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BUY SoC IP LIKE MP3s

IPextreme's Core Store Sells Soft IP Online at Fixed Prices

By Tom R. Halfhill {2/11/08-01}

In tech lingo, “IP” is an overloaded acronym that can mean “intellectual property” or “Internet Protocol.” Now there may be a third definition: “impulse purchase.” Intellectual-property vendor IPextreme has opened a retail website called the Core Store that makes

buying IP for system-on-chip (SoC) development almost as easy as buying digital music.

The Core Store sells synthesizable processor- and peripheral-IP cores at fixed, published prices. With a few mouse clicks, chip developers can review online documentation for the IP they want, submit their purchasing information, and receive by email a standard-form license. After approving and returning the license, developers receive an invoice. After submitting their payment (Visa, MasterCard, and PayPal accepted), developers can download files for the soft IP and begin working with it immediately.

Although competing websites allow developers to shop for licensable IP online, those sites rarely disclose pricing, and developers usually must negotiate a licensing contract with the IP provider to close a sale. IPextreme's Core Store is more like Amazon.com or iTunes. It advertises fixed prices and offers a standard end-user license agreement with non-negotiable terms.

Making semiconductor IP almost as easy to purchase as a Hannah Montana MP3 is momentous enough, but the Core Store debuts with another coup. The first (and so far, only) microprocessor available on the site is Freescale Semiconductor's ColdFire V1, a 32-bit embedded-processor core descended from the classic Motorola 68000 (68K) architecture. (See [MPR 8/28/06-02](#), “Connecting the Continuum.”) Amazingly, the Core Store is offering the ColdFire V1 for only \$10,000 plus a royalty of two cents per chip. That price undercuts ARM's processors by tens or hundreds of thousands of dollars. Even low-priced cores from ARC International,

Gaisler Research, MIPS Technologies, and Tensilica are more costly than the ColdFire V1.

The Core Store also sells AMBA-compatible peripheral IP from National Semiconductor at prices ranging from \$2,000 to \$5,000 per core. Although the store's initial catalog is limited, there's enough IP to start a respectable SoC project. Developers can obtain any additional IP they need in the usual ways—including conventional licensing through IPextreme, which sells IP from Cambridge Consultants, Cypress Semiconductor, Freescale, Infineon, and National. The Core Store's open pricing, easy licensing, and accessibility is a breakthrough in semiconductor-IP marketing.

See It, Buy It, Use It

SoC developers who have spent months shopping for IP and negotiating licenses from multiple vendors will find the Core Store hard to believe, but it's real. Figure 1 shows part of the storefront's home page. Purchasing IP is as easy as choosing the core, specifying the quantity, and clicking “Buy.” All it takes is a credit card with a sufficient limit or a PayPal account with a healthy balance. No site registration is required.

The downloadable deliverables are more complete than bare-bones RTL files. IPextreme is a full-service IP broker that doesn't simply take a middleman's cut of the sale. The company's business model is based on serving as a buffer between chip developers and IP providers—especially IP providers that don't want to bother with the nuts-and-bolts details of selling and supporting IP.

CoreStore

Required information to complete purchase.

Thank you for visiting the Core Store™. We'd like to make your experience as smooth as possible. Please take a moment to review the process and if you have any questions relating to the buying experience please email us at core.store@ip-extreme.com

IP Title		Use Price ^A	Royalty ^{**}	Quantity	BUY
Microprocessors					
Freescale ColdFire V1		\$10,000.00	\$0.02	<input type="text"/>	<input type="checkbox"/>
AMBA Peripherals					
Advanced Audio Interface		\$2,500.00	none	<input type="text"/>	<input type="checkbox"/>
CAN Controller		\$5,000.00	none	<input type="text"/>	<input type="checkbox"/>
USART		\$2,000.00	none	<input type="text"/>	<input type="checkbox"/>
I2S Audio Interface		\$2,500.00	none	<input type="text"/>	<input type="checkbox"/>
MICROWIRE/SPI Interface		\$2,000.00	none	<input type="text"/>	<input type="checkbox"/>
Smart Card Interface		\$2,000.00	none	<input type="text"/>	<input type="checkbox"/>
Support					
10 Hr Support Pack		\$2,500.00	none	<input type="text"/>	<input type="checkbox"/>

^APrice per instantiation. ^{**}Royalty per unit manufactured.

Submit Reset

VISA MasterCard PayPal

Figure 1. Soft IP for sale on the Core Store's home page. Although for now the Core Store's IP catalog is limited to one Freescale processor and a few National Semiconductor peripherals, IPextreme hopes to entice more suppliers into selling IP this way.

Freescale is a good example. When Freescale decided to license some of its processor cores to outside developers, it turned to IPextreme for assistance. IPextreme packages the IP for easier integration, including such necessities as documentation, device drivers, synthesis scripts, and test benches. In addition, IPextreme created its own configuration software, called XPack. XPack's graphical user interface helps developers configure the IP and prepare it for synthesis with industry-standard design tools. (See the sidebar "Freescale Outsources Licensing to IPextreme" in *MPR 4/2/07-01*, "Freescale Licenses Power Cores.")

IPextreme even provides technical support to developers, tracks sales of the chips designed with the IP, and collects any royalties due. Normally, tech support is included with the IP that IPextreme sells. At the Core Store, it's a little different. Because of the website's low fixed pricing, tech support isn't included. Instead, developers can buy ten-hour support packages for \$2,500. Some experienced developers may need no tech support at all. Others can purchase as many support packages as needed. In addition, IPextreme provides unlimited access to an online knowledge base that gives detailed answers to common technical questions.

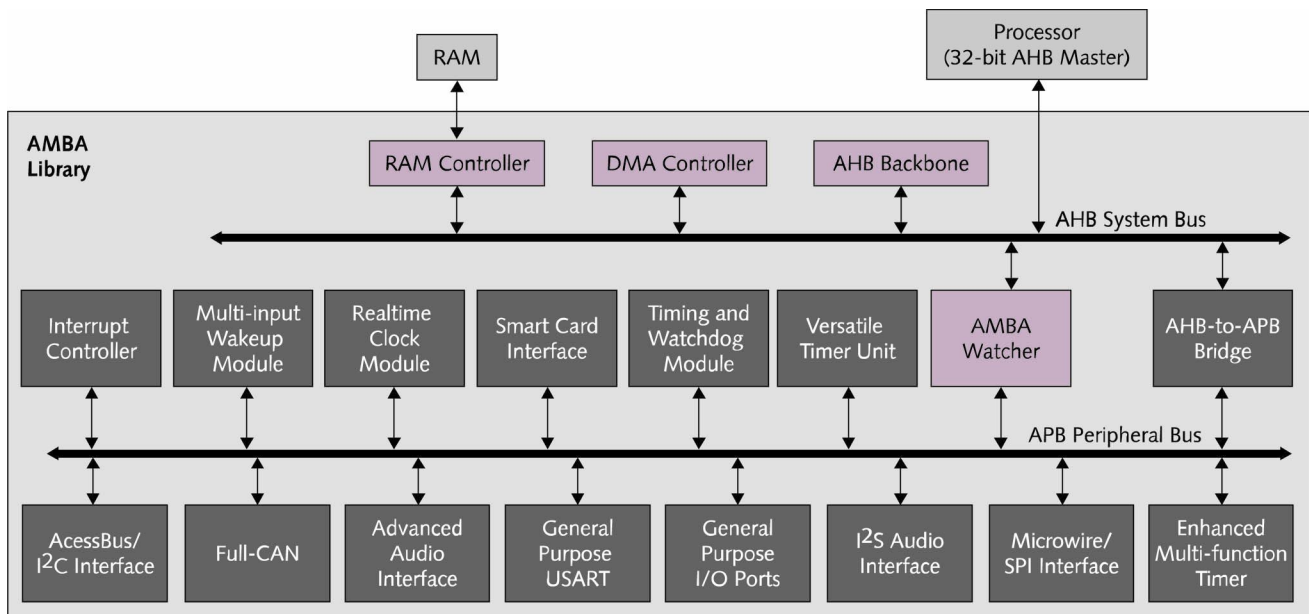


Figure 2. Block diagram of a generic SoC that could be designed using National Semiconductor's fixed-price IP available at IPextreme's Core Store. All the peripheral IP is synthesizable, royalty-free, and compatible with the AMBA 2.0 specification.

The Core Store's standard licenses allow developers to use the IP for one SoC project. Each additional project requires another purchase. Single-project licenses are common throughout the industry and usually are the lowest-priced IP licenses. However, when developers anticipate using some IP in multiple projects, a broader license often saves money in the long run, even though it costs more upfront. In general, the terms for multiple-project licenses are highly negotiable. For that reason, the Core Store doesn't offer multiple-project licenses at this time. Developers needing such a license can bypass the Core Store and deal with IPextreme in the usual manner.

Likewise, a standard license at the Core Store allows developers to use only one instance of a particular IP core per chip. Additional instances require additional purchases. For example, if a developer wants to design a multicore-processor SoC using two or more ColdFire V1 cores, the developer must purchase multiple ColdFire V1 licenses at \$10,000 a pop. The same rule applies to implementing multiple instances of a peripheral-IP core in a single design.

These restrictions are common with low-priced single-use, single-project IP licenses. Developers needing to implement multiple instances of a core often negotiate a deal that reduces the per-core price—but negotiations take time. The Core Store is intended to provide a quick way to buy IP under common licensing terms. Developers with more-complex requirements can negotiate custom licenses with IPextreme.

AMBA-Compatible Peripheral Cores

At its debut on January 21, the Core Store began offering six peripheral-IP cores, all from National. IPextreme plans

to add more peripherals soon. If Freescale perceives enough customer demand, the Core Store may offer the ColdFire V2 Standard Product Platform (SPP) for the ColdFire V1 later this year. The V2 SPP includes several silicon-proven peripheral cores, such as a 16-channel DMA controller, four 32-bit DMA timers, a 10–100Mb/s Fast Ethernet controller, a multimaster crossbar switch, a FlexBus external I/O interface, an interrupt controller, three UARTs, a queued serial peripheral interface (QSPI), and a platform expansion bus.

All the initially available peripheral cores from National are synthesizable IP blocks compatible with the AMBA 2.0 Peripheral Bus (AHB) specification. These peripherals include National's Advanced Audio Interface (a full-duplex 8/16-bit serial interface), a bidirectional I²S audio interface, a control-area network (CAN) controller, a full-duplex USART, a MicroWire/SPI controller, and a smart-card interface (compatible with ISO 7816-3).

National's peripheral cores have been available for conventional licensing for years, and all have been proven in silicon in National's own devices. At the Core Store, the USART, MicroWire/SPI controller, and smart-card interface cost \$2,000 each; the audio interfaces cost \$2,500 each; and the CAN controller costs \$5,000. All these cores are royalty-free.

Figure 2 shows a block diagram of a generic SoC that developers could build using National's peripheral IP. Although any processor core capable of acting as an AMBA master controller would work in this purely fanciful design, only the ColdFire V1 is immediately available from the Core Store.

Price & Availability

IPextreme's online Core Store opened for business on January 21. The first products are Freescale Semiconductor's new ColdFire V1 32-bit embedded-processor core and six peripheral-IP cores from National Semiconductor.

The Core Store's fixed price for a single-project, single-instance ColdFire V1 license is \$10,000 plus royalties of two cents per chip. Additional instances of the processor also cost \$10,000. Ten-hour technical-support packages cost \$2,500. Downloadable deliverables include synthesizable Verilog models, synthesis scripts, test benches, and documentation.

The six peripheral-IP cores from National range in price from \$2,000 to \$5,000 each, with royalty-free licenses. IPextreme expects to offer more IP at the Core Store soon. The website requires no registration, but purchasers must approve a nonnegotiable license. The Core Store accepts online payments with Visa, MasterCard, and PayPal.

IPextreme's Core Store:

- www.ip-extreme.com/corestore
- Information about Freescale's ColdFire V1:
- www.ip-extreme.com/IP/coldfire_v1.html

Fire Sale for ColdFire?

A typical reaction to the ColdFire V1 pricing at the Core Store is that Freescale must be desperate to offer such a processor for only \$10,000. Licensing a similar processor core from ARM might cost 10 to 100 times as much money. It's certainly true that the ColdFire/68K architecture has seen better days. In the 1980s, 68K-based microprocessors powered servers, workstations, and personal computers. In the 1990s, for a while, 68K chips dominated the 32-bit embedded-processor market, making an especially strong showing in laser printers and automobiles. Then came ARM.

Unlike the 68K CISC architecture, ARM processors have an efficient 32-bit RISC architecture. And ARM's business model was even more compelling—any company could license an ARM processor core for use in its own custom chip design. In the 1990s, ARM caught the rising tide of ASICs and SoCs and surged past its competitors. Motorola, which at that time owned the 68K, responded by streamlining the CISC architecture to create the hybrid ColdFire architecture. (See *MPR 10/24/94-05*, "Motorola Redefines 68K Instruction Set.") ColdFire V1, now owned by Motorola spinoff Freescale, is the latest (and smallest) implementation of that architecture. But Freescale has been slow to offer its processor cores for licensing, which has limited their penetration in ASICs and SoCs. Freescale began licensing some ColdFire and Power Architecture cores only last year. (See *MPR 4/2/07-01*, "Freescale Licenses Power Cores.")

Although it's highly unlikely that ColdFire will recapture the market share lost to ARM, it's still a competitive 32-bit embedded-processor architecture—and now it's a steal at the entry-level price of \$10,000. Thousands of engineers and programmers are familiar with the architecture, or at least with its closely related forebear, the 68K. Freescale says IPextreme has been successfully licensing the ColdFire V2 (which, despite its name, actually came before the V1) since 1Q07.

ColdFire V1 competes favorably in core size, throughput, code density, and power consumption with the popular ARM7TDMI-S. A minimal ColdFire V1 configuration requires only about 46,000 gates, and a larger configuration with a hardware multiply-accumulate (MAC) unit is only about 52,000 gates. Throughput is about 1.05 Dhrystone mips per megahertz. Even with 16-bit Thumb instructions, ARM code is only a little denser than ColdFire code, which mixes 16-, 32-, and 48-bit instructions. Freescale says ColdFire performance doesn't suffer as much as ARM7 performance does when running dense code, because Thumb instructions impose some translation overhead. When fabricated in a 0.13-micron CMOS process, the ColdFire V1's maximum clock speed is about 150MHz, and Freescale's estimated power consumption is a mere 0.05mW per megahertz (7.5mW at 150MHz).

All those numbers make the ColdFire V1 look pretty good against the 15-year-old ARM7, and particularly against the synthesizable ARM7TDMI-S. The newer ARM Cortex-M3 processor—which has Thumb-2 instructions and many additional improvements—is stiffer competition, but the V1 is still in the ballgame. (See *MPR 11/29/04-01*, "ARM Debuts Logical V7.") Both the ARM and ColdFire architectures are well supported by development tools, operating systems, and software. Whether or not its bargain price suggests a fire sale, the ColdFire V1 is a viable alternative to an ARM7 or Cortex-M3.

Processor Price Erosion

Freescale's aggressive pricing and easy licensing will apply some pressure to market leader ARM. Although ColdFire isn't a serious threat by itself, it accelerates a trend toward lower prices and transparent pricing in the processor-IP business. This trend bucks the longstanding industry practice of not publishing the upfront price of a core license, then haggling over a deal that depends partly on the depth of the purchaser's pockets. An open pricing model like the Core Store's could radically change the market—and perhaps the fortunes of leading IP vendors.

The \$10,000 ColdFire V1 is only the latest evidence of this movement. Another factor is the growing popularity of FPGAs for product deployment, not just for prototyping. Altera and Xilinx, the dominant FPGA vendors, offer synthesizable 32-bit processor cores at the almost-free price of \$495. Until last year, ARM did not even allow customers to deploy ARM processors in FPGAs. Finally, ARM relented, to a degree. The Cortex-M1 is the first ARM processor core

approved and optimized for deployment in programmable logic. (See *MPR 3/19/07-01*, “ARM Blesses FPGAs.”) Notably, the Cortex-M1 is also the first (and only) ARM processor for which ARM comes close to publicly disclosing a price (“under \$100,000”).

Late last year, Altera announced a partnership with Synopsys that makes Altera’s Nios II processor core available for standard-cell implementations in ASICs. It’s essentially the same processor that Altera has been licensing for FPGAs and structured ASICs for \$495. Although a Nios II ASIC license will cost significantly more—the price hasn’t been announced yet—Altera and Synopsys promise it will be a relative bargain. (See *MPR 12/17/07-02*, “Altera Aims For ASICs.”) Note that Freescale allows customers to implement and deploy ColdFire processors in programmable logic as well as in fixed logic, although the ColdFire cores currently aren’t optimized for programmable logic.

Another low-priced processor-IP vendor is Gaisler Research, based in Sweden. For commercial FPGA projects, Gaisler licenses the SPARC-compatible LEON3 processor for

only 20,000 (about \$29,000). For commercial ASIC projects, Gaisler licenses the LEON3 for only 35,000 (about \$50,600). What’s more, these licenses include an impressive library of peripheral IP, such as memory controllers (SRAM, SDRAM, DDR1, DDR2, and PROM) and I/O interfaces (USB 2.0, Gigabit Ethernet, UARTs, and more). Impoverished developers can save even more money by obtaining the RTL source files for some SPARC processors directly from Sun Microsystems—they’re free.

If this trend continues, ARM and other processor-IP vendors will feel pressure to reduce prices and perhaps even to publish fixed prices. Right now, ARM’s prices range from six figures for older, slower cores to seven figures for the latest, fastest processors. Second-tier vendors like ARC, MIPS, and Tensilica generally undersell ARM to gain market share and sow future royalty streams, but they too resist publishing fixed prices. If IPextreme can attract more IP providers—and if more IP providers imitate Freescale’s low-ball pricing—the Core Store could really shake up the market for semiconductor IP. ♦

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