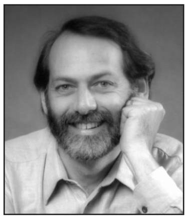
THE SLATER PERSPECTIVE

Are Single-Chip PCs Finally Coming?

Highly Integrated Chips Emerging But Won't Serve Mainstream PCs



Six or seven years ago, when it became apparent that the capability to put several million transistors on a chip was just around the corner, many industry observers (myself included) confidently predicted that PCs would soon be reduced to a single chip plus memory. Even Intel gave presentations that forecast this outcome, and its 386SL and 486SL processors looked like steps in this direction. Chips and Technologies, VLSI Technology, AMD, and Vadem all introduced high-integration PC products.

As expected, transistor counts grew—but the anticipated integration path stopped short. The extra transistors have been used for faster CPU cores and larger caches, not for on-chip system logic or peripherals. All the announced high-integration products either failed entirely or were limited to non-PC niches. Texas Instruments developed a highly integrated design based on a Cyrix core but killed the product before it came to market. AMD designed a 486 chip with an integrated PCI interface but didn't put it into production.

Today, there is one highly integrated processor in the PC market: Cyrix's MediaGX. (SGS-Thomson is marketing a highly integrated processor based on Cyrix's earlier 486 core, but it is too slow for even the entry-level PC market.) National, in explaining its reasons for acquiring Cyrix (see cover story), has focused on the fact that the company now has all the building blocks for a complete PC. National plans to integrate more functions in future descendants of the MediaGX. Given the dismal track record of the PC-on-a-chip concept, is there reason to believe National may do better? Clearly, a single-chip PC *can* be built—but *should* it?

Since a high-integration design must start with a proven CPU core and peripherals, it is hard for it to be less than a year—and generally more like two years—behind the leading edge. During the time it takes to design, debug, and bring into production an integrated chip, changes can occur in the system architecture (such as the emergence of PCI, which left the 486SL with the wrong bus structure) or in the input/output system—as is apparent in the MediaGX, which lacks support for USB, 3D graphics, and video.

For Intel, another problem is the economics: system-logic and graphics chips sell for much less revenue per square millimeter of silicon than Intel's processors, so adding these functions only makes sense for Intel if it has plenty of additional capacity in its leading-edge process technology—which has rarely been the case.

For companies other than Intel, another challenge in making an integrated processor successful is that it requires a unique motherboard design; system makers can't just plug the competitive chip into an existing design, raising the hurdle for design wins.

Yield is another problem. Two small chips will produce more working silicon from the same number of wafers as one chip twice as large. This downside can be offset by decreased packaging cost—but high-pin-count packages have been too expensive for low-cost systems.

Finally, there is the loss of flexibility that results from putting everything on one chip; all systems built around a particular PC-on-a-chip will be very similar.

Despite all the drawbacks of highly integrated chips, their lure remains strong—particularly for companies seeking a differentiated position in the PC microprocessor market. That Intel is not pursuing this approach makes it all the more attractive for Intel's competitors: it offers the prospect of avoiding head-to-head competition with Intel.

There are potential cost advantages in reducing the number of chips per system, and some efficiency can be gained by closely coupling the graphics controller, DRAM controller, and I/O bus interfaces with the processor and its cache controller. Plastic BGAs have slashed the cost of high-pin-count packages, and the emergence of Direct RDRAM as the memory standard reduces the pin count for the memory interface. National doesn't have Intel's problem of system logic reducing profit margins; for National, adding the processor increases the margin of the system logic.

For the mainstream PC market, the fact that highly integrated chips will lag in performance and lack in flexibility probably will keep them from playing a major role. The emergence of the Internet as a mainstream application, however, combined with the potential popularity of low-cost PC-based appliances, could significantly increase the market for lower-performance, less flexible systems.

You don't need even a midrange PC to have a decent Internet access device. As the cost of network-enabled computing becomes lower, the market for low-cost access devices will expand far beyond traditional PC markets. The ongoing, rapid improvements in 3D will make games a harder target for single-chip systems, but the cost-sensitive part of the game PC market could be attacked by an integrated device with a good 3D engine in a year or two. M

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