

ARCHITECTURES: Handset integration strategies vary

Ron Wilson

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Fremont, Calif. — One would think that few things in life are as stable as the basic architecture of cell phone handsets. Against the background of incremental change to the established architecture in handsets, you see an occasional flicker of quite different architectures. Usually this takes the form of a special-function chip that a vendor wants to get included into the handset — some clever combination of functions that hasn't been implemented in the most recent round of system-on-chip respins, but that might gain a point of market share somewhere. And once in a long while we see someone argue for a rethinking of the whole architecture.

Two instances of this phenomenon are visible this week. One, from long-established Atmel Corp., fits in the category of add-on chips. The other, from startup Sandbridge Technologies Inc., is much more radical. Both are calculated attempts to push into the market by exploiting the problems that growing features sets and dysfunctional generation evolution have created for handset designers.

In Atmel's case, the chip aims at a specific additional feature: media playing. Atmel (San Jose, Calif.) has announced the AT83SND2CMP3 MP3 player chip to install, with no mess or fuss, the functions necessary to enable a handset for MP3 playback, MP3-based ringtone playback and control of NAND flash, MultiMediaCard (MMC), Xd-Picture Card and Secure Digital external memory devices. In a 100-pin, 9 x 9-mm BGA, drawing 37 milliamps and priced at \$3.85 in staggering quantities, the chip will not go unnoticed in the space, power or bill-of-materials budgets of handset manufacturers, but it will get an important set of features to market quickly.

In contrast, Sandbridge (White Plains, N.Y.) is responding to a potentially more serious problem with a radical change in architecture. The root of the problem appears to be the aborted rollout of 3G networks. Not only has 3G failed to become ubiquitous, but it is not even the primary network for most carriers in most areas. That has forced handset makers to support 2G and 3G air interfaces and basebands in parallel, soon to be augmented by the curtain call of other network interfaces about which handset makers are speculating.

If that weren't enough, 3G brings another problem: big, streaming files of stuff like video, audio and data to be relayed to computers. This drives up memory requirements, both for bulk storage and for working memory within the handset and creates new processing needs as tasks like MPEG or H.264 decoding, audio processing and graphics processing appear along with the deluge of data.

Sandbridge believes that sufficiently justifies rethinking the architecture.

The company's idea, very much in the mainstream of architectural thinking these days, is to eliminate all the special-purpose processing sites that have accreted onto the handset's backbone. No more baseband processor for each air interface. No more audio DSP, video DSP,

graphics processor, encryption engine, MP3 decoder and so forth. Instead, implement all of these tasks as software on a cluster of sufficiently fast and efficient processing engines. The adjectives are the rub, of course. There is a huge loss of performance and energy efficiency in moving from a dedicated accelerator to a software-driven engine. This is not mitigated particularly by moving to a bunch of such engines, even though in theory one can slow down the individual clocks, slash the operating voltages and save energy compared with a single processor.

But Sandbridge thinks they have done sufficient energy-savings to have power consumption on a par with any other 3G modems. Partly this is through using a TSMC 90-nm process. But much effort has gone into further reductions.

One example is the decision to use very deep pipelines in the design of the individual processors, minimizing the need for high speed in individual circuits, and allowing both a lower operating voltage and the choice of smaller transistors on many paths. The pipelining also makes single-port SRAM feasible in many cases where more-conventional designs would require faster, higher-energy multiport designs.

Another example is a unique time-domain-multiplexed multithreading approach that, in conjunction with the deep pipelines, has the effect of substantially reducing the bandwidth required of memory. Since memory accesses can consume most of the energy in a task, anything that can reduce memory bandwidth is fundamentally important.

All this thinking is employed in a processing engine — the SandBlaster — somewhat reminiscent of the blended RISC/DSP chips of a generation ago. A proprietary RISC CPU teams with a single-instruction, multiple-data (SIMD) signal-processing engine and local memory. The processor has hardware support for eight concurrent threads.

Sandbridge has incorporated this engine into a handset chip, the SB3010 baseband processor. The device combines four SandBlaster processing elements and their requisite local memory structures. This cluster of processors is attached via bus bridge to a conventional ARM9 CPU that handles application processing, eliminating the need for less-critical tasks to be recompiled. The necessary memory and peripheral interfaces for a modern handset are integrated onto the chip as well.

Ambitious design

The company claims the chip, sampling officially as of today, has processing done at an 800-MHz clock frequency, more than sufficient to maintain 2-Mbit/second WCDMA transmission, and can support GPRS, 802.11b, Bluetooth and GPS. The level of concurrency for all these modem tasks is not clear from the literature.

Clearly, this is an ambitious, semi-custom 90-nm design by a very experienced team. The company has drawn senior talent from IBM's T.J. Watson and Lucent's Bell Laboratories, among other star-studded organizations. They've developed a modern architecture backed by highly skilled circuit design to exploit a leading-edge process. Whether it's enough to change the architectural thinking of a very conservative industry is a question that remains to be answered.