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MEDIA PROCESSORS REDEFINED

Networking Creates Opportunities for Unique Architectures

By Peter N. Glaskowsky {1/24/00-01}

Media processors—which in 1995 seemed to point the way to a bright new future for advanced microprocessor architectures—almost burned out in 1998. Indeed, *Microprocessor Report* did not even run a 1998 year-in-review article for media processors, because there was little to say. Apart from Philips's announcement of a new TriMedia core and the November debut of Equator's MAP-1000, the focus that year was on host-based media processing in the form of Intel's MMX, PowerPC's AltiVec, AMD's 3DNow, and similar instruction-set extensions for other general-purpose processors.

A LOOK BACK 1999 2000 A LOOK AHEAD

Much has changed in the past year. Complete new media-processor architectures have been introduced by Cradle, Fujitsu, Sony, and Sun. New members of the TriMedia and Equator families have been announced, and an entirely new class of processors has appeared to accelerate networking products.

A computer network is a communications medium, so there is considerable overlap between multimedia processors and network processors. Multimedia data are often packaged as bitstreams with variable-length fields, as are network streams. Most of the new network processors, including chips from C-Port, IBM, and Intel's Level One subsidiary, would work well as media processors—especially in a networked environment. Sun's MAJC, though currently marketed as a "convergence" processor, would make a good network processor. Some designs, such as Cradle's Universal Microsystem (UMS) and Equator's MAP-1000, include features to support both markets.

Digital TV Creates Niche for Media Processors

The start of commercial digital-TV broadcasting in the United States refocused attention on "classic" media processors—i.e., those designed specifically for digital multimedia. Though the market penetration of digital TV remains low (the preexisting digital satellite TV services, such as DirecTV and EchoStar, still have many more viewers), most TV makers now offer high-definition television sets. The best of these offer sophisticated tuner/decoder modules that can handle multiple simultaneous programs from analog broadcast, digital broadcast, satellite, and even Internet sources.

Most digital-TV sets rely on fixed-function decoder chips managed by conventional RISC microprocessors, which also handle the user interface. Philips already uses its own TriMedia chips in its high-definition televisions, however, and other consumer-electronics firms are likely to follow suit in the next year with products based on other media processors. This approach will provide greater flexibility than is possible with hardwired designs, making these TV sets more attractive to end users.

Media-processor vendors also promise to reduce the total cost of digital-TV systems by eliminating the host processor, leaving their chips as the only CPU required in the product. This goal will prove difficult to achieve because of the disparate nature of multimedia codecs and user-interface applications, but success seems likely in the long run. Some media processors provide good support for conventional code; software for the MAP-1000 is written in straightforward C, while Sun's MAJC promises excellent performance from simple Java. Philips's Nexperia family will combine a TriMedia engine and a MIPS RISC core on a single chip to provide suitable environments for either type of code.

Video Games Grow Up

Video games have also grown in importance over the past year. The announcements of Sega's Dreamcast, Sony's PlayStation 2, and Nintendo's Dolphin illustrate the changing nature of video-game consoles. Previous generations of these products were useful for little more than gameplay, despite the availability of add-ons for Internet access. The next-generation systems will include Internet access as a basic feature, along with greatly improved graphics, video, and audio features.

Sony's PlayStation 2 stands ready to usurp several of the roles played by other devices in family rooms around the world. The PS2 can play video games, CDs, and DVDs, display email, and surf the Web. With the right peripherals (connected to the PS2's rich variety of expansion ports), it could store and replay TV shows or home movies and control an entire home theater. Nintendo's Dolphin is likely to have similar capabilities.

Sony and Toshiba have developed a new media processor for the PS2. The Emotion Engine includes several special-purpose function units built around an enhanced MIPS RISC core. (We expect Nintendo and its partner IBM to take a similar approach with the PowerPC-based Gekko processor being developed for Dolphin.) The Emotion Engine is large and complex, even compared with today's best desktop PC microprocessors, but it offers vastly superior performance for the intended applications.

Internet support for game systems presents the greatest challenge and the greatest opportunity for media processors. The great variety of multimedia data types found on the Internet precludes the use of fixed-function logic; an ASIC-based solution would be obsolete soon after tapeout. All of today's Web-browser plug-ins appear first for conventional desktop CPUs, but these chips are typically too expensive and too power-hungry to be used in price-sensitive consumer devices. Because new plug-ins can become popular quite rapidly, media-processor vendors and their OEM customers must be prepared to write new code to support new data types (or have it written for them by the plug-in developer) on short notice.

This need drives advances in media-processor software-development environments. All chip vendors now offer tool sets with editors, compilers, simulators, and in-circuit emulators that simplify and streamline the development process. Vendors remain divided on some issues, however. Some offer compilers able to extract parallelism from ordinary C code. Equator looks to be furthest along this path, but BOPS and others are also making progress. Others help the programmer express parallelism with special high-level-language constructs, while a few still oblige their customers to write machine code for critical inner loops. All offer code libraries optimized for certain specific applications, from simple fast-Fourier-transform (FFT) routines to complete video-encoding solutions.

Most software developed for today's media processors will eventually migrate to new hardware environments, most often to next-generation chips in the same family. Here too, the vendors offer different levels of support. BOPS, for example, promises to preserve the programming model for its chips from one generation to the next, though programmers may need to rewrite some portions of their code to make use of additional resources. Equator says its future compilers will allow improved performance from old software on new hardware by just recompiling the same C code, even though the internal architecture of its chips may change radically. Sun makes the boldest claim for MAJC—because the MAJC architecture can distribute threads among multiple processor cores and exploit Java method-level parallelism, future MAJC chips will provide better performance on the same object code without rewriting or recompiling.

Gaming has also revitalized the market for media processors on the PC. PC media-processing tasks, such as DVD playback and video editing, represented the original applications for some of the earliest media processors. Host-based multimedia instructions seemed to close that door, but media processors are knocking on the door once more. Microsoft now supports hardware acceleration of transform and lighting calculations in programs written for its Direct3D API. BOPS, for example, is developing a configuration of its ManArray licensable core to accelerate geometry processing. The company is seeking partners among graphics-chip makers to integrate the ManArray core with a rendering engine to boost PC graphics performance. With the same performance advantages that give Sony's Emotion Engine its great speed on 3D games, media processors could be a valuable addition to the PC platform.

Networking Offers a Large (and Growing) Market

Even if networking is just a niche within the overall media-processor market, it is surely one of the largest, most dynamic, and most demanding. Sales of networking hardware are extremely strong and will only grow over time as the Internet gets bigger. The turnover rate for Internet hardware is extremely high: yesterday's routers are replaced by today's switches, and today's switches will soon be replaced by even newer devices that support high-level functions such as link encryption, caching, and quality of service (QoS) management.

Network processors are doubly valuable for this market. They can reduce the overall cost of a network device by replacing proprietary (hence expensive) ASICs with off-theshelf programmable chips, and they can extend the life span of an individual product by allowing software updates to add new features to installed equipment.

For a market that didn't really exist a year ago, the network-processor business is already crowded. We have identified at least 15 vendors that offer or are developing network processors. These include some of the biggest companies in the semiconductor industry, such as Intel and IBM, but most are small startups hoping to join the ranks of the industry elite. The obvious analogy is to the 3D-graphics market, where dozens of companies are chasing just a few big design wins. The trend toward vertical integration among 3D companies may be echoed by the network-processor makers. Those with their own network-hardware business have guaranteed customers, putting them a step ahead of the competition. Those trying to go it alone, such as C-Port, are more likely to be acquired by a single customer than to see substantial sales to several OEMs. Cisco, for example, currently uses internally developed ASICs plus general-purpose MIPS RISC processors in most of its products. It has made no effort to acquire a processor vendor because it benefits from competition among makers of MIPS-compatible chips. The advent of proprietary, incompatible network processors eliminates this benefit. Once Cisco settles on a network processor, it may prefer buying out the chip vendor to buying from it.

As mentioned earlier, some media processors are also being marketed as network processors. Equator has equipped its MAP-1000 with medium-speed network interfaces, but it has yet to offer a variant able to handle the extremely high data rates required by Internet switching systems. The multiple programmable elements of Cradle's UMS make it a better fit for this application. The UMS offers reconfigurable pin interfaces for the physical layer, simple protocol engines for the protocol layer, DMA engines to assist with data movement, and multiple RISC and DSP cores to perform high-level functions.

Purpose-built network processors have architectures similar to those of media processors, but with optimizations for their target market. They have also been designed to work with specialized companion chips and coprocessors that will handle more repetitive tasks, leaving the high-level functions for the network processor itself.

The Intel IXP1200, which will be sold by Level One, is the first product in Intel's Internet Exchange Architecture (IXA), which includes companion chips, development tools, and code libraries. Intel has announced plans for a scaling engine to link multiple IXP1200s, Ethernet switches and interface chips, and an asynchronous transfer mode (ATM) engine. Together, these components will simplify the task of designing complex networking products and cut both development and manufacturing costs.

Internally, the IXP1200 consists of a StrongARM core and six programmable networking microengines plus memory and I/O interfaces. This structure is similar to that of IBM's Network Processor, which has a PowerPC core plus 10 RISC-based picoprocessors, and of C-Port's C-5, which has 16 channel processors augmented by five routing coprocessors.

Media-Processor Events of 1999

The Motion Pictures Experts Group ratifies the MPEG-4 standard (*MPR 3/29/99-05*, p. 18). The new standard is complex enough to provide lifetime employment for a legion of media-processor software developers.

Sony describes its Emotion Engine, a media processor for the forthcoming PlayStation 2 (*MPR 4/19/99-01*, p. 1). Nintendo responds, saying it will use a new PowerPC microprocessor, code-named Gekko, in its next-generation game console (*MPR 5/31/99-en*, p. 5).

Motorola and Lucent unveil the StarCore SC140 (*MPR 5/10/99-03*, p. 13), a VLIW core optimized for communications applications that will form the basis of future network processors from Motorola (*MPR 10/6/99-03*, p. 19) and Lucent.

Alliance announces an intelligent SRAM that stores and maintains network routing tables (*MPR 8/2/99-02*, p. 14).

Fujitsu tips its plans for a family of VLIW media processors based on the FR-V configurable core (*MPR 8/2/99-04*, p. 18).

Sun waves its hands to make MAJC, a new media-processor architecture that combines several approaches to parallelism including VLIW, SIMD, multithreading, chip multiprocessing, and even Java method speculation (*MPR 8/23/99-03*, p. 13; *MPR 9/13/99-02*, p. 12). The MAJC-5200 is later announced at the Microprocessor Forum (*MPR 10/25/99-04*, p. 18).

The Intel/Level One IXP1200 merges a StrongARM core with six multithreaded microengines (*MPR 9/13/99-01*, p. 1). The new network processor is at the heart of a family of chips Level One will offer to network hardware vendors.

Philips announces the NX-2600 and NX-2700 as part of its new Nexperia product line, which will include chips with TriMedia and MIPS processor cores (*MPR 9/13/99-en*, p. 11).

Startup Cradle boasts that its Universal Microsystem (UMS) marks the end of conventional ASIC development (*MPR 10/6/99-05*, p. 26). The UMS architecture combines multiple instances of four different types of programmable processing engines with fully configurable I/O interfaces.

Equator shrinks its MAP1000 to create the 0.18-micron MAP1000A and schedules two new derivatives for digital-TV applications (*11/15/99-msb*, p. 4).

This proliferation of processors allows each network interface to have its own dedicated controller, reducing or eliminating multitasking conflicts. It also increases the effective amount of local storage on the chip, since each processing element has its own register set. This is the clearest point of distinction from media processors that typically have just one core and use VLIW and SIMD to achieve parallelism—but some media processors, such as those from Cradle and Sun, also offer chip-scale parallelism.

Instead of processing multimedia data, network processors must handle high-data-rate packet flows, performing potentially complex functions on packets before passing them along to the correct downstream interface. The C-Port, IBM, and Intel chips all promise between 4 and 5 Gb/s of peak throughput, though these figures will decline as more sophisticated algorithms are implemented. Some functions, such as packet encryption, require substantial processing and may best be implemented in external coprocessors. Other functions, such as bandwidth management, impose less overhead and can be implemented in the network processor itself.

As with multimedia processors, software-development strategies vary. Intel's customers must use assembly language, albeit in a fairly sophisticated symbolic assembler. C-Port OEMs will have the luxury of writing code in C or C++ instead, which will reduce development time—if performance doesn't suffer. Interestingly, C-Port and IBM are codeveloping a common API for their chips, which should promote competition between these families and encourage the development of more third-party tools.

A Market Revitalized

Those who gave up on the media-processor market in 1998 gave up too soon. With new applications such as networking, higher expectations from video-game OEMs, and restored opportunities in the PC platform, this market has never been stronger. The success of individual competitors is far from assured, of course. Competition in the network-processor niche is exceptionally strong, especially given the participation of industry heavyweights like Intel and IBM.

There seems to be plenty of investment money available for media-processor development, so it won't be necessary for vendors to make much money in the next year or two. With potential customers to chase and funds to fuel R&D, the vendors are sure to make great progress—and great products—in the media-processor market during the coming years. ◇