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TRANSMETA CHARGES THE EMBEDDED MARKET

Searching for New Customers in the Shadow of Banias

By Tom R. Halfhill {1/13/03-01}

With the debut of Intel's new Pentium M mobile-PC processor (code-named Banias) only months away, Transmeta is trying to expand the potential market for its competing x86-compatible chips. The company has announced a new line of Crusoe SE (Special Embedded) processors aimed at embedded systems that need to run x86 software with high performance and relatively low power consumption.

For now, Crusoe SE processors are identical to the TM5800 Crusoe chips Transmeta sells for mobile PCs and blade servers; architectural differentiation will come later. However, Transmeta does promise five-year availability for Crusoe SE parts and certifies them for 24/7 operation without a cooling fan at junction temperatures up to 100°C and case temperatures up to 85°C. In addition, before shipping, each Crusoe SE must pass a 24-hour burn-in test while running a real-time operating system (RTOS).

Initially, Transmeta is selling three speed grades: 667MHz, 800MHz, and 933MHz. For each of the two lower speed grades, Transmeta offers two different part numbers with different power-consumption ratings—"standard power" and "low power"—based on characterizations of actual chips fabricated on the same wafers. The 933MHz chip is available only as a standard-power part.

For example, the 667MHz Crusoe SE is available as a standard-power part at 6.2W and as a low-power part at 5.1W. The chips are identical and run at a nominal 1.2V, but they're bin-sorted for power consumption. The power ratings are maximum TDP (thermal design power), meaning that power dissipation will never exceed the rating within the specified voltage and temperature range. Average or "typical" power consumption is significantly less, but varies according to the software load and is more difficult to quantify.

Crusoe SE is Power-Stingy

Table 1 compares the basic specifications of Crusoe SE chips with Intel's low-power Pentium III embedded processors.

	Transmeta Crusoe SE	Transmeta Crusoe SE	Transmeta Crusoe SE	Intel Pentium III	Intel Pentium III	Intel Pentium III
Core Clock Freq	300–667MHz	300–800MHz	300–933MHz	700/850MHz	800MHz	933MHz
Core Voltage	0.9V–1.2V	0.9V–1.3V	0.8V–1.3V	1.35V/1.6V	1.15V	1.15V
Max TDP - Std Power	6.2W	8.0W	9.0W	—	—	—
Max TDP - Low Power	5.1W	6.8W	—	16.1W	11.2W	12.2W
Junction Temp Range	0–100°C	0–100°C	0–100°C	0–100°C	0–100°C	0–100°C
Availability	Now	Now	Now	Now	Now	Now
Price	<$50	N/A	N/A	$144*	$144*	$209*

Table 1. Clock frequencies and voltages in this table are the ranges available with Transmeta's LongRun (default settings) and Intel's SpeedStep (DC/AC). Transmeta isn't announcing Crusoe SE prices, other than a general indication for the 667MHz chip in "typical embedded quantities." Intel doesn't publish prices for Pentium III embedded processors, either, so the table shows 1,000-unit quantity pricing for the same chips sold as mobile-PC processors. (N/A: data not available; *mobile-PC pric-

(Specifications for the new Pentium M mobile processor are still confidential.) Note that the 850MHz Pentium III will ordinarily reach that clock frequency only with AC line power; when running on batteries, Intel's power-saving SpeedStep technology automatically reduces the clock rate to 700MHz. With LongRun, Transmeta's more-flexible power-saving technology, Crusoe SE processors can operate over their entire voltage and clock-frequency range under AC or DC power.

Transmeta's TDP ratings are impressively low for embedded x86 processors at these relatively high clock speeds—especially because the chips integrate a memory controller and PCI interface, which normally would consume more power (and board space) in the north bridge part of a core-logic chip set. Pentium III doesn't have integrated memory control or PCI.

The ability of Crusoe SE chips to operate at high temperatures with passive cooling makes them strong candidates for embedded systems that require high performance and reliability. Doing without a cooling fan eliminates a mechanical point of failure from the system. The only drawbacks of Crusoe SE chips are consequences of their x86-emulation code-morphing software: performance that's somewhat less than implied by their clock frequencies, higher memory requirements, and uncertain real-time response.

That last drawback might be a show-stopper if it weren't possible to modify the behavior of LongRun, Transmeta's voltage/frequency-scaling technology. LongRun monitors software performance and can adjust the processor's core frequency and voltage up or down as often as 200 times per second. In an embedded system that demands hard real-time response, LongRun could interfere with critical interrupt routines. However, embedded-system developers can limit the range of LongRun's voltage/frequency scaling or even disable it altogether by modifying a look-up table in memory. Transmeta says it will release more data about Crusoe SE's real-time performance in a few weeks. The company also plans to deliver new software extensions for LongRun that will let developers identify critical code for priority handling.

Transmeta's charge into the embedded market isn't limited to processors. The company has forged alliances with suppliers of embedded BIOS chips, firmware, and system software, including ALi, General Software, Insyde Software, LynuxWorks, Microsoft, MontaVista, Phoenix Technologies, QNX, Red Hat, Silicon Motion, and Wind River Systems. Transmeta also announced several customers that are using Crusoe SE: Advantech, Evalue Technology, Gespac, IBASE, ICP America, TransDominion Technologies, TransLink USA, and Tri-M Systems. These customers are generally using the processors in single-board computers and other industrial systems.