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Samsung Launches Media Processor

MSP Is Designed for Microsoft's New 3D-Software Architecture

by Yong Yao

Already the world's top memory-chip vendor, Samsung is poised to make a big splash in the market for high-volume PC logic chips. The Korean giant has designed an ambitious media processor intended to take over most of the audio, video, and communications functions in a typical PC. The company has already signed up several partners for its new MSP (multimedia signal processor) project. Microsoft, one of the two controlling forces in the PC industry, has picked the initial MSP as the key component for its new 3D hardware reference platform, code-named Talisman *(see* **101102.PDF***)*.

Talisman demands a high-performance architecture, and MSP delivers. The chip uses a SIMD (single-instruction, multiple-data) architecture with a 288-bit ALU capable of achieving 6.4 billion integer operations per second (BOPS) or 1.6 billion floating-point operations per second (GFLOPS) in the initial implementation, expected to ship in 3Q97. Samsung plans to increase this rate rapidly in future versions of MSP. The chip also includes a separate ARM7 processor to perform housekeeping functions without bothering the host CPU, making the product suitable for standalone applications such as DVD players as well as PCs.

MSP will compete against announced media processors from Chromatic, MicroUnity, and Philips, as well as unannounced devices from several other vendors. Samsung's business model gives it advantages over these competing devices. But penetrating the mainstream PC market will take time: we expect Samsung's second-generation product, due in 1998, to take MSP into high-volume PCs.

Openness Is Key to MSP's Success

Samsung's business plan takes advantage of its position in the PC industry as well as partnerships with other key players. Its most powerful partner is Microsoft. Microsoft has chosen Samsung's MSP (along with Philips' Trimedia chip) to be a key hardware component for its new 3D reference design, Talisman. With Microsoft's support, the MSP architecture can maintain PC content compatible with embedded applications like set-top boxes and digital TVs, which will encourage ISVs to develop MSP content.

Samsung is working with other chip vendors to deliver a complete multimedia solution. Its first chip, the MSP-1, lacks a VGA core and a 3D rendering engine. In a Talisman design, the MSP-1 works with chips from Cirrus Logic and Fujitsu to form a 3D-graphics accelerator. In a standalone product, as Figure 1 shows, these specialized devices can be replaced by commodity audio and video interfaces.

Samsung's MSP partners also include CPU, DSP, and chip-set manufacturers. Samsung not only grants rights to third parties to build MSP devices but also licenses its design so vendors can make derivative devices or even design complete new processors that implement the same instruction set. The company claims it has already signed at least one second source for the MSP-1 and at least one vendor that has the right to make compatible designs, but these vendors have not yet been publicly identified.

The MSP business model also encourages other companies to develop MSP software. Samsung and its early

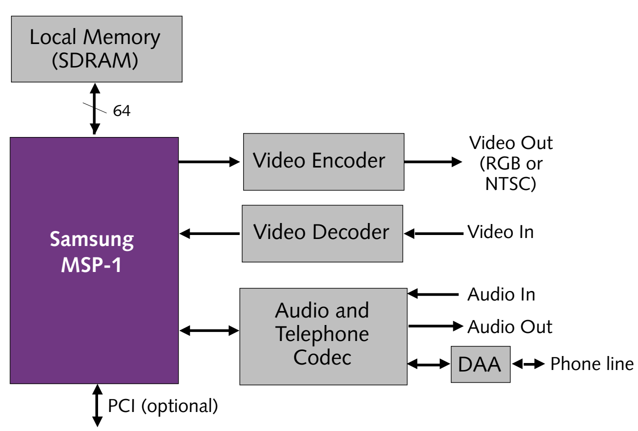

Figure 1. The MSP-1, with a few basic components, implements an audio/video subsystem for a device such as a DVD player. In a PC, additional components are needed for 3D rendering and VGA compatibility, but the local memory can be removed.

partners will provide basic software modules such as MPEG-2, AC-3, and V.34 codecs, leaving room for others to add value with different functions. To accelerate the adoption of its MSP architecture, Samsung plans to publish the MSP instruction set (ISA). To ensure openness even for the ISA, Samsung plans to establish a consortium for approving future ISA extensions. The company will provide a suite of MSP software-development tools, including a compiler, debugger, assembler, linker, and various simulators.

This openness contrasts with Chromatic's plans for its Mpact media processor *(see* **091404.PDF***)*. Chromatic has a unique business model: allowing two large semiconductor partners to market its media processors while Chromatic is the sole source of Mpact software. A startup that has yet to receive any product revenue, Chromatic may not have the resources to deliver all the software demanded by PC users. Even if it can, the closed software model leaves little room for its customers to differentiate their products.

One downside to Samsung's model is that, since most MSP software modules must be licensed from third parties, the cost can be significant. That means for each MSP device sold, Samsung has to pay a royalty fee for these modules.

Deep Pockets, Strong Manufacturing

Driven by the DRAM and SRAM market, Samsung has developed some of the leading IC manufacturing processes in the world. The company completed the design of a 256-Mbit DRAM in 0.25-micron CMOS in 1994 and claims it is ready to put the device into production as soon as there is a market for the high-density part. Of course, Samsung's IC fabrication is geared toward memory chips, which are very different from logic chips. The company's recent partnership with Digital *(see* **1009MSB.PDF***)* gives it access to the Alpha vendor's high-speed logic processes, which it hopes to use for future MSP implementations.

As the sixth-largest semiconductor vendor in the world, Samsung also has enormous fabrication capacity, but, again, nearly all of it is designed for memory chips, not logic. Still, there is potential for the company to quickly ramp MSP capacity as the market demands it. MicroUnity, in contrast, relies on external foundries that may not give priority to its media processor.

Samsung's deep pockets also set it apart from MicroUnity, which has been suffering from severe financial problems *(see* **1010MSB.PDF***)*. The Korean vendor earned enormous profits from DRAM sales in 1994 and 1995, easily funding the development of MSP. Even after MSP debuts, Samsung can afford to be patient during the years it will take to build a large market for the part.

Samsung has been working on MSP since September 1994. This early start should get the MSP-1 to market before most competitors' devices. Due to the lack of a 3D rendering engine, however, this first part does not have the same integration level as do competitive devices, driving up the cost of a complete multimedia subsystem. By the time Samsung gets its fully integrated part to market, there will be many other devices to compete with.

Samsung also has a ready internal market for its part. The company owns a large stake in AST, ranked as the number 10 PC vendor worldwide in 1995, although it has run into many problems maintaining its position this year. MSP is also suitable for set-top boxes, Web terminals, and DVD players, playing into Samsung's position as a leading maker of consumer products. For example, the company is the sixth largest vendor of color televisions in the world.

Like Samsung, Philips is a world leader in consumer products and hopes to find a fertile internal market for its Trimedia processor *(see* **091505.PDF***)*. The first Trimedia chip, however, is behind schedule and lacks the on-board host CPU found in MSP. But unlike the MSP-1, the Trimedia chip can perform 3D rendering, and it is likely to reach the market by late 1997, well before Samsung's fully integrated MSP part. Like MSP, Trimedia is supported by Microsoft's Talisman.

Key Multimedia Functions Supported

MSP provides a full range of multimedia functions, including MPEG-1 and MPEG-2 decoding, AC-3 audio decoding, H.324 codec (for videoconferencing), wavetable synthesis, V.34 modem and V.17 fax, video processing and filtering, and PC telephony. It has most of the video features included in today's 2D accelerators, such as image scaling, color-space conversion, and image filtering for noise reduction.

Audio functions include MPEG-1 and -2 audio, real-time G.722 and G.723 speech codec, wavetable synthesis, and real-time Dolby AC-3 decoding. The chip also provides FM synthesis for minimal Sound Blaster support, as required by the Talisman specification.

Compared with Chromatic's Mpact, MSP's audio capabilities are not as sophisticated; for example, it lacks Mpact's 3D positional sound. The 3D sound features, however, can be added later by Samsung or third parties. The telecommunication functions supported are V.32bis and V.34 modem, V.17 fax, and basic telephony.

Missing are MPEG-1 and MPEG-2 encoding. Samsung believes the encode market is too small to fit its business model. Adding MPEG encoding could also delay time to market. The encode feature can be added later, when MSP has enough horsepower to handle it. Because of the open software architecture, this software can be developed by Samsung or by third parties.

Like other media processors, MSP cannot perform all these functions concurrently. If the sum of the desired functions exceeds the capability of the core processor, performance on one or more functions may be degraded, or the software may deny a request to initiate a new function. Samsung claims its software handles these situations gracefully, due to the on-chip host CPU dedicated to the real-time kernel.

First Chip Requires Graphics Accelerator

In a non-Talisman PC, the MSP-1 depends on the existing graphics subsystem to provide VGA compatibility and 3D rendering. Thus, it can be used on an add-in card or in combination with another graphics chip. Communication with the graphics subsystem occurs via the PCI bus and the VGA feature connector. The advantage of this configuration is that the MSP chip's superior floating-point capability will offload the host CPU from handling 3D-graphics front-end processing, freeing it for other tasks.

The local memory is optional in a PC configuration, because it does not act as a complete frame buffer. For the MSP-1, the main graphics subsystem maintains the frame buffer or, in a Talisman configuration, there is no frame buffer at all. The local memory is simply for caching certain memory data, such as image layers and texture, to achieve high performance. Bitmaps are transferred through the VGA feature connector to avoid bogging down the PCI bus.

The MSP-1 supports either a 32-bit or 64-bit interface to SDRAM for the local memory. With the wider interface, the SDRAM provides a peak bandwidth of 800 Mbytes/s at 100 MHz. A typical system would use 4M of local memory, although the chip supports up to 32M.

The MSP-1 is packaged in a 256-pin PQFP and built in 0.5-micron four-layer-metal CMOS. The chip is expected to operate at 100 MHz, with a die size of just 105 mm^2. Samples are due in 1Q97, with production volumes by 3Q97.

An expansion card with just the MSP-1 would presumably function as a Windows-compatible sound card and might also be useful for digital video capture and playback. It is unlikely, however, that there would be any performance advantage for 2D and 3D graphics. A full Talisman design is needed to achieve strong 3D performance. Except for non-PC applications, we expect the MSP-1 will be used only in Talisman cards.

The first MSP device will be most useful as a software-development platform for future MSP derivatives. Despite the different hardware organization, all MSP products should be equivalent from a software perspective. The cost of an MSP-1 add-in card will probably be too high for such cards to have significant penetration in the mass PC market, but they could be popular for 3D-game developers.

Second Product Is Fully Integrated

Samsung is already working on the follow-on device, the MSP-1G. By moving to a 0.35-micron process, the company can integrate a VGA core, RAMDAC, and 3D-rendering engine onto the MSP, creating a full-fledged multimedia processor. Even with the added logic, the MSP-1G die size is reduced slightly, to 100 mm^2, due to the more compact process geometries.

In a Talisman design, we expect the rendering engine to replace the external POP and perhaps the Compositor as well, greatly reducing the cost of a Talisman accelerator card. Thus, the MSP-1G, expected for production in 2Q98, should encourage PC makers to adopt the MSP architecture for their motherboards.

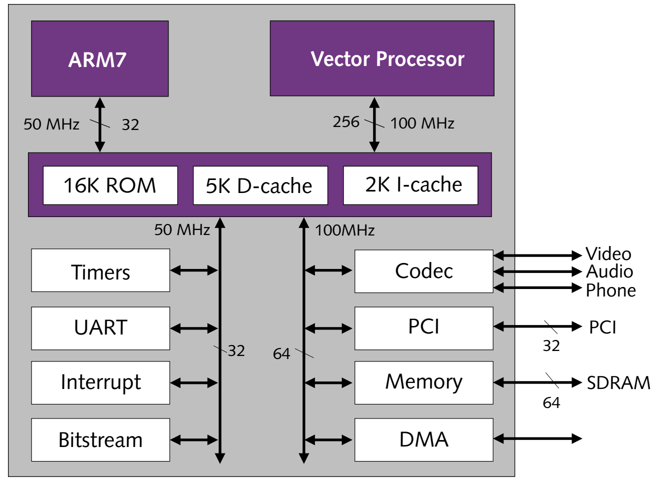

Figure 2. The MSP-1 contains two main processors, 23K of on-chip memory, and several system interfaces.

The MSP-1G will actually reduce PCI traffic compared with a standard 3D rendering chip, because the MSP chip requires only high-level 3D geometry information rather than the individual polygon specifications required by a rendering chip. In 1997, most 3D rendering chips will move to the new AGP interface *(see* **100803.PDF***)* to address their bandwidth problems. Ultimately, Samsung is likely to offer an AGP version of its MSP-1G chip as well, but its reduced bandwidth needs make this move less urgent than for the rendering chips.

Two-Headed Design

MSP is unusual in combining two complete processors on the same die, along with a plethora of system logic, as Figure 2 shows. The two key components are an ARM7 CPU and the Samsung-designed vector processor. The ARM7, running at 50 MHz, executes a real-time kernel developed by Microsoft as part of Talisman. It is responsible for scheduling all events to maintain hard real-time deadlines.

Having an on-board processor just for the real-time kernel allows that device to focus entirely on this scheduling task. In an NSP system, for example, the real-time kernel runs on the host CPU but must share time with Windows 95. Since Windows is not designed for real-time operation, this sharing can result in scheduling conflicts, causing a perceptible decline in audio or video quality.

Chromatic resolved this problem by developing its own real-time kernel running on the Mpact engine. When Microsoft completes its Talisman real-time kernel, Chromatic could also take advantage of this open kernel for real-time applications, but the startup (or Microsoft itself) would have to port the kernel to the Chromatic architecture. Given the complexities of the VLIW Mpact design, this would be no small feat. The ARM7 is a much simpler platform for which to develop software.

	Samsung MSP-1	Samsung MSP-1G	Chromatic Mpact	Philips TM-1	Micro-Unity
Clock speed	100 MHz	100 MHz	100 MHz	140 MHz	300 MHz
Integer perf	6.4 BOPS	10.2 BOPS	3.2 BOPS	5.3 BOPS	4.8 BOPS
FP perf	1.6 GFLOPS	2.5 GFLOPS	none	0.3 GFLOPS	1.2 GFLOPS
IC process	0.5µ 4M	0.35µ 4M	0.35µ	0.35µ	0.35µ
Die size	105 mm^2	100 mm^2	65 mm^2	130 mm^2	290 mm^2
Power (typ)	4 W	4 W	4 W	4 W	40 W
Memory	SDRAM	SDRAM	RDRAM	SDRAM	SDRAM

Table 1. Samsung's MSP exceeds the integer and floating-point performance of other media processors with competitive die size and power. (Source: vendors)

Processing 288 Bits Per Cycle

The vector processor performs all multimedia processing. Rejecting the complicated multithreading of the MicroUnity processor *(see* **091402.PDF***)* and the VLIW style favored by Chromatic and Philips, Samsung has built a straightforward SIMD processor that is conceptually similar to an MMX processor *(see* **100301.PDF***)*. The key difference is the width: MSP processes 288 bits per cycle, versus 64 for an MMX processor.

The vector processor contains a 288-bit ALU that can generate 32 integer results per cycle with 8- or 9-bit precision; alternately, 16 results of 16 bits each or 8 results of 32 bits each can be computed. The ALU can also do floating-point arithmetic, calculating eight 32-bit FP values per cycle. Data is held in 288-bit registers.

Samsung has not yet released details on the internal design of the vector processor or the instruction set, although it plans to do so in the future. The vector processor uses 32-bit instructions with a fairly straightforward encoding. There are roughly 110 instructions, which can be considered a superset of the 57 MMX instructions, although the encodings are obviously different. Some of the unique instructions accelerate MPEG decoding and encoding as well as digital filter functions. The MSP instruction set also includes block I/O instructions.

Memory and System Logic Included

As Figure 2 shows, the first MSP chip contains 23K of on-chip memory that can be quickly accessed by either the ARM or the vector processor. Of this, 16K is ROM while the remainder is RAM, split as 2K of instruction cache and 5K of data cache. The internal caches are direct mapped and may be too small for some applications. Given Samsung's expertise, future versions are likely to include more memory; the main limitation is keeping the die size reasonable.

	Samsung MSP-1	Chromatic	
		Mpact	Pentium-100
MPEG-2 decode	48%	63%	0%*
V.34 modem	28%	19%	16%
H.324	36%	15%	6%

Table 2. Samsung's MSP-1, at 100 MHz, can handle some multimedia tasks with less load than on the Chromatic Mpact, also at 100 MHz. The Mpact shares the load with the host CPU, in this case a Pentium-100. *No CPU assistance is needed.

The MSP-1 contains the usual interfaces to audio and video codecs, PCI, and SDRAM. Less usual is the integrated system logic, including a DMA controller, four timers, a full-duplex serial port, and an interrupt controller. These devices are controlled by the ARM core. These peripherals enable MSP to be used in standalone applications rather than PCs, which already have such logic built into the chip set.

Theoretical Performance Edge

This powerful architecture provides a theoretical performance advantage over the competition. As Table 1 shows, the initial MSP achieves better peak performance on both integer and floating-point calculations than announced products from Chromatic, Philips, and MicroUnity. Chromatic, however, is likely to have a second-generation device available around the time MSP-1 ships, so the comparison in Table 1 is not quite fair.

In addition, the table shows only peak performance. In real applications, the performance deltas between the MSP devices and others may be smaller or even reversed. One way to look at real application performance is to calculate the percentage of the chip's total power required to perform a fixed task. Table 2 compares the MSP-1 with Chromatic's Mpact in this way. Note that the Samsung numbers are based on simulations and have not been verified on real hardware. In addition, improvements in the MSP driver software could impact the final delivered performance.

Using the current estimates on MPEG-2 decoding, for example, the MSP-1 can perform the task with lower utilization than on Mpact, freeing more resources for additional multimedia tasks. Despite the 2:1 ratio in peak BOPS, however, the Samsung chip is only 30% better on MPEG-2. On V.34 and H.324, the Chromatic processor actually does better than the MSP-1. One difference is that the Chromatic design shifts some of the processing onto the host CPU. In addition, Samsung claims its chip is more optimized for video than audio functions, but it is clear that not all algorithms can take advantage of the very wide SIMD data path in the MSP architecture.

A key advantage for Samsung will be in 3D processing, which is floating-point intensive. Chromatic's chip completely lacks FP capability and offers relatively weak 3D performance. Unfortunately, Samsung cannot take advantage of this edge until the MSP-1G, since the MSP-1 does not have full-blown 3D support. The 3D performance goal for the MSP-1G is 800,000 triangles per second at 50 pixels per triangle, similar to that of the 3D accelerator being codeveloped by Intel and Lockheed Martin for that time frame. Chromatic's second-generation Mpact may also reach the same 3D performance level. Therefore, MSP may not have its claimed performance advantage compared with other advanced 3D accelerators and media processors.

Table 1 shows a few other advantages for the Samsung design. Even when fully integrated in the MSP-1G version, the Samsung part has a smaller die size than the complex Trimedia and MicroUnity chips. The MicroUnity part burns far more power than any of the others.

A Challenge to Intel

Samsung's MSP conflicts with Intel's core business strategy. To continue to dominate the industry, Intel must continually attract PC buyers to ever faster and more powerful CPUs. Intel counts on the spiraling performance demands of mainstream software to encourage PC users to upgrade their systems. To date, the progression to more complicated graphical interfaces has been one key factor in the software spiral.

Future software is likely to require plenty of audio, video, and 3D performance, driving PC users to demand faster processors. Samsung offers an alternative: simply add a high-performance media processor and keep your old CPU for a while. If software demands increase further, upgrade the media processor, not the CPU. Talisman allows these multimedia functions to be handled by the media processor with little performance demanded from the host CPU.

This alternative will not fully replace a fast Intel CPU. Nonmultimedia applications that require high performance do not benefit from MSP; even if they could somehow be ported to run on the Samsung chip, its SIMD architecture is suited only for multimedia. These applications might include sifting through large data sets or executing complex algorithms for intelligent agents. MSP is also useless for scientific applications that require more than 32 bits of floating-point precision.

Depending on how the software story plays out over the next few years, MSP-powered systems could diminish interest in Intel's fastest processors. Samsung would love to deliver the high-volume, high-value component in PCs while relying on a commodity low-end x86 processor, and it is patient enough to invest for years while this scenario develops.

To avoid this situation, Intel is likely to oppose MSP vigorously. A simple measure would be refusing to use MSP on its own motherboards, which would lock Samsung out of about a third of the market. In addition, MSP will likely change Intel's attitude toward Chromatic's approach, which emphasizes collaboration with the host CPU for achieving better multimedia performance; to date, Intel has been uninterested in Chromatic as well. Certainly, Intel does not like programmable PC devices other than its own CPUs. Mpact, however, assists the host CPU in processing multimedia data, whereas the MSP chip replaces the CPU for these functions.

MSP Targets Multiple Markets

MSP is the central strategy for Samsung to become a major player in providing solutions for DVD, videophones, PCs, and set-tops. Samsung divides the multimedia market into three segments: traditional PCs; consumer devices such as game consoles, DVD players, and digital TVs (DBS, cable, and wireless); and embedded PCs, a term Samsung uses for a non-PC device that can access PC content (for example, PC-based set-top boxes or x86-based Web browsers).

Each of these market segments has its unique competitive characteristics. Samsung realizes Intel's power in directing future multimedia PCs and has prepared for the worst. Although the first MSP designs are suited for desktop PCs, Samsung is also eyeing the other two segments. The key strategy is to maintain software compatibility across all three segments. This way, content developed for any segment can be used for any other.

The biggest problem in today's consumer electronics market is software incompatibility. For instance, Sega's game titles cannot run on Sony's PlayStation. Samsung hopes to resolve this problem by rallying vendors around its MSP architecture. Realistically, Sega is unlikely to port its games to MSP, but PC content developed for MSP might also run on MSP-based set-top boxes, for example.

Price & Availability

Samsung expects to sample the MSP-1 in 1Q97, with volume shipments in 3Q97. The vendor has not yet announced pricing. For more information, contact Samsung at 408.954.7150 or fax 408.954.7229.

Open Strategy Could Bear Fruit

Samsung has taken a number of steps to leverage its position in memory chips into a bigger and more profitable role in the PC market. MSP is the boldest so far and has a good chance to succeed. With multimedia becoming an integral part of most new PCs and integration trends leading to reduced chip counts, a combination media processor is a good solution for many market segments. Although Samsung faces fierce competition, its own strengths and its willingness to seek out partners set it apart. Obtaining the backing of Microsoft, although diluted somewhat by Microsoft's simultaneous endorsement of Trimedia, is a great coup.

The company faces many obstacles before reaching its goals. It must demonstrate an ability to deliver complex logic chips using a fabrication process different from that of its successful memory products. It must also deliver the necessary core software with high quality and timeliness, as well as provide tools for third parties to contribute additional software. Samsung will face opposition from Intel and perhaps from some PC makers objecting to its ties with AST.

Despite the company's claims of openness, it has yet to identify most of its partners, including any potential hardware sources. Assuming Samsung follows through on its licensing promises, it would still be years before another vendor could independently construct a compatible but competing device. An open software strategy is a good first step, but PC makers may wait to see if the hardware strategy is equally open. M