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National Semi Acquires Cyrix

Cyrix Gains Licensed Fab; National Touts PC on a Chip

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This article is an expanded and updated version of the news flash distributed with our last issue.

National Semiconductor has leapt into the PC processor market by acquiring x86 vendor Cyrix for an estimated $550 million in stock. The deal positions the combined company as a stronger force in the PC processor market, bringing Cyrix's x86 designers together with National's fab capacity. National recently opened a 0.35-micron fab, competitive with the best process technology that Cyrix is getting from its current foundry, IBM. National also holds the essential Intel patent cross-license agreement that will allow it to legally manufacture and sell Intel-compatible processors.

From National's standpoint, the deal allows it to extend its line of PC-on-a-chip products, currently embodied by its NS486 processor (see MPR 9/11/95, p. 1). The Cyrix processors will provide more powerful cores for future highly integrated products. National CEO Brian Halla envisions a future in which PC-compatible "appliances" sell for $500 or even $200, with sales of these low-cost devices far outstripping those of traditional PCs.

How these two strategies will play together in the long term is unclear. The initial press announcement was somewhat schizophrenic, with Cyrix stressing head-to-head competition with Intel while National honed in on the PC-on-a-chip concept. We expect the new company to pursue both strategies for an initial period, but after a couple of years it may choose to focus on one or the other.

Halla Revitalizes National's Fab Technology

Under former CEO Gil Amelio, National's fab technology had languished; as recently as 1995, National's best process was 0.8-micron (drawn), while many other chip vendors were putting 0.35-micron processes into production. Amelio's cost-cutting measures left little funding for expensive new fabs. In the fall of 1995, National did break ground on a new fab in South Portland, Maine, but continued funding problems slowed progress on the new facility.

After Amelio left to take over Apple in January 1996, Halla took charge at National and immediately gave the green light for the Portland project to proceed at full speed. He also expanded the size of the facility significantly, boosting the total investment to more than $1 billion over three years. The Portland fab went from shovel to sample silicon in 18 months, and National will begin shipping production parts from the new fab next month.

National also vastly increased funding for IC process development, hiring many experienced hands to accelerate development of a 0.35-micron process. Halla wanted the Portland fab to deploy the 0.35-micron process when it opened, with a goal of reaching the 0.25-micron level in 1998 and 0.18-micron in 1999. After spending $70 million for process development in 1996 and an expected $100 million this year, National has met its initial goal: the first production parts from the Portland fab are being built in a 0.35-micron (effective) CMOS process.

National hopes to make a fast transition to the 0.25-micron level. The initial process is designed such that 70% of the equipment can also be used to build 0.25-micron parts; this high degree of commonality should smooth the transition. The company expects its 0.25-micron process to be fully qualified in its Santa Clara (Calif.) development fab by December, with volume production in Portland around the middle of 1998—still a year behind the industry leaders.

Plenty of Capacity for Cyrix Parts

Halla clearly has big plans for the Portland fab. By the end of 1999, the fab will be built out to a capacity of 7,000 wafers per week, roughly the size of AMD's Fab 25 or Intel's largest fabs. This capacity will easily support a doubling or tripling of Cyrix's market share in addition to National's current products. If necessary, the entire fab could be devoted to x86 chips; National's other products can be fabricated offshore through an existing arrangement with foundry TSMC.

National also intends to maintain Cyrix's existing rela-

tionship with IBM, which currently manufactures chips for Cyrix and sells some of them under its own label. The current IBM/Cyrix agreement runs through 1999. Like National, IBM has an Intel patent license, which Cyrix uses to give legal protection to its processors.

The key question is whether National's fabs are up to building Cyrix's chips. As Table 1 shows, the metal layers for National's CMOS-7 process compare well with those of IBM's CMOS-5X, used to fabricate Cyrix's leading-edge 6x86MX today. National's process has a 25% larger transistor, however, which may reduce peak clock speed. The 6x86MX does not use the more advanced local-interconnect and C4 solder-bump features of IBM's processes.

One potential problem is that the 6x86MX uses five metal layers, whereas the Portland fab is currently running only three metal layers. The fab already implements CMP (chemical-mechanical polishing), a key technology for stacking metal layers, and National believes CMOS-7 can easily support five metal layers.

Cyrix's MediaGX processor (see MPR 3/10/97, p. 1) should be a straight shot into National's fab. That chip was designed to be easily ported to multiple fabs and uses only three metal layers. IBM builds the MediaGX in a 0.4-micron process today and plans to shrink it to the 0.33-micron process by 1Q98. This chip is likely to be the first Cyrix product produced in National's fab.

In fact, one scenario is that Cyrix will shift all MediaGX production to National's fab while leaving the 6x86MX in IBM's fab. This approach would provide a big boost in output for both chips without risking a problem with National's move to five metal layers. In any case, it will probably be 2Q98 before the Portland fab is producing significant volumes of any Cyrix processor.

Vendor Process Name	National CMOS 7	IBM CMOS-5X	National CMOS 8	IBM CMOS-6X	National CMOS 9
Example product	MediaGX	6x86MX	n/a	Mach 5	n/a
First volume production	3Q97	4Q94	3Q98	3Q97	3Q99
Supply voltage	3.3 V	3.3 V	2.5 V	1.8 V	1.8 V
I/O voltage (max)	5.0 V	5.0 V	3.3 V	3.3 V	2.5 V
Gate length (drawn)	0.40 µm	0.33 µm	0.25 µm	0.25 µm	0.18 µm
Channel length (effective)	0.35 µm	0.25 µm	0.22 µm	0.15 µm	0.15 µm
Gate oxide thickness	70 Å	70 Å	50 Å	40 Å	40 Å
Number of metal layers	3–5 metal	5 metal	5–6 metal	6 metal	6–7 metal
M1 contacted pitch	1.2 µm	1.2 µm	0.64 µm	0.7 µm	0.48 µm
M2 contacted pitch	1.3 µm	1.8 µm	0.80 µm	0.9 µm	0.60 µm
M3 contacted pitch	1.3 µm	1.8 µm	0.80 µm	0.9 µm	0.60 µm
M4 contacted pitch	1.5 µm	1.8 µm	0.80 µm	0.9 µm	0.60 µm
M5 contacted pitch	1.8 µm	1.8 µm	0.92 µm	0.9 µm	0.70 µm
M6 contacted pitch	—	—	0.92 µm	0.9 µm	0.70 µm
Local interconnect?	No	Yes	No	Yes	Yes
Stacked vias?	Yes	Yes	Yes	Yes	Yes
Routing index*	1.3 µm²	2.0 µm²	0.49 µm²	0.53 µm²	0.24 µm²
Wafer cost index*	$2.7	$3.2	$4.0	$4.7	$5.2

Table 1. National's IC process parameters compare well with IBM's. At the 0.35-micron level, National lags IBM by more than two years, but National plans to close that gap by delivering a 0.18-micron process in 1999. (Source: vendors except *MDR)

Boosting Cyrix's Prospects

The deal solves several problems for Cyrix. The company has been struggling as a fabless x86 vendor competing against AMD and Intel, two large companies with plenty of internal fab capacity. Cyrix has been frustrated by its arrangement with IBM, which provides a fairly inflexible number of wafers and makes it impossible (or at least very expensive) for Cyrix to access IBM's leading-edge process technology. Cyrix, for example, only recently gained access to IBM's 0.35-micron technology, at about the same time that IBM moved its PowerPC chips to 0.25-micron technology.

Another problem with using an external foundry is the slow turnaround time. Prototype runs of Cyrix processors can take several weeks to get through IBM's fab, whereas an in-house fab can typically complete a "rocket lot" in a few weeks. If a new design requires two or three tapeouts to get right, these delays become critical.

These problems, along with some poor pricing and product-transition decisions, left Cyrix in a difficult financial position: the company has lost money in five of the seven most recent quarters. The lack of profitability depressed Cyrix's stock price, making it an inexpensive acquisition. An unhappy board of directors parted ways with founder and CEO Jerry Rodgers at the end of last year, and the company did not identify a replacement.

The merger with National eliminates the need to find a new CEO and provides Cyrix with the financial stability of a billion-dollar semiconductor company well-known in the PC industry. Cyrix now has access to a fab in which its products will have top priority, and it can tune its designs to the in-house fab. If National follows through with its aggressive process-development plans, Cyrix will have access to leading-edge process technology for its future products.

National's Intel patent license is another key advantage for Cyrix, giving the company clear rights to produce Intel-compatible chips. National claims its cross-license is broad and puts no constraints on its ability to manufacture and market x86 processors. Sources indicate, however, that the current license expires in 1999, and Intel may be less generous when the license is renewed. National's ability to gain favorable terms will depend on the strength of its own (and Cyrix's) patent portfolio. In any case, the company will still be able to manufacture x86 chips based on Intel patents filed before 2000, but a diluted license could eventually constrict the company's ability to compete in the PC market.

National Seeks Highly Integrated x86 Chips

In addition to maintaining Cyrix's current product lines, National aims to create new highly integrated x86 processors. Cyrix's MediaGX, which combines its 5x86 CPU core with system logic and 2D graphics, caught National's attention. In combination with a "south bridge" system-logic chip, the MediaGX today starts at just $63. The integrated processor is used in the Compaq Presario 2200 and in other systems that sell for as little as $699, sans monitor.

National is the leading vendor of "super I/O" chips, devices that connect to standard keyboards, floppy drives, and serial and parallel interfaces. This logic is missing from the MediaGX today. National also manufactures Ethernet controllers and mixed-signal devices used in modems.

The company has been on a shopping spree since Halla's arrival, picking up Mediamatics and PicoPower as well as Cyrix. Mediamatics provides expertise in audio and video, particularly DVD decoding software, while PicoPower (formerly part of Cirrus Logic) builds system-logic chip sets for portable computers.

With the acquisition of Cyrix, all the pieces are in place to build a superintegrated x86 processor. National plans to launch the first such product by the middle of next year. The company would not be specific about its plans, but the obvious opportunity is to enhance the 5x86-based MediaGX with a full set of PC interfaces from National's technology portfolio. Such a device would be similar to SGS-Thomson's STPC (see MPR 8/4/97, p. 1) but with a more powerful CPU core and with the super-I/O functions integrated.

National Envisions PC Appliances

Such a device could be used in very low cost PCs, as the MediaGX is today, but National seeks to expand the market for x86 chips by focusing on devices with even lower costs. The sub-$500 products that Halla envisions are likely to omit one or more key PC features—such as CD-ROM, floppy, and hard drives and a large amount of DRAM—making them incompatible with Windows 95 and its successors. These products will not be PCs, at least by the current definition.

But there are many emerging markets for low-cost PC-like devices. Handheld computers, network computers (NCs), set-top boxes, and so-called information appliances could all be built around a superintegrated x86 processor such as the one National is proposing. Halla believes the combined market for these low-cost devices could be ten times larger (in units) than the current PC market.

While classic microeconomics says that the market size expands greatly as the product price falls, there is no evidence to date that any of these emerging markets will grow to the size of the current PC market, much less a larger size. Microeconomics does not apply when the feature set of the product must be reduced to reach lower price points. There is plenty of time for one or more of these new product categories to become wildly successful, but at this point betting on them is somewhat risky.

Even if these new products succeed, there is no guarantee they will use x86 processors. In general, RISC processors offer more performance with a lower price and lower power dissipation than x86 processors. Microsoft's Windows CE, which is targeted at these low-cost applications, doesn't even ship on x86 today; the software vendor started with MIPS and SH platforms because there was little customer demand for an x86 port. By next year, an x86 version of WinCE will be available, along with several other versions, providing for intense competition among these processors.

National argues that despite a lack of pure compatibility, the similarities between Win95 and WinCE will encourage more software development on an x86 version of WinCE than on RISC versions. WinCE 2.0 will support the same DirectX APIs as Win95, for example, making it easier to port PC applications to WinCE devices. These ported applications, however, will run more naturally on an x86 processor.

Also, x86 vendors such as AMD and SGS-Thomson are leading the way in deploying highly integrated processors for low-cost devices. Current MIPS and SH products require at least two chips to offer the same set of functions. National plans to put more functions on a single chip than any vendor has to date, but there is no inherent barrier to the RISC vendors matching this level of integration.

Competing With Intel Is Always Tricky

Thus, the new company can compete with Intel on two fronts: a direct assault using the mainstream Cyrix products and a flank attack using the PC-on-a-chip strategy. A direct assault on Intel's position is, of course, more dangerous, as Cyrix has already discovered. The company's 6x86MX product is doing well, however, and if Cyrix's designers can keep pace with Intel, there is an opportunity to gain market share using National's fab capacity. Because these mainstream products have a high selling price, this product line could be quite profitable. Intel will fight such products vigorously, however, and any Cyrix misstep could result in disaster.

To date, Intel has shown little interest in building processors for sub-$1,000 PCs and no interest in the potential PC-appliance market. For National, competing against AMD and SGS-Thomson is a much better prospect than competing against Intel. If this market fails to emerge, however, these companies could be fighting over table scraps. And if PC appliances become as successful as Halla envisions, Intel is likely to jump into this market, leaving National competing head-to-head with Intel again.

Thus, National must move carefully, as neither opportunity is a slam dunk, even with the combined strength of the two companies. By 1999, Cyrix's M3 core should be completed, and the viability of both the mainstream PC processors and the low-cost superintegrated chips should be more clear; at that point, National may choose to focus on one or the other. The good news is that Cyrix is strengthened by the acquisition, and National now has two new opportunities for future success— a big turnaround from the Amelio days. MPR