New Rules Enable Faster Mobile CPUs

Hotter Chips, Variable Clock Speeds Help Some Mobile Users—But Not All

In previous columns (see MPR 5/11/98, p. 3), I have noted the growing performance gap between mobile and desktop PC processors. Intel has talked about closing this gap, but despite the latest 0.18-micron mobile processors, the gap remains at a full four speed grades, from the Mobile Pentium III-500 to the desktop Pentium III-733.

Recently, processor vendors have made two moves to help alleviate this problem. First AMD, followed by Intel, raised the thermal limit for low-cost mobile processors from 10 W to 16 W, creating additional frequency headroom. Second, Intel is preparing a variable clock-speed technology it calls SpeedStep, which boosts operating frequency when extra power is available. Both of these moves help the frequency problem but create new issues.

Since the introduction of the first Mobile Pentium processor in 1995, Intel has tried to adhere to a consistent thermal limit, initially 8 W for the CPU, later 10 W for the CPU plus L2 cache (measured using Intel's thermal design power, or TDP, metric). As long as OEMs design their mobile systems with adequate cooling and battery power, these systems can accept any of Intel's mobile processors.

AMD was the first to break out of this thermal envelope last spring, introducing its Mobile K6-2P processor (see MPR 3/29/99, p. 4) with a power dissipation of up to 16 W. Just by changing the data sheet, AMD boosted the speed of its mobile line by about 20%. After pooh-poohing AMD's approach for months, Intel finally followed suit with its latest Mobile Celeron (see MPR 10/6/99, p. 4), which dissipates up to 15.6 W (TDP).

Both companies are now offering lower power in their premium products. AMD offers the Mobile K6-IIIP, which reduces power by integrating the L2 cache, for about $100 more than the Mobile K6-2P. Intel has kept its Mobile Pentium II and Mobile Pentium III processors to 11 W or less by using a 0.18-micron process while restricting its low-cost products to the older, hotter 0.25-micron process.

In a full-size notebook, the most common size for low-end (sub-$2,000) systems, a 16-W processor can be cooled with a modest fan and a large heat sink. Because the CPU uses only a fraction of the total system power budget, its higher power reduces battery life by a tolerable 10% or so. Many expensive notebooks, however, are of the thin-and-light variety. Cooling a more powerful processor in these systems is very difficult. And in the emerging mininotebook market, OEMs are looking for 7–8 W; 16 W is out of the question.

Thus, the most demanding professional users are left out in this move to hotter processors. Intel's answer to this problem is SpeedStep, which it will deploy early next year. This technology enables higher CPU speeds by increasing the CPU's voltage, and thus its power, when a mobile system is operating from AC power instead of its battery. According to Intel, this delivers the best of both worlds: low power in battery mode, near-desktop performance when plugged in. AMD plans to deliver its own variable-speed technology, known as Gemini, in 1H00.

Varying the voltage is a great idea, but it is not a panacea. We don't yet know how much power these chips will use in the faster mode, but to achieve near-desktop performance, the processor must have near-desktop power dissipation. We expect SpeedStep Pentium III processors to dissipate 15–20 W (TDP) in the high-speed mode. This increased power will not affect battery life, as AC power is used instead, but the processor must still be cooled.

OEMs have two options. One is only to run in high-power mode when the system is in a docking station, which could have an extra fan that sucks the heat out of the notebook. Because few mobile users have access to docking stations, Intel has discouraged this option.

Second, OEMs can build into the notebook itself enough cooling for a 20-W processor. This brings us back to the thin-and-light problem: fitting large fans and heatsinks into a svelte notebook is very tough. But without this extra cooling, variable-speed processors must operate within the lower power envelope, limiting their performance.

We expect Intel will market SpeedStep processors using the high-power clock speed. For example, what the company calls a Mobile Pentium III-700 might run at 550 or 600 MHz in low-power mode. Emphasizing the higher number makes good marketing sense, but for users who are truly mobile, the mobile performance gap isn't solved, just hidden.

By providing the option of higher-power mobile processors, Intel and AMD can offer better performance to users willing to tote bigger, heavier notebooks or plug their mobile systems into the wall. For on-the-go users who like smaller notebooks, desktop-level performance remains elusive. I only hope that, after hiding the mobile performance gap with SpeedStep/Gemini, the two CPU vendors don't lose their motivation to improve low-power performance. M

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