HeroeS³: A Framework for Heterogeneous SW-Intensive System Design with SystemC

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1. HOLISTIC MODELING APPROACH FOR APPLICATIONS AND THEIR PHYSICAL ENVIRONMENT

Embedded system applications, such as real-time control, are increasingly implemented on SW-intensive architectures. Design flows for such systems are typically model-based and platform-based, that is, development starts from a system level specification model of the application, for instance MATLAB/Simulink, which needs to be mapped to a platform of generic and custom HW and SW intellectual property components. Virtual platforms enable early software development and estimation before the actual platform is available by providing execution environments based on more or less abstract models. However, such design flows are highly heterogeneous with respect to (a) multiple domains, such as the analog/digital HW and SW, and (b) the abstraction levels of the HW/SW component descriptions. Moreover, the physical environment needs to be taken into account when there is a close and mutual interaction. Thus, we propose a holistic multi-level approach for co-modeling and co-refinement of the application, platform and the physical environment as depicted by Figure 1.

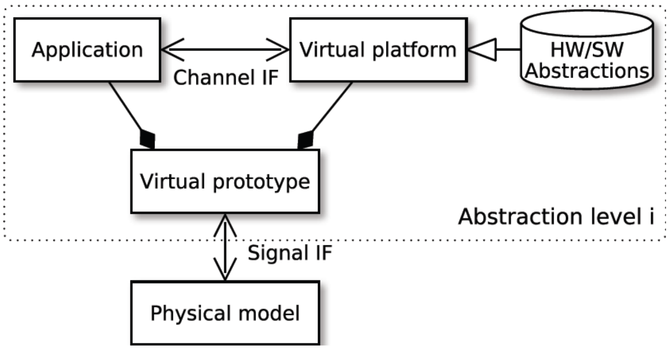

Figure 1: Heterogeneous multi-level virtual platform.

2. MULTI-LEVEL SYSTEMC VIRTUAL PLATFORM FRAMEWORK

The presented methodology is mapped to a an eight levels spanning SystemC based virtual platform framework – referred to as *HeroeS³* – providing smooth application to platform mapping and continuous co-refinement of a virtual prototype with its physical environment model. In order to support heterogeneous modeling and simulation, various SystemC extensions are combined to provide continuous/discrete models of computation and different communication abstractions as depicted by Figure 2. For this we utilize also analog mixed-signal extensions (SystemC/AMS), abstract models of RTOS, HAL and communication middleware. Moreover memory mapped TLM bus models and wrappers of the QEMU user mode and full system emulators are employed for simulation. As such, there is no need to switch the simulation environment.

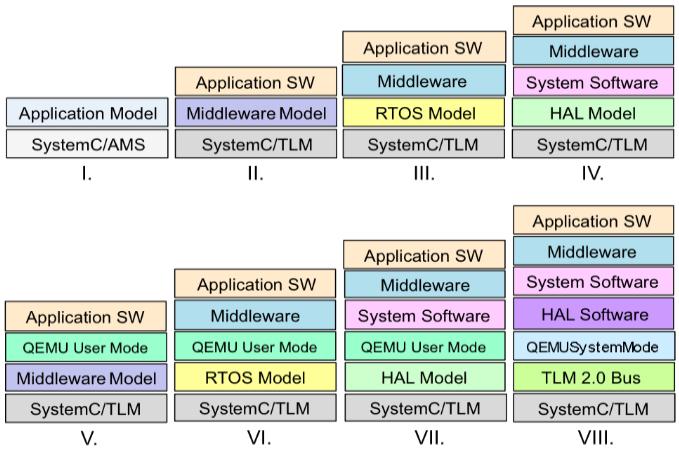

Figure 2: SystemC stacks for application refinement.

3. DEMONSTRATOR CASE STUDY: SOFTWARE DESIGN FOR AUTOMOTIVE CONTROL SYSTEMS

We developed a prototypical interface to the dSPACE AUTOSAR tool chain, that is, tools for system integration (SystemDesk), target code generation (TargetLink) and experimentation/measurement (ControlDesk) with respect to SW in networked Electronic Control Units (ECU). A virtual ECU exported by dSPACE tools can be simulated by the SystemC virtual platform framework. We support two simulation modes: (a) fast offline simulation for rapid exploration of different SW deployments and network configurations and (b) soft real-time simulation synchronizing with ControlDesk and the host's HW clock for interactive experimentation using XCP/A2L interfaces. As such, we can support a smooth refinement of MATLAB/Simulink application models to distributed AUTOSAR compliant SW stacks.

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