technology update

SPECIFYING WIRELESS AND BROADBAND DESIGNS

Creating the system specification is a critical step in the life of any system-on-a-chip (SoC) design. The specification impacts the entire design cycle through implementation and verification. It defines the project performance and schedule goals, and should provide a springboard for overall success. Pekka Leinonen, from the Synopsys Professional Services team in Europe, describes how they have developed a successful approach to wireless and broadband designs using executable specifications to address the all-important first step in defining the system.

Developing an executable specification has proven to be a powerful technique for validating system-level requirements, and also provides an excellent reference point for the entire implementation process.

As well as reducing ambiguity and accelerating the overall design process, providing an executable specification has enabled Synopsys Professional Services to raise the interface with customer design teams to the highest level – the product concept. An executable specification demonstrates design intent at an early stage in the project, with far less risk of misinterpretation.

Companies are now focusing on their specific core competences, areas where they are clearly able to add value and differentiate. Recognizing this, Synopsys has structured its services offerings to address two types of customer needs: consulting design services for companies that are interested in developing and augmenting their design capabilities, and turnkey design services for companies opting to outsource all or part of their SoC development.

Synopsys' turnkey offerings include support at the earliest phase of product development – the concept phase, where the systems design and architectural partitioning are being conducted (Figure 1).

Developing the design concept and executable specification is an area where experience counts for a great deal. Creating the specification requires an understanding of the system level functionality, often based on detailed knowledge of protocols and standards, in addition to familiarity with a range of SoC design methodologies.

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Wireless and Broadband Design Services

Figure 1: Turnkey Design Service Offerings

"The term 'concept' is used to encompass the definition of first-pass functional system specifications or product requirements."

Figure 2: Wireless Systems-Level Design Flow

System-Level Dilemma

Product convergence has led to a proliferation of designs that combine communication functionality within consumer applications. With each new advance in wireless or broadband communication comes a raft of new, often-competing standards and applications. Taking both of these trends together results in product concepts that become more complex with each new generation of development. For example, designing a basic GSM handset is a complex design problem in its own right. But to produce a competitive mobile handset today typically requires that it supports multiple standards (such as 2G, 2.5G), operates on multiple frequency bands, has PDA or 'infotainment' functionality (such as games or MP3), and has an infra-red or Bluetooth connectivity.

As the SoC concept and specification phases become more complex, they also become more critical within the context of the entire design process. Making the wrong decisions at the system level can be disastrous. On the other hand, making the right decisions at the concept and specification stage can pay back with interest. For example, achieving the performance, power and cost goals will be determined by the decisions made at the system and architecture level, rather than optimization decisions during design implementation. Evaluating design trade-offs at this early stage is critical. Working with an experienced team that has done these kinds of evaluations many times before will significantly reduce the risks inherent in the process.

Executable Specification Methodology

Synopsys has developed a proven executable specification methodology over hundreds of successful consulting engagements. The general approach to specification development follows similar principles for both wireless and broadband systems.

The term 'concept' is used to encompass the definition of first-pass functional system specifications or product requirements. In the case of wireless systems, this will include identification and development of the key algorithms. The concept phase can be the highest level of handoff from the customer.

Verification of complex systems is such an important issue that it is also considered during the concept phase, with the development of an initial verification plan. Development of a system-level verification environment and test scenario happens in parallel with the executable specification. Both are re-used at the RTL stage.

The specification phase revolves around the development of an executable specification. This approach helps converge on a specification that can be quickly 'frozen' for implementation. However, specification changes are a fact of life in chip development, and one of the values of the executable specification is that changes can be simulated and evaluated before re-implementation in RTL. Avoiding unnecessary iterations is essential in keeping project schedules on track.

One of the key objectives in taking this structured approach to concept and specification is to develop an 'unbroken' flow, from high-level concept all the way to RTL.

Specifying and Modelling Wireless Systems

The key challenge in wireless baseband design is the transformation process from complex algorithms to RTL. Taking a traditional approach of developing a text-based specification followed by an HDL-based RTL design, and then creating a testbench in a hardware description

language, usually results in inefficient and cumbersome verification. Developing an executable specification and system-level testbench using tools like CoCentric™ System Studio enables accurate modelling of the baseband processor and channel, which can be re-used when developing the RTL.

The development of the executable specification usually starts with a floating-point model, based on a C-language description in the systems-level tools. Development of this model will include aspects of the signal processing design, such as the design of digital filters, for example. It will include optimization of the filter order and generation of the coefficients to achieve the desired response. Behavioural system-level building blocks such as modulators, multi-path fading channels, oscillators and mixers can be used to speed up the initial creation of the model, as well as enabling evaluation of different algorithmic techniques.

When the floating-point model has been verified with appropriate system-level simulations, it can be refined to a fixed-point model that will accurately reflect the effects of finite word-length arithmetic.

Once verified that the system response is the same with both floating and fixed-point models, the model is further refined by back-annotating latencies from the RTL design to the fixed-point model. The bit-true cycle-accurate model provides the link between the floating-point representation and the RTL implementation and enables co-simulation of the RTL against the refined fixed-point model. Figure 2 illustrates the wireless systems-level design flow.

Within the wireless application space, Synopsys Professional Services has experience in UMTS (3G), GSM (2G/2.5G, EDGE/GPRS), DVB-(S/C), satellite receivers, microwave point-to-point modems, combined satellite and terrestrial modems, and custom proprietary modems. In addition to direct design experience, Synopsys has developed reference models that can be used to ensure conformance to the appropriate standards.

Specifying and Modelling Broadband Systems

A significant challenge in broadband communications systems is the level of detailed specification required for complex processors with multiple channels and modes of operation. Verification is also a major issue with the need to verify systems that combine high performance with extensive programmability, under all the usage scenarios.

Because of the complexity, developing an executable specification is a good way of removing any ambiguity in the functional specification. Depending on the application, it may be sensible to model the whole system or just key parts of the design. As in the wireless case, the executable specification can be used as a reference during the RTL implementation and verification.

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