

# ARC CORES ENCOURAGES “PLUG-INS”

*Third-Party Extensions Enhance Configurable CPU Cores*

*By Tom R. Halfhill {6/19/00-03}*

High-level synthesis tools and configurable CPU cores already bring some of the malleability of software to microprocessors. Now ARC Cores is taking the next step: CPU “plug-ins.” The technical concept and business model for ARC’s plug-ins will be familiar to users

of PC software. For programs such as Adobe PhotoShop, QuarkXPress, and Web browsers, plug-ins take the form of digital image filters, file-format converters, and multimedia players, and they are usually created by third-party developers. In a similar fashion, ARC is encouraging intellectual-property providers and even its own customers to develop and sell extensions to ARC’s configurable embedded-processor cores. The plug-ins are aftermarket packages that add new features or application-specific enhancements to the cores—just as plug-ins for popular PC programs add new features to the host applications.

Plug-ins could take the form of CPU-level extensions to the synthesizable cores (such as new instructions, registers, condition flags, and bus-interface gaskets) or low-level software (such as device drivers and protocol stacks). ARC expects that most plug-ins will be packages of hardware and software enhancements that adapt the CPU cores for various kinds of embedded applications, such as digital cameras or broadband modems. Such plug-ins could save ARC’s customers a significant amount of development time and money.

For example, a digital-camera manufacturer could purchase a third-party plug-in that includes optimized CPU instructions for image compression, a CCD interface, device drivers for integrated peripherals, and even a digi-cam RTOS with a skeleton user interface. This would be a much quicker path to market than developing all the intellectual property from scratch or buying it piecemeal from

multiple suppliers. It would also be an attractive solution for companies that lack the resources to tackle such an extensive development effort themselves.

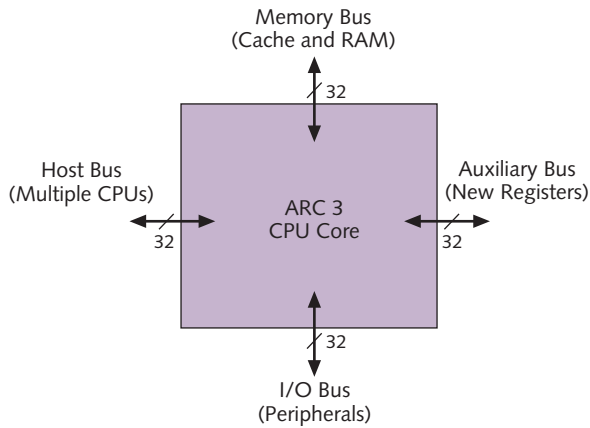
## **Plug-Ins Work With Any ARC CPU**

To make it easier for third-party developers to create plug-ins, ARC is documenting the signal interfaces and other technical details of its synthesizable models. These Verilog/VHDL interfaces are analogous to the plug-in APIs for popular software programs, and they work with all ARC CPU cores, including the latest ARC 3 (see *MPR 5/31/99-04*, “ARC Expands DSP Capabilities”).

Almost any kind of CPU extension is possible. Developers can create application-specific instructions (including complex multicycle operations) that use new registers and execute conditionally according to new condition codes. Existing instructions can predicate their execution on new condition codes too.

Custom bus interfaces are another option. The synthesizable models of ARC’s CPU cores define four generic 32-bit buses. Because the models don’t define the bus protocols, developers can use the buses for almost any purpose, as Figure 1 shows. If a particular design leaves a bus unused, the synthesis tool won’t compile it, which helps to minimize the gate count and therefore the die size, cost, and power consumption of the finished chip.

In addition to encouraging third-party developers to make plug-ins, ARC plans to market some extensions of its



**Figure 1.** The synthesizable models of ARC’s embedded-processor cores provide four generic buses without defining the bus protocols, so designers can use any bus for any purpose.

own. In fact, ARC views plug-ins as a way to periodically deliver enhancements to its CPU cores without having to introduce new versions. ARC hopes an incremental approach to product development will allow its CPU cores to evolve more quickly in response to market forces while permitting customers to choose only the enhancements they want. In the past, ARC points out, it took years for a microprocessor such as the 68020 to evolve into the 68030, and the new CPU often came with features that some customers didn’t need.

ARC’s business model for CPU plug-ins is similar to the business model for software plug-ins, with one important exception—licensing. Normally, the developer of a software

plug-in doesn’t have to obtain a license from the company that makes the host application. The programming APIs are public and anybody can use them. This situation promotes the widespread development of commercial and even free-ware/shareware plug-ins for popular software applications.

However, ARC says a license-free business model won’t work for CPU plug-ins because developers need significantly more technical support and documentation to create and verify their extensions. That’s probably true. Sun Microsystems’ community source licenses allow anybody to hack away at high-level models of some SPARC and Pico-Java cores, but it will probably be a while before freelance programmers armed with Visual Verilog repeat the success of shareware authors armed with Visual Basic. So ARC requires plug-in developers to obtain a special, lower-cost license that includes documentation and tech support. Licensing terms are negotiable, but a plug-in license is much less expensive than a conventional CPU license—only a few thousand dollars, says ARC. And it’s nonexclusive, so if a licensee’s intellectual property is generic enough, it can be offered for other CPU architectures as well.

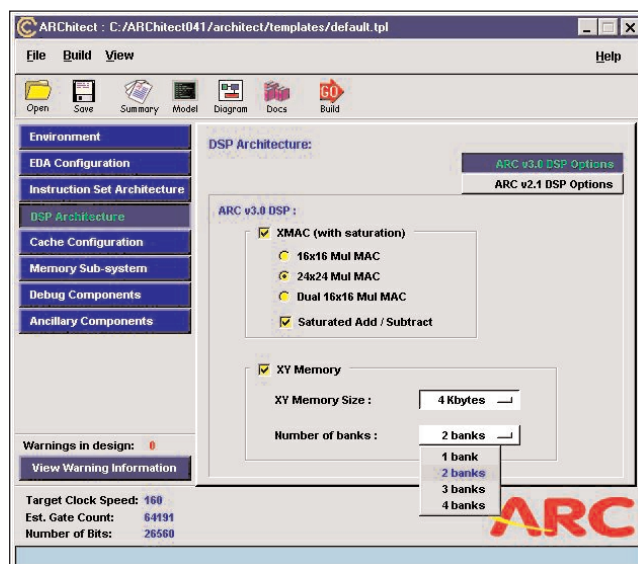
Other than the licensing requirement, ARC’s business model for CPU plug-ins resembles the familiar software model. Developers own the extensions they create and are free to patent them and sell them to anyone at any price. Indeed, Cisco has already patented some of its proprietary extensions to the ARC 3 core (U.S. Patents 6,032,253 and 6,065,027, both granted this year). Because such patents cover intellectual property that extends the base definition of the core architecture, they normally won’t infringe on ARC’s own technology patents.

To promote the plug-ins, ARC plans to publish a catalog and add the most popular extensions to ARChitect, a graphical design tool that allows customers to rapidly customize a CPU core without programming in Verilog or VHDL. Figure 2 shows how ARChitect lets customers add DSP extensions to the ARC 3 core. In the future, checkboxes and drop-down lists will offer more plug-in options.

### Jump-Starting an IP Library

ARC came up with the idea of CPU plug-ins partly because it can. No other vendor of embedded-processor cores can offer so much configurability to third-party developers, especially without making them obtain a costly architectural license.

In terms of configurability, ARC’s nearest competitor is Tensilica, whose Xtensa core has similar but more-limited capabilities (see *MPR 3/8/99-02*, “Tensilica CPU Bends to Designers’ Will”). Tensilica’s customers can modify Xtensa only by choosing from preconfigured options or by using Tensilica’s own design language, TIE (Tensilica instruction extension). TIE resembles Verilog and VHDL, but it’s simpler and has safeguards to prevent designers from creating faulty extensions. Tensilica’s approach is safer for designers who want to add some custom instructions to the basic core



**Figure 2.** ARChitect is a graphical tool that allows ARC’s customers to configure a CPU core without programming in Verilog or VHDL. Note the estimated gate count and clock frequency of the finished chip in the lower-left corner of the screen.

without getting neck-deep in Verilog or VHDL code. The tradeoff is that TIE is less powerful than Verilog or VHDL, and it limits the degree of control that designers can exercise over the core.

To some extent, ARC’s plug-ins are similar to the synthesizable peripherals, protocol stacks, device drivers, and other intellectual property available for rival CPU architectures and on-chip buses, such as AMBA and CoreConnect. But ARC’s competitors in this field—including ARM, MIPS, Motorola, IBM, and Lexra—don’t let customers get anywhere near the synthesizable models of their CPU cores. It’s difficult or impossible to add new instructions, registers, condition flags, and buses to architectures that weren’t designed to accommodate such features. Any attempt to do so would require an expensive architectural license and might even violate the terms of the license. In contrast, ARC allows developers to create virtually any kind of plug-in without requiring them to obtain an architectural license. This enables ARC to leverage the configurability of its cores in a different and innovative way.

But we suspect ARC has an even deeper motivation: to build a library of intellectual property around its cores while investing a minimum of its own resources in the effort. In other words, ARC is letting third-party developers do the grunt work.

It’s a clever strategy, and one that has paid off handsomely for software vendors. The wide availability of plug-ins for such programs as PhotoShop, QuarkXPress, PageMaker, Netscape Communicator, and Microsoft Internet Explorer has greatly extended their capabilities and contributed to their success in the marketplace. If ARC can

### Price & Availability

ARC Cores’ licenses for plug-in developers are available now; terms are negotiable. The prices and availability of individual plug-ins will be determined by their developers. For more information, go to [www.arccores.com](http://www.arccores.com).

successfully adapt that model to CPU cores, it will have a significant competitive advantage.

ARC is already approaching customers that have developed embedded applications around customized versions of ARC’s cores, asking them to consider packaging their solutions as plug-ins for sale to other companies. Some of ARC’s customers may hesitate to empower potential competitors, but others may welcome the chance to recoup their development costs by reselling the intellectual property they’ve created. Some of those companies may even find it more profitable to develop and sell intellectual property instead of end-user products.

Plug-ins also dovetail with ARC’s long-term business strategy. ARC recently acquired its first two intellectual-property providers (see *MPR 4/10/00-03*, “ARC Cores Builds IP Library”) and last year bought MetaWare, a supplier of embedded-development tools. Plug-ins complete the picture by allowing ARC to offer highly integrated solutions to product developers that are in a hurry to catch the latest market waves. Together, all these moves should put more of ARC’s CPU cores into ASICs and system-on-a-chip devices. ♦

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