Most Significant Bits

TI's Rio Grande Runs Dry

Struggling to find a strategy in the crowded x86 CPU market, Texas Instruments has pulled the plug on Rio Grande, its highly integrated x86 processor *(see 080201.PDF)*. The device included a 66-MHz 486SX processor core (based on a Cyrix design) along with an integrated memory controller and PCI interface. The company says that it had produced working silicon and had scored some design wins in the notebook market, but not enough to justify volume production. One major failure: the inability to convince TI's own notebook division to use the integrated processor.

Rio Grande was undone by the rapid drop in the price of 486SX chips. TI sells its 50-MHz 486SXL for $65 in quantities of 1,000; with inexpensive system logic abounding, the company could charge no more than $80 for the Rio Grande processor. But with an estimated manufacturing cost of nearly $40 for the integrated chip, it made little sense for TI to produce the part.

Like Intel's 486SL, Rio Grande took too much of a die-area penalty for integrating system logic. Given the competition in the chip-set market, it is cheaper for system vendors to buy a separate CPU and chip set than it is to buy an integrated processor. The only other microprocessor to integrate a PCI interface, Digital's 21066, also has yet to find a sizable customer; the demise of Rio Grande indicates that the time is not yet right for highly integrated processors.

Intel Slashes Pentium, 486 Prices

Intel's quarterly price cuts have brought the Pentium-60 soundly into the high-volume price range while pushing the venerable 486DX and DX2 below $200. The new Pentium-75, the first x86 processor to be offered in a TAB package, is aggressively priced at $495. (It costs $40 more in a PGA package.) With the Pentium-75 only $36 above the DX4-100, there is little doubt which way Intel wants the market for high-end notebooks to go.

The Pentium-60 price fell 34% to a mere $383—less than the price of a 486DX2-66 at the beginning of the year and below today's DX4-100 price. (The Pentium-60 and -66 price reductions are effective 10/31, while all the others were effective 10/1.) The Pentium-90 fell half as much, to $587. The top-of-the-line Pentium-100 hardly changed at all, staying above $900, suggesting that Intel's yields at this clock frequency are still poor. In the wake of these price cuts, Dell dropped Pentium system prices to $1,895 for a complete 60-MHz system and $2,395 for a 90-MHz configuration.

Intel's steep cuts for its 486DX and DX2 processors show that, despite the Pentium push, the company isn't ready to concede the 486 market to its competition. With the DX2-50 sinking to just $149, Intel is putting great pressure on the SX versions, which it would like to eliminate. The fact that the 486SX2-50 price dropped 39% to $102, however, shows that Intel wants to keep that part competitive. Intel still is not offering an SX2-66, the part that gave AMD its foot in the door at Compaq. The table below shows the full range of new prices.

	3Q94	4Q94	% change
i486SX-25	$79	$74	6%
i486SX-33	$87	$81	7%
i486SX2-50	$168	$102	39%
i486DX-33	$251	$149	41%
i486DX-50	$271	——	n/a
i486DX2-50	$204	$149	27%
i486DX2-66	$271	$199	27%
DX4-75	$429	$382	11%
DX4-100	$516	$459	11%
Pentium-60	$581	$383	34%
Pentium-66	$643	$479	26%
Pentium-75	——	$495	n/a
Pentium-90	$707	$587	17%
Pentium-100	$964	$935	3%

Outside of the 100-MHz Pentium, the smallest cuts were for the 486SX, which Intel clearly isn't interested in pushing. With prices already well below $100, there is little incentive to slash the prices further, and Intel would like the market to shift to the DX2. Intel also faces less competition for the SX, since AMD and Cyrix/IBM are both focusing their 486 efforts on DX2 chips, which produce the most revenue (and profit) from their limited fabrication capacity.

PowerPC 604 Announced at 100 MHz

IBM and Motorola have confirmed that the PowerPC 604 *(see 080501.PDF)* is on track for volume shipments by the end of this year. Both companies are now sampling 100-MHz versions of the part. The initial announcement hinted at faster versions of the 604, but it now appears that these faster parts will be delayed until 1995 and may require a shrink from IBM's CMOS-5L process to 5S or 5X *(see 080504.PDF)*.

In 1,000-unit quantities, IBM will sell the 100-MHz 604 for $549. At this price, the 604 fits between Intel's 75- and 90-MHz Pentiums (see previous item), satisfying PowerPC's goal of offering twice the performance of x86 at the same price. The 100-MHz 604 is said to deliver 160 SPECint92, compared with 90 for the 90-MHz Pentium. Motorola's 100-MHz 604 is slightly more expensive than its counterpart's, but Motorola is offering a 90-MHz speed grade, which IBM is not, and pricing it at $499.

Both companies are also sampling the 100-MHz

601, with volume shipments expected in November. Like other 601 processors, the new version is built only by IBM but is sold by both vendors. IBM's 1,000-piece price for the 100-MHz 601 is $399, comparable to a DX4-75. The table below shows the full range of PowerPC prices from both companies.

	Motorola 1K price	IBM Microelectronics		1K price
		3Q94	4Q94	% decline
603-66	$175	$215	$165	23%
603-80	$199	$254	$195	23%
601-50	——	$227	$165	27%
601-66	$189	$257	$165	36%
601-80	$299	$360	$249	31%
601-100	$439	——	$399	n/a
604-90	$499	——	——	n/a
604-100	$599	——	$549	n/a

Both companies continue to drop prices rapidly to match Intel's free-falling Pentium and 486 pricing. The price of the 80-MHz 601, for example, has fallen by 60% in the past year. Further price cuts are still possible; the 601 carries an estimated manufacturing cost of about $65, while the 603 costs only $45 to build.

Motorola Deploys First PPC 603 Systems

On the heels of its chip announcements, Motorola said that it will manufacture PCs and servers using PowerPC processors. These systems will be sold primarily to OEMs and VARs rather than under Motorola's own label, although the company says that it will sell to "select end users" as well. The PowerPC systems will be offered as upgrades to the 68000- and 88000-based products currently available from the Motorola Computer Group.

The new systems include a PC using a 66-MHz 603 CPU and Motorola's Eagle system-logic chip. The systems are Prep-compliant and use the Big Bend motherboard *(see 081202.PDF)*. With no memory, disk, or monitor, the PC is priced at $3,295. In contrast, a fully configured 60-MHz Pentium PC with similar integer performance can be purchased for $1,895.

The new systems will be sold with IBM's AIX operating system, currently the only OS openly available for PowerPC. Once Windows NT for PowerPC is ready later this year, Motorola will offer its systems with NT as well. These systems will not support the current version of Mac OS, even if Apple decides to license it.

Motorola Computer Group has had little success, except in a few niche markets, with its existing products. Compared with Pentium PCs or even Macintosh systems, the Motorola PC is far overpriced; to become a serious player in the system market, Motorola will have to do better. The new systems will, however, help ISVs that are interested in porting to NT-on-PowerPC.

Separately, IBM announced a $3,995 workstation (fully configured) that uses a 66-MHz PowerPC 601

processor and its own PCI system-logic chip set. This system was set to be the first of IBM's own RISC PCs, but the company decided to delay the introduction of its new PC line until next spring, when both OS/2 and NT will be available with significant application support. Until then, the new system will be sold as the RS/6000 Model 40p. The performance of the 40p is competitive with that of $3,995 workstations from HP and Sun.

Toshiba Endorses PowerPC

Gaining a significant new partner, IBM announced that Toshiba has licensed the PowerPC architecture and will build systems based on that processor family. Toshiba revealed few details of its product plans; it appears that the Japanese vendor will initially focus on a line of PowerPC servers using IBM's AIX operating system.

The agreement exacerbates Toshiba's schizophrenic approach to processor architectures: the company resells a line of SPARC workstations and is one of the top suppliers of MIPS microprocessors. Although Toshiba is big enough to tolerate multiple architectures, it is possible that PowerPC will push out SPARC over time.

Toshiba remains committed to the MIPS architecture and is one of two vendors planning to deliver the R10000 *(see 081403.PDF)*. Under its agreement with IBM, the company may build PowerPC processors, including derivative versions, for internal use but may not sell such chips on the open market. Initially, Toshiba plans to buy PowerPC chips from IBM and Motorola; if its volumes become large enough, Toshiba may ultimately decide to build its own processors.

Toshiba is also a major player in the x86-based PC market but is focused mainly on notebook systems. In the near term, it is unlikely that Toshiba will build notebooks based on PowerPC, particularly with AIX. Even with Windows NT, soon to be available on PowerPC, the disk and memory requirements would make a PowerPC notebook significantly more expensive than a portable Pentium system. Toshiba's schizophrenia may simply be a hedging strategy allowing it to succeed no matter which processor does well in the future.

Judge Rules for Intel on ICE Microcode

Judge Patricia Trumbull has ruled against AMD in a long-pending decision regarding AMD's rights to Intel's ICE (in-circuit emulator) microcode. This decision was in the first module to be heard in Intel's 486 copyright infringement suit against AMD, and it applied to only one specific issue: AMD's rights to the special microcode Intel included in the 486 to control in-circuit emulators.

The immediate result of the decision is that AMD is dropping this microcode from its 486 processors, and no AMD 486 processors with system-management mode (which uses this microcode) will be available until next year. The lack of a chip with SMM will have little imme-

diate impact on AMD; due to limited fab capacity, it is selling almost solely to the desktop market. It is possible, however, that AMD could be unable to ship any 486 chips for as long as three months.

As usual, the two sides have entirely different views of the situation, which hinges on the interpretation of one paragraph in a 1984 amendment to AMD's 1982 agreement with Intel. At the time, Intel made in-circuit emulators for its microprocessors using special "bond-out" versions of the chips, which had extra signals to support the ICE interface and special microcode to control it. Intel did not want AMD to sell bond-out chips to other emulator makers, so AMD agreed to an amendment that prohibited it from copying circuitry used for ICE functions.

AMD has not been accused of making bond-out chips for emulator makers—which the company says is all the agreement was intended to cover. The company did, however, copy all of Intel's 486 microcode, as the courts have so far ruled it has the right—except for the microcode used for ICE functions, which AMD didn't bother to delete. All of AMD's 486 chips shipped so far include the ICE microcode, even though it cannot function in a standard 486 because the signals that it controls are not connected. The company did, however, use the ICE microcode in its low-power versions of the chip to implement its version of system-management mode (SMM).

AMD's only 486 chips with SMM are the DXL and DXLV processors. The company says that, out of nearly four million 486 processors shipped, only 3,000 included SMM. For the moment, at least, AMD is precluded from selling 486s with SMM. The company plans to introduce a 100-MHz clock-tripled 486 in 1Q95 that will use a new clean-room implementation of Intel-compatible SMM, allowing it to address the portable market.

On the day the decision was announced, AMD CEO Jerry Sanders declared that there would be no further wafer starts in the U.S. of 486s with ICE microcode, and that database tapes with the revised microcode had already been shipped to Digital in South Queensferry, Scotland, which is producing 486s as a foundry for AMD. Sanders stated that there are fewer than 100,000 chips in inventory with the SMM functions bonded out, and that these chips will be reworked or destroyed to comply with the court's decision.

Intel sees things differently. According to Intel—and the judge—AMD is simply not licensed to copy the ICE microcode, and it is irrelevant whether the code is capable of being exercised or not. Intel and the court followed a strict, literal interpretation of the agreement, while AMD unsuccessfully tried to focus on its intent.

Intel considers all AMD 486 chips to be infringing and has sought a temporary restraining order and a pre-liminary injunction blocking AMD from shipping any 486 chips that include the ICE microcode, whether the SMM functions are bonded out or not.

An injunction, if granted, would force AMD to sell only 486 chips that have the ICE microcode deleted. AMD would like the judge to "allow time for the transition" to the revised mask set; Intel seeks a strict cutoff. If Intel prevails, AMD could be unable to ship any 486s for the 10–12 weeks required to process the "ICE-free" wafers that were just started.

This decision could put a big hiccup in AMD's 486 production. Although the effect will be transient, it could be a serious hardship for AMD's customers and ruin the company's fourth-quarter results.

The longer-term issue is the possibility of damages. AMD, of course, sees the maximum damages as small, based on the 3,000 SMM chips shipped. Intel, on the other hand, says it will use AMD's total 486 sales to date—roughly $1 billion—as a starting point. Unless the California Supreme Court reinstates AMD's 386 arbitration award, the company's 386 processors could all be ruled illegal as well, adding to the potential damages. AMD argues that in the vast majority of chips, the ICE microcode could not be accessed and provided AMD with no economic benefit, so Intel was not damaged. AMD did, however, apparently gain some time-to-market advantage by not bothering to remove the ICE code.

Like most x86 litigation, this won't be over for years. Several other modules on different issues in the 486 suit must be heard before the question of damages can be addressed. It could be 1996 before a decision is reached on damages, which will certainly be appealed, so the final outcome could easily be in 1997 or later—by which time the issues in the case will be thoroughly irrelevant, and it will just be a matter of how much money Intel ultimately gets from AMD.

Philips Buys HDL, MIPS License

Seeking a high-end embedded controller, Philips Semiconductor has purchased HDL Systems (Sunnyvale, Calif.), acquiring its license to the MIPS architecture. HDL, a small startup, has developed a fully synthesized R3000-compatible CPU core *(see **071506.PDF**)* for low-power applications.

Philips is a major player in 8-bit microcontrollers *(see **081304.PDF**)* but has no presence in the 32-bit market. The company had once planned embedded SPARC processors but never followed through. Many of Philips' current customers—including its parent, Philips Electronics NV— will be interested in the HDL core for consumer products. Following big design wins at Nintendo, Sony, and Time Warner, this move will further improve MIPS' position in this market segment. ♦