



MicroBlazing Away

Xilinx Boosts Embedded Ecosystem

"No, but this one is really important."

We editors are endlessly bombarded by battalions of bulldozing PR professionals trying to cleverly coax us into crafting a sentence or two on each and every snuffle of product evolution that emanates from their esteemed engineering organizations. "This one is important," they will say. "Our new 2.4.3.5.21b driver version is vastly improved over 2.4.3.5.21a. You'll probably want to do a three-article series just on the switch from absolute to relative memory addressing..."

Right.

So, when Xilinx calls up to say they'll be "enhancing" their embedded processing capabilities, our technically-advanced editorial auto-skeptic system, complete with press-release spam bucket, shifts seamlessly into high gear. (That's why we got the new 5.3.4.12 version.) This time, however, after reviewing the new announcement's curriculum-vitae, we have to call a false alarm on our anti-article defense system.

Embedded processors on FPGAs got off to a dubious start. "Hey!" astute FPGA designers said. "We've got enough logic here to put down a whole processor, and then we could just write software for some of this complicated functionality." There was a communication breakdown, however, because their idea of "complicated functionality" was a state machine with more than 10 states that could be soft-programmed. Marketing, however, heard "processor" and had visions of advanced operating systems running full-blown applications while the rest of the FPGA fabric handled the peripheral duties.

Somewhere between the two (and closer to the state machine side) was reality. It's now been several years, and reality and marketing have been ever-so-slowly converging. Now, Xilinx is announcing (among other things) a memory management unit (MMU) compatible with their MicroBlaze soft-core embedded processors. Reality is now one step closer to marketing. Operating systems that require memory management (like Linux and friends) can now be

booted on a soft-core processor in a Xilinx FPGA.

Xilinx is announcing a new version of the MicroBlaze 32-bit soft-core processor architecture (version 7). The soft-core is highly configurable and can be deployed in a wide variety of implementations, depending on the application requirements. Everything from a tiny, minimal-footprint version to a full-blown memory-managed high-performance processor can be dropped down on a few LUTs doing anything from Linux down to smart state-machine duty.

On the Linux side, LynuxWorks BlueCat Linux is being deployed on the MicroBlaze, adding a commercially-supported Linux variant to the offering. With the performance of the core on current 90nm and 65nm FPGAs, the amount of on-board memory available along with commodity external memory interfaces, and the very high bandwidth connection available to on-chip accelerators, peripherals, and memory, some very interesting applications can now be developed for this architecture. Taking advantage of available DSP resources for high-speed algorithm acceleration in conjunction with this sophisticated processing environment, it should now be possible to create a small reconfigurable-computing system on a single chip with breathtaking performance on some classes of problems.

The new MMU allows Linux 2.6 virtual memory to be implemented using both on-chip and off-chip memory resources. The MMU also includes an MPU mode that permits protected partitions to be created for secure RTOS applications. While we may not yet be to the level of virtualization available for discrete and ASIC-based processor architectures, the new MMU makes MicroBlaze finally a grown-up processor architecture that can support a much broader range of existing software.

The MMU option in full MMU mode occupies around a thousand LUTs and one block RAM on either Virtex-5 or Spartan-3 devices. The MPU mode requires about half that many LUTs, and the privilege mode for special instructions uses a scant 30-40 LUTs. Xilinx points out that the full MicroBlaze with MMU still occupies less than ten percent of a low-cost Spartan-3E 1600E device, leaving plenty of room for other goodies in your design.

In addition to the memory management unit and PLB, the new MicroBlaze has a couple of additional instructions that improve floating point performance. They've also added FSL instructions to simplify access to co-processors. Also new are capabilities to enable third-party trace tools like Lauterbach T32 and Computex F-Sight to accelerate embedded software debug.

With the available bandwidth of connections available through FPGA fabric, it's kinda' silly to have only a traditional shared-bus architecture for connecting processors and peripherals. To resolve this issue, Xilinx is also announcing a new direct Processor Local Bus interface (PLB) that should significantly improve system performance. The new PLB (PLBv46) is optimized for FPGA implementation, and it provides both shared-bus and point-to-point connections. This allows you to configure the interconnect to match your performance needs while still being frugal with FPGA resources.

To prove the performance benefits of the new enhancements, Xilinx uses a TCP/IP networking application – the MicroBlaze Gigabit Ethernet Reference Design -- as a benchmark. Moving from the previous (MicroBlaze v6 with EDK 9.1) to the latest (MicroBlaze v7 with EDK 9.2) boosts maximum throughput from 70Mbps to 495Mbps – about a 7X improvement. These numbers are both on the 65nm Virtex-5 LXT FPGA platform.

Xilinx has also upgraded their Embedded Development Kit based on Xilinx Platform Studio. The design suite allows point-and-click definition of embedded systems on Xilinx FPGAs and assists in interfacing those systems to peripherals and to other design blocks in the programmable logic LUT fabric. Platform Studio includes software development and debug tools based on GNU tools that allow C-based embedded application development. The company's ChipScope Pro on-chip bus analyzer allows easy in-system debug of hardware, software, and the hardware/software interfaces.

Enhancements to the suite include wizard support for the new multi-port memory controller, support for the new PLB-based point-to-point and shared-bus connections between components, a new clocking wizard, and several improvements to the Eclipse-based software development kit. The SDK now boasts support for remote debug, rolls in the latest version of GNU tools and TCP/IP libraries, and offers XMK support for MicroBlaze memory protection.

To get us all started with the new MicroBlaze family, Xilinx is releasing a low-cost development kit – the Spartan-3E 1600E Edition with a development board, EDK and ISE tool suites, the MicroBlaze v7 Linux Reference Design, documentation, probes, connectors, and power supplies for around \$600 USD. Using this kit, you can try out the new MicroBlaze platform yourself and reach your own conclusions about how grown-up it really is. As far as we're concerned, our automatic skeptic mode has been temporarily disabled.

by Kevin Morris, FPGA and Structured ASIC Journal

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