PROJECT RESULT

EDA for SOC Design and DFM

2A717: Design refinement of embedded analogue and mixed-signal systems (Beyond Dreams)

Open-source design framework sets standard for mixed-signal embedded systems

Designers of embedded systems, the tiny chips at the heart of most modern consumer devices, face a problem when dealing with mixed-signal information from analogue and radio-frequency sources as well as digital data. Modelling such complex environments is difficult and slow, leading to high development costs and delays. Beyond Dreams aimed to develop a new simulation and modelling framework to aid design of these complex sub-systems. The project not only succeeded, it also came up with a new, open-source SystemC analogue and mixed-signal standard already taken up by companies around the world.

Consumer electronics such as mobile phones, digital watches, MP3 players and personal digital assistants are all based on embedded systems, the tiny system-on-chip (SoC) elements at the heart of many user devices. Embedded systems are relatively cheap to construct and have spread throughout the electronics market. However they often need to act on mixed-signal information – that is data from analogue and radio-frequency (RF) sources, as well as digital data.

This need to handle mixed analogue/digital signals brings problems of its own. Semiconductor developers increasingly model new systems using digital simulation, yet while system-level modelling is straightforward for digital products, it is far less easy for analogue systems. The result is growing development costs and delays.

The MEDEA+ 2A717 Beyond Dreams project brought together chipmakers, universities and research institutes to address these issues. The project aimed to develop a methodology, a simulation and modelling framework, standardised languages, libraries and modelling formats to guide designers in the development of analogue and mixed-signal (AMS) sub-systems.

Reducing design time/cost

Beyond Dreams focused on embedded AMS systems, an area which deals with the development complexity arising from mixing digital hardware/software systems with analogue and RF systems in SoC or system in package (SiP) designs.

Project participants hoped to reduce design time and cost for these SoC and SiP systems by developing standardised modelling techniques and an implementation which would become freely available as open-source software. In addition, a unified design framework and flow, ideally based on SystemC, should bring the different design disciplines together, enabling design/intellectual property reuse and interfacing with third-party design and simulation tools.

In the event, Beyond Dreams achieved and even exceeded its key goals. It:

- Developed an AMS system-level design methodology which set a new benchmark in this area;
- Established an extension to the SystemC standard for embedded AMS systems, and an IP-XACT-based integration framework which was swiftly validated both within and outside the project;
- Released a SystemC AMS reference implementation under open-source license, to model and simulate complex AMS systems; and
- Refined the embedded AMS design methodology and technology to the benefit of the semiconductor-design community at large.

First mixed-signal language

Beyond Dreams has delivered a new, structured design methodology for analogue and mixed-signal systems. This new SystemC-based language extension is the first-ever system-level modelling language for mixed-signal environments. Existing mixed-signal languages – such as Verilog-AMS or VHDL-AMS – tend to focus on circuit-level behavioural modelling. For designers, being able to carry out system-level modelling for mixed-signal systems is a major leap forward.

Demonstrations of the SystemC AMS reference implementation by Beyond Dreams partners have shown, using abstract models, a gain in simulation speeds of between 1,000 and 100,000 times compared with traditional modelling languages. While there is some loss of precision, it is only 3 to 5 %, more than outweighed by the gain in speed.

System simulation with SystemC AMS outperforms many existing commercial electronic design automation tools in terms of dealing with mixed-signal system simulation complexity. Such tools can crash when attempting to model complex communication systems with many nodes. SystemC AMS is able to handle systems of more than 1,000 nodes with ease.

Setting a new industry standard

Beyond Dreams' standardisation efforts have also driven a new SystemC-based language extension for mixed signals, which was accepted as a standard by the Open SystemC Initiative (OSCI). The new open-source SystemC AMS 1.0 standard was released in March 2010.

Key chipmakers in the project – such as Infineon Technologies, NXP Semiconductors and STMicroelectronics – have adopted this standard, integrating the SystemC AMS reference implementation from research institution partner Fraunhofer into their own design processes.

SystemC AMS has already proven its worth in a number of new mixed-signal applications. In developing communications, automotive and imaging systems, designers have witnessed the kind of improved system simulation performance that they have seldom seen. The video-sensor model developed for the ST-Ericsson's SMIA platform showed an increase in simulation speed of two to six orders of magnitude compared with methodologies based on the existing mixed-signal VHDL-AMS language, allowing the debug of the software long before the availability of the hardware parts.

Since it was released as an open-source standard, SystemC AMS has been downloaded more than 2,500 times and well distributed around the world.

In addition, leading academic institutions in three countries – University Pierre and Marie Curie in Paris, Vienna University of Technology and Delft University of Technology – have introduced SystemC AMS into their curricula. They have also launched an academic connections programme to support other institutes wishing to gain expertise in the technology.

Faster heterogeneous design

Beyond Dreams has paved the way towards faster and simpler design for complex, mixed-signal sub-systems. Its results are already feeding into a newly launched CATRENE project, H-INCEPTION, which is researching a system-level design and simulation framework for cyber-physical systems in areas such as bioelectronics, thermodynamics and mechanics.

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