From SystemC to real hardware

SystemC FPGA design flow for a microcontroller-based temperature measurement system (**SL2HW-Demo**)

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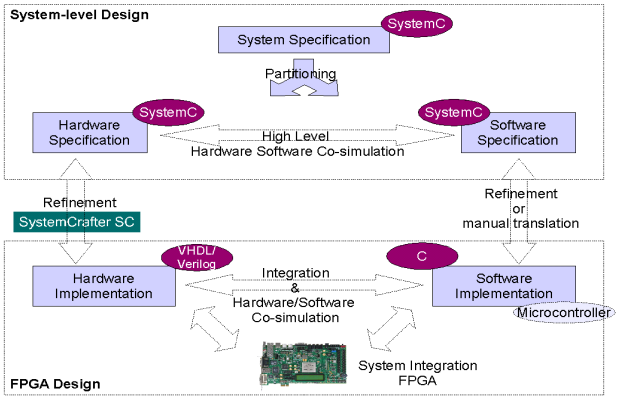
***Abstract*—This demonstration presents a complete design flow of a digital circuit component from a SystemC description to its implementation in hardware (FPGA) including embedded software algorithms. The design is an example of temperature measurement and analysis based on a sensor with an SPI interface and a RISC microcontroller.**

I. INTRODUCTION

Enhancing design is a current focus of research and development: new methodologies must be developed to increase productivity and decrease time-to-market. The ultimate goal consists in enabling an automated synthesis based on a high-level specification. SystemC, a widely accepted industry standard that adds hardware concepts to C++, allows for the modeling of hardware and software at different levels of abstraction, from abstract functional models through different behavioral models down to the cycle-accurate RTL level. It is thus possible to describe hardware and software in a common high-level programming language, and to refine it in a systematic, iterative design flow (see figure) which leads to a synthesized model.



II. DESIGN METHODOLOGY

The design flow is based on the top-down design methodology and can be split into two processes:

System-level design

- SystemC description development and test bench creation
- SystemC description debugging, simulation, and verification
- design partitioning into hardware and software.
- models refinement to describe hardware and software more efficiently, trade-offs experimentation, and refined description verification
- hardware part synthesis of the SystemC description as RTL (VHDL) and verification of the synthesized SystemC model

FPGA design

- manual translation of the software part of the SystemC description into machine code (Assembler/C) for an existing (microcontroller) soft core
- software verification within the microcontroller
- integration and hardware/software co-simulation
- synthesis of the design as working hardware

This design methodology can be used for synthesizing SystemC as hardware, for hardware/software co-design, or for hardware acceleration.

III. DEMONSTRATION

The demonstration design shows an example of temperature measurement and analysis based on a sensor with an SPI interface and a RISC microcontroller. The SPI interface has been implemented as a SystemC model and translated into VHDL, and the FPGA (Xilinx Virtex-V) implementation is based on the Xilinx embedded processor soft core MicroBlaze. The system-level design platform is a standard C++ development environment, and the FPGA design platform is the Xilinx ISE/EDK tool. The software tool SystemCrafter SC is used to synthesize SystemC automatically as hardware. The temperature sensor used is an LM74 with a delta-sigma analog-to-digital converter and SPI- and MICROWIRE-compatible interfaces.

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