EMBEDDED DESIGN WITHOUT HARD BARRIERS

AS THE MARKET-DEFINING PROPERTIES OF TODAY'S ELECTRONIC PRODUCTS CONTINUES TO MOVE INTO THE SOFTWARE DOMAIN, A DESIGN'S INTELLECTUAL PROPERTY (IP) IS INCREASINGLY CHARACTERIZED BY THE UNIQUE 'INTELLIGENCE' THAT IS PROGRAMMED INTO THE PRODUCT.

In turn, the underlying physical hardware that supports the intelligence is playing a reduced role in defining a product's IP. This has changed the fundamental landscape of electronics design, allowing product developers who work in the software space to become the prime movers in defining the function and behavior of today's electronic products.

The explosion of programmable hardware components such as FPGAs over the last few years has allowed an even greater part of the design to move into the soft domain. Not only are these components becoming more capable, higher in capacity and more feature-rich, they are becoming significantly cheaper. The availability of high-capacity, high-performance FPGAs at relatively low cost has opened up the possibility of using this technology to change the way designers interact with hardware and software by extending the concept of programmed device intelligence from just software, to encompass both software and hardware.

With this approach the system hardware itself can be defined in the soft realm – from mass logic through to high-performance microprocessors and matching system memory – allowing developers to create whole systems within the reprogrammable fabric of an FPGA. A much greater portion of the design process is done in a soft domain, meaning that the defining value of that product has moved away from the unique properties of the physical platform. This hardware platform nevertheless supports the soft elements and forms the interface to the outside world, and therefore remains a large and crucial part of the electronic development process – and in the process, takes a proportionally large share of the product development time and cost.

For all the revolutionary advances in electronics devices and how electronic products are designed, the process we use to develop and complete those products has generally failed to progress at the same pace. We still treat the design of the board-level hardware separately from the development of the software that runs on it, and programmable hardware design ends at the pins of the device – a separate discipline in its own right.

As more of a design is moved into a soft platform, the lines between the traditional design disciplines such as hardware, software and FPGA design begin to blur. Dealing with these design elements independently and with separate tools becomes increasing difficult and inefficient as design complexity increases and time-to-market cycles shrink.

The move to higher levels of abstraction within individual processes helps to cope with specific complexities but at the same time but increases the specialization required within each domain. Ultimately, of course, these individual elements of the design must be brought together to create a final product, but the increased specialization of each piece is making the final puzzle much harder to assemble. This blows out design times and is ultimately to the detriment of product innovation.

A COHESIVE SOLUTION

Rather than a traditional 'point-tool' solution of approaching the design problem as a collection of independent processes that are eventually linked together, a unified methodology offers a solution to this complexity barrier by treating the product design process as a single problem.

Unifying the design processes at a platform level creates a product development system that can manage design complexity while harnessing the potential of soft design within the programmable device realm. Bringing together all the hardware and software elements of the design process within one intrinsically connected environment creates a singular design flow and data model that dramatically simplifies the process.

For example, by exploiting the mutual-awareness and shared data of the hardware, software and programmable hardware design processes, a unified design system can seamlessly automate many of the inter-discipline tasks such as synchronizing the pin definitions of programmable devices across both the chip and board-level design spaces, and automatically managing hardware dependencies between the software and its execution platform. These things simply can't be done effectively if the parameters and constraints controlling the different elements of a design exist in independent applications.

Importantly, unifying design processes creates an environment where the abstraction level of those processes can be raised as a whole, rather than within each separate piece of the traditional point-tool collection. In this way the complexity of today's designs is managed as a whole, creating a new approach to electronics design where the overall process can be dealt with as a single higher-level problem.

Through a cohesive abstraction of the processes, unified design reduces the need for expertise in multiple design disciplines and the use of multiple different tools. It also reduces the level of low-level hardware design and system software needed by ▸

THE COMBINATION OF A UNIFIED DESIGN SYSTEM AND A RECONFIGURABLE HARDWARE PLATFORM OPENS THE POSSIBILITY FOR EMBEDDED DEVELOPERS TO CREATE AN ENTIRE ELECTRONIC PRODUCT WITHOUT CUSTOM HARDWARE DESIGN.

EXISTING DESIGN SKILLS CAN BE USED BEYOND TRADITIONAL DESIGN BOUNDARIES

design specialists. For example, within a unified environment it is possible to insert a section of pre-designed electronics into the design project and have this functionality manifested across the whole design, from PCB layout and schematic hierarchy through to the embedded FPGA elements.

REDEFINING THE HARDWARE PLATFORM

The emergence of a soft design paradigm, which can be fully harnessed within a unified design system and large-scale programmable devices, decreases the need to imbue the physical hardware platform part of the design – in practice the PCB assembly – with unique, market-defining IP. This shift in emphasis means that the energy expended on full custom hardware development at the board level does not add to the overall value of the final product, with the PCB simply becoming a host for the design's intelligent devices and a set of standardized physical interfaces needed to connect the programmed intelligence to the 'outside world'.

It makes sense then to consider the viability of an 'off-the-shelf' approach the problem of hardware design where the programmed intelligence of a product, once developed, is simply lifted from the development environment and programmed into a tailored, off-the-shelf hardware platform. This is possible within a unified design environment because the design system can manage the low-level hardware dependencies to ensure the software and programmable hardware make the right connections to the targeted physical environment.

Using this approach a designer could choose from a range of targeted basic hardware platforms – say a handheld application, an industrial device, a consumer application or a rack-mount piece of equipment – customize that platform by plugging in a range of special purpose modules that contain fixed and programmable components, then simply download the custom design intelligence into it to provide a product solution ready to go to market. It could be considered as Commercial Off-The-Shelf (COTS) hardware, but thanks to the potential of high-capacity FPGAs the capabilities effectively cover software, hardware and programmable hardware – sufficient to develop then create a complete and viable product.

This concept enables someone who doesn't have the necessary hardware skills for custom PCB design – let's say a hardware-savvy embedded developer – to build a production-ready

BY USING A HARDWARE DEVELOPMENT PLATFORM BASED ON CHANGEABLE FPGA AND PERIPHERAL BOARDS, THE ENTIRE DESIGN CAN BE CREATED IN REAL HARDWARE AND DEBUGGED ON THE FLY, WITHOUT THE NEED FOR CUSTOM PCB DESIGN.

intelligent electronic device. Once your intent is captured in the unified design system, the programmable facilities available on the host board and its modules can be used to configure the entire platform. In practice, this means automatically 'connecting' the fixed hardware resources together as needed and creating the additional embedded hardware necessary to provide a suitable application platform.

Regardless of its physical properties, an off-the-shelf reconfigurable hardware platform provides a targeted system into which both hardware and software can be programmed. This speeds development of soft designs and reduces, or potentially eliminates, the task involved in custom PCB design. In the case where there is a need to convert the system to a single dedicated Application Specific Circuit Board (ASCB), for mechanical 'fit' reasons for example, then the ability to easily outsource the required board layout work is greatly facilitated by having the design already implemented, tested and working.

At a fundamental level, the combined flexibility of a reconfigurable hardware platform and unified design system allows you to commit to hardware decisions much later in the design cycle and update or interactively change the design at any time, without time or cost penalties. This, reinforced by the inherent portability of designs created within such an environment, has a profound effect on product design cycles. It streamlines hardware design, opens the door to concurrent software and hardware development, and raises design abstraction to a level where existing design skills can be used beyond traditional design boundaries.

Ultimately though it has the potential to commoditize the concept of commercial reconfigurable off-the-shelf hardware as a means to bring a wide range of products to market, and to allow designers and companies to create innovative products without having to design – or pay someone to design – custom hardware or application-specific circuit boards. As designs move further into the soft realm, a unified approach to off-the-shelf hardware will allow designers, regardless of their hardware development expertise, to quickly implement systems that deliver the device intelligence needed to achieve true product differentiation in the market. ■

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