Proposal DATE 2010 Tutorial:

Application of the SystemC AMS 1.0 Standard

Authors:

Martin Barnasconi, NXP Semiconductors, Eindhoven, The Netherlands

Karsten Einwich, Fraunhofer IIS/EAS Dresden, Germany

Christoph Grimm, Vienna University of Technology, Vienna, Austria

François Pêcheux, University Pierre et Marie Curie, Paris, France

Motivation of the topic

Embedded HW/SW systems interact more and more tightly with their analog physical environment. This leads to systems in which digital HW/SW is functionally interwoven with analog and mixed-signal blocks such as RF interfaces, power electronics, or sensors and actuators as shown for example by the communication system in Figure 1. We call such systems *Embedded Analog/Mixed-Signal (E-AMS) systems*. Examples of E-AMS systems are cognitive radios, sensor networks or systems for image sensing. A challenge for the development of E-AMS systems is to understand the interaction between HW/SW and the analog and mixed-signal subsystems (e.g. power drivers, sensors, RF circuits) at architecture level. This requires means for modeling and simulating the interacting analog/mixed-signal systems and HW/SW systems at functional and architecture level.

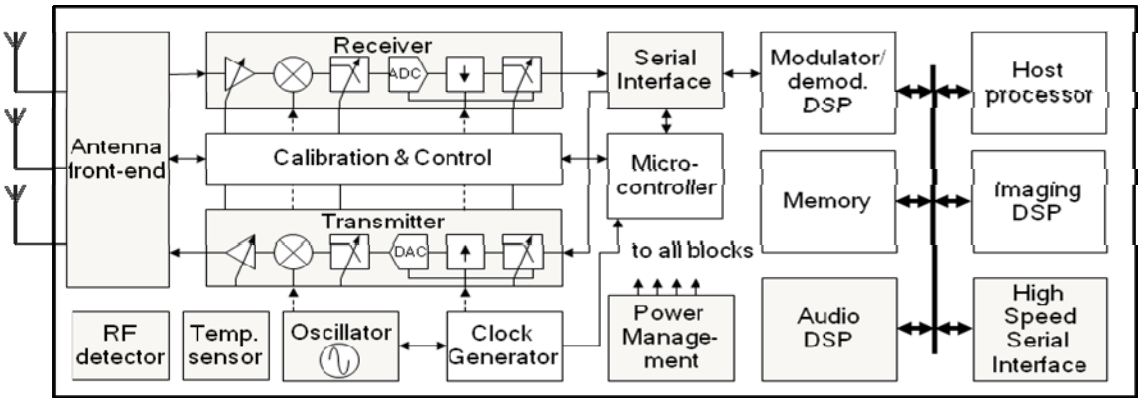

Figure 1: *Example of an embedded analog/mixed-signal architecture: Communication System.*

SystemC supports the refinement of HW/SW systems down to RTL by providing a discrete event (DE) simulation framework. On top of this, a methodology for generalized modeling of communication and synchronization is available. Transaction Level Modeling (TLM) allows designers to perform abstract modeling, simulation and design of HW/SW system architectures. However, the SystemC simulation kernel has not been designed for the modeling and simulation of analog, continuous-time systems and lacks the support of a refinement methodology to describe analog behavior starting at functional level down to implementation level.

SystemC AMS extensions introduce new language constructs for the design of embedded analog/mixed-signal systems. The SystemC AMS DRAFT standard was published in December 2008. The official OSCI standard is expected in December 2009 and targets the availability of a proof-of-concept implementation of a SystemC AMS 1.0 standard compliant system simulator.

Reasoning for a tutorial

With the availability of this brand new SystemC AMS 1.0 standard and proof-of-concept implementation, this DATE 2010 tutorial will be the first event to present and demonstrate the capabilities of the novel SystemC AMS standard.

Tutorial objectives and structure

The tutorial will cover the following elements

- Motivation, Use cases and requirements for E-AMS system-level modeling
- Modeling concepts for E-AMS systems
- SystemC AMS simulator capabilities and basic language examples
- Application example of a heterogeneous E-AMS system

The first part will present the initial motivation, use cases and requirements to develop the SystemC AMS standard, and will give an overview on the modeling language and execution semantics specifically for analog and mixed-signal functions, to facilitate design and modeling of telecommunications, automotive and imaging sensor applications at various levels of abstraction

The modeling concepts beyond the defined language constructs will be presented, together with the design methodologies for abstract E-AMS system level modeling and refinement.

A first step guidance how to use the open source SystemC AMS proof-of-concept implementation will be given, including several code examples to demonstrate the usage of the language.

A complex example of a full-fledged heterogeneous E-AMS system will be demonstrated, using the new SystemC language extensions. The presented system is a Wireless Sensor Network dedicated to the detection and localization of seismic perturbations. The example covers several disciplines (physics, digital, analog, RF, software), several modeling principles (bit-cycle-accurate, timed-dataflow, linear networks, baseband equivalent) and some numerical analysis methods (discretized partial derivative equations, system of non-linear equations).

Target is to have a full-day tutorial, with these topics presented in 4 blocks of ~1.5hour each.

A live-CD is made available for all participants, which can run on any laptop and contains all the material needed to run the application without any installation or configuration and includes the full SystemC/SystemC-AMS source code.

Target audience

This tutorial is being organized for people interested in system-level modeling using SystemC and the AMS extensions for design and verification of heterogeneous E-AMS systems. The tutorial targets system engineers and system architects active in projects where analog and digital functionality comes together. Some prior knowledge on SystemC is preferred, but even beginners are able to follow the presentations and use the live-CD.

Speakers

Martin Barnasconi, NXP Semiconductors, The Netherlands

Martin Barnasconi received his Electrical Engineering Degree in 1993 and worked the last 16 years on Radio Frequency components, integrated circuits and system-level design for Philips Consumer Electronics, Components and Semiconductor division. Martin is currently working at NXP Semiconductors as Product Manager to develop system-level design and verification methods for Analog/Mixed-Signal and RF applications. In his role as chairman of the AMS Working Group for the Open SystemC Initiative (OSCI), he is driving the standardization of the Analog/Mixed-Signal extensions for SystemC and released the SystemC AMS Draft 1 language standard in December 2008.

Karsten Einwich, Fraunhofer IIS/EAS, Dresden, Germany

Karsten Einwich received the Dipl.-Ing. degree from the University of Technology Dresden in 1993. From 1993 he worked at the Fraunhofer Institute for Integrated Circuits in Dresden in the design automation division. He is head of the system specification group in the mixed signal system department. His work is focused on modelling, simulation and design of complex Mixed Signal systems especially for telecommunication and automotive applications. Since 2001 he is engaged in the extension of SystemC for Analogue and Mixed Signal (AMS) designs. He was a co-founder of the SystemC-AMS study group and is now member of the OSCI SystemC-AMS working group. He received the German EDA Achievement Award 2008 for his contributions to the SystemC AMS standardization.

Christoph Grimm, Vienna University of Technology, Vienna, Austria

Christoph Grimm works on the design and design methodology of embedded mixed-signal systems. He has authored more than 100 scientific publications. He is editor of the book "Languages for System Specification", Kluwer 2004 and co-author or contributor to many standards such as the "SystemC AMS" Language Reference Manual, or the standards IEEE 1076.1 (VHDL-AMS) and IEEE 1076.6 (VHDL-SIWG). In 2003, he was General Chair, and in 2005/6 Program Chair (AMS Topic) of the Forum on Specification and Design Languages, and vice chair of the OSCI SystemC-AMS WG and chairs the scientific advisory board of OVE. He is scientific advisor to several microelectronic and automotive companies. Since 2006 he is full professor for Embedded Systems at the Institute for Computer Technology, since 2008 head of the institute.

François Pêcheux, University Pierre et Marie Curie, Paris, France

François Pêcheux received the M.S. and Ph.D. degrees in Computer Science and electrical engineering from the University Pierre et Marie Curie, Paris, France, in 1998 and 1992. From 1995 to 2002 François Pêcheux has been with the Laboratoire de Physique et Applications des Semiconducteurs in Strasbourg, France. He also joined the Ecole Nationale Supérieure de Strasbourg (ENSPS) as an Assistant Professor. He developed several computer-aided design design tools and dedicated software for the efficient modeling of systems at the CNRS, and participated in the development of some mixed-signal models for submicron devices, taking into account physical interaction with the direct environment. In September 2002, he rejoined the LIP6 Laboratory Integrated Systems Department at the UPMC. He is the author or co-author of multiple articles and conference contributions on (SystemC-based) IC design methodology for homogeneous and heterogeneous systems. Currently he is working as a researcher in the ALSoC Team and is responsible for the SystemC training activities of UPMC/LIP6 and for the development of digital/analog IPs.