MULTICUBE

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University of Lugano - ALaRI (Switzerland),
University of Cantabria (Spain),
STMicroelectronics Beijing (China),
Institute of Computing Technology – Chinese Academy of Sciences (China)

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SEVENTH FRAMEWORK PROGRAMME

MULTICUBE

MULTI-OBJECTIVE DESIGN SPACE EXPLORATION OF MULTI-PROCESSOR SOC ARCHITECTURES FOR EMBEDDED MULTIMEDIA APPLICATIONS

Main Objectives

Many point tools exist to optimize particular aspects of embedded systems. However, an overall design space exploration framework is needed to combine all the decisions into a global search space, and a common interface to the optimization and evaluation tools. The MULTICUBE project focuses on the definition of an automatic multi-objective Design Space Exploration (DSE) framework to be used to tune the System-on-Chip architecture for the target application evaluating a set of metrics (e.g. energy, latency, throughput, bandwidth, QoS, etc.) for the next generation of embedded multimedia platforms. This overall objective is two-fold.

From one side, the MULTICUBE project will define an automatic multi-objective DSE framework to find design alternatives that best meet system constraints and cost criteria, strongly dependent on the target application, but also to restrict the search space to crucial parameters to enable an efficient exploration. In the developed DSE framework, a set of heuristic optimization algorithms must be defined to reduce the overall exploration time by computing an approximated Pareto set of configurations with respect to the selected figures of merit. Once the approximated Pareto set has been built, the designer can quickly select the best system configuration satisfying the constraints.

MULTICUBE will focus on multi-objective design space exploration for embedded System-on-Chip architectures

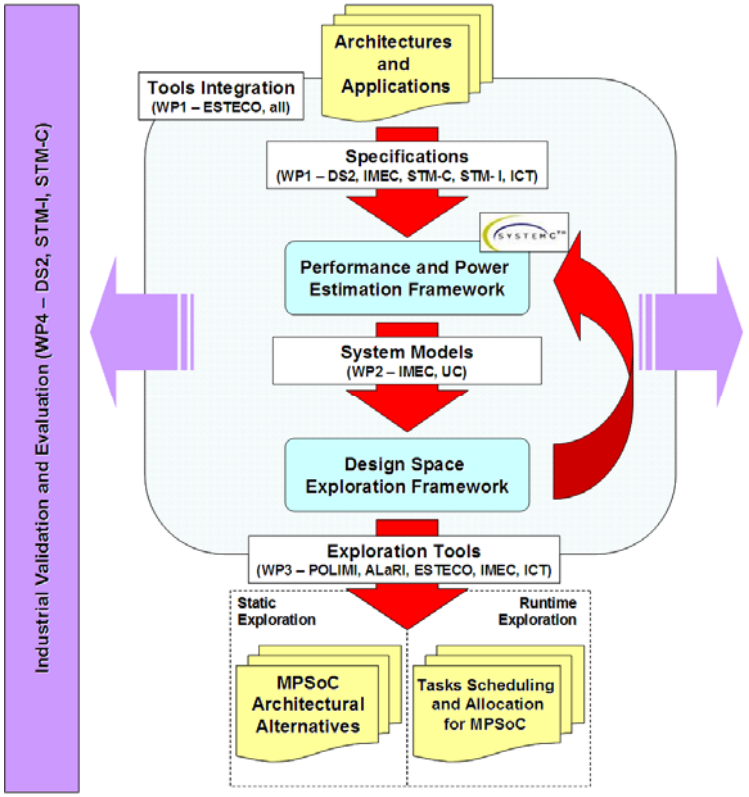
From the other side, the MULTICUBE project will define a run-time DSE framework based on the applications of the results of the static multi-objective design exploration to optimize the run-time allocation and scheduling of different application tasks. The design exploration flow results in a Pareto-optimal set of design alternatives with different speed, energy, memory and communication bandwidth parameters. This information can be used at run-time by the operation system to make an informed decision about how the resources should be distributed over different tasks running on the multi-processor system on-chip. This resource distribution cannot be performed during the design exploration itself, since it depends on which tasks are active at a particular point in time.

Technical Approach

The goal of MULTICUBE is to cover the gap between the system-level specification and the definition of the optimal application-specific architecture. MULTICUBE activities are driven by the idea to cover this gap by building a stack of tools and accurate methodologies directly targeted to specific multiprocessor SoC based on Network on Chip architectures. In the MULTICUBE design flow, the specifications of the target architectures and applications will be provided as inputs to the design flow. A SystemC-based multi-level modeling methodology for multiprocessors will be developed. Once received the target architecture as input, we will provide to the next step the system model to evaluate different architectural alternatives in terms of metrics. Then, the Design Space Exploration framework will be defined to sail over architectural solutions following several heuristic optimization algorithms. This step is implemented as an optimization loop, where the selected architecture instance generated by the DSE framework is given back to the estimation framework for the metrics evaluation. The tool integration phase in MULTICUBE will be performed to implement an automatic system optimization engine to generate, for the target MPSoC architecture, either the best architectural alternative (if the exploration is done statically) or the best tasks scheduling and allocation solution (if the exploration is done at run-time).

Key Issues

- Increased productivity of system development through a fast, reliable DSE process allowing finding an optimized solution in a short time. DSE will be performed at system-level, thus avoiding costly, low-level analysis steps (i.e. ISS simulations).
- Improved competitiveness of European companies that rely on the design and integration of embedded systems in their products by reducing costs and time to market.
- Stimulate high-tech European SMEs (such as ESTECO) that offers general-purpose innovative design solutions and tools to apply them for embedded systems design.
- Reinforced European scientific and technological leadership in the engineering of complex systems both at the industry side (STM as a large company and DS2 as a SME) and the academic and research side (IMEC, Politecnico di Milano, ALaRI, University of Cantabria and ICT).



Expected Impact

The design methodology will be implemented at system-level in a set of open-source and proprietary EDA tools to guarantee a large exploitation of the results of the MULTICUBE project in the embedded system design community. The overall goal is to support the competitiveness of European industries by optimizing embedded HW/SW systems while reducing the design time and costs. To ensure a wide applicability of the proposed DSE framework, the MULTICUBE project is strongly industry-driven. Two European industrial partners (STM Italy and DS2) and STM China will define the requirements of the design tools and validate step-by-step the results of the exploration tools to design a set of target industrial applications. The integration of design tools and the commercial exploitation of the tools will be done by an European SME, ESTECO. ALaRI will be mainly in charge of dissemination and exploitation activities. The research and technological development will mainly be done by IMEC, Politecnico di Milano, University of Cantabria and the Institute of Computing Technology.