The optimization algorithms automatically explore the design space, building the set of designs that contains the Pareto optimal solutions, performing real exploration using the SoC simulator and also virtual exploration using the RSM.



MPEG4 encoder encoding 10 frames at 4CIF resolutions

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