Cyrix 6x86MX Outperforms AMD K6

Former "M2" Delivers Strong Performance, Adds MMX to Cyrix Repertoire

by Linley Gwennap

Intel's competitors continue to turn up the heat on the x86 giant. Following AMD's recent K6 announcement, Cyrix and IBM Microelectronics today announced volume availability of their 6x86MX processor, code-named M2. This chip extends the performance of the original 6x86 by increasing its clock speed and adding a larger on-chip cache. The new chip is also Cyrix's first to incorporate Intel's MMX multimedia extensions.

The 6x86MX relies on the same superscalar CPU core as the original 6x86 (M1), which does not implement the advanced instruction translation and reordering found in Intel's P6 processors or AMD's K6. Surprisingly, the relatively simple CPU delivers better performance on typical PC applications than either of these cores on a clock-for-clock basis. Based on the Winstone 97 benchmark, the 6x86MX, at its maximum speed of just 188 MHz, outperforms a 233-MHz K6 or a 233-MHz Pentium/MMX and approaches the performance of a 233-MHz Pentium II.

6x86MX Does Well on Winstone 97

Although the company has dropped its supercilious "+" suffix, Cyrix continues to use the PR (performance rating) nomenclature for its chips, whose clock speed is not an adequate representation of their relative performance. For the new chips, the company slightly redefined the PR rating, which originally referred to Pentium (P54C) performance. Today's market is more complicated, as Pentium/MMX (P55C) offers better per-clock performance than the P54C, and the K6 offers more performance than the P55C at the same clock rate. Cyrix's new PR rating encompasses all of these competitors.

Both Cyrix and IBM announced three speed grades for the 6x86MX: PR166, PR200, and PR233. These parts operate at core CPU speeds of 150, 166, and 188 MHz, respectively. All the parts use a 2.5× bus-clock multiplier for best performance, with the 188-MHz CPU relying on a 75-MHz bus, although slower speeds are supported if desired.

Figure 1 shows Cyrix's performance positioning, based on mainstream PC applications under Windows 95. The data shows the 6x86MX-PR166 outperforming a K6-166 by 3% and a P55C-166 by 8%. Cyrix's PR200 and PR233 outscore the corresponding K6 and P55C chips by a similar margin. According to Cyrix, its PR233 chip comes within 1% of a 233-MHz Pentium II on this benchmark.

Figure 2 shows similar data under Windows NT. In this case, the Cyrix chip comes in about 3% ahead of Pentium/MMX and the K6. Pentium II gets a small boost on Windows NT, putting the 233-MHz part about 3% above the fastest 6x86MX.

Given this data, Cyrix's PR ratings are actually a bit conservative when compared against Pentium/MMX, particularly under Windows 95, where Cyrix's PR166 actually outruns a P55C-200. The ratings position Cyrix well against both Pentium/MMX and AMD's K6, a key competitor, under either of the two popular PC operating systems. As Cyrix introduces faster versions of the 6x86MX, it presumably will

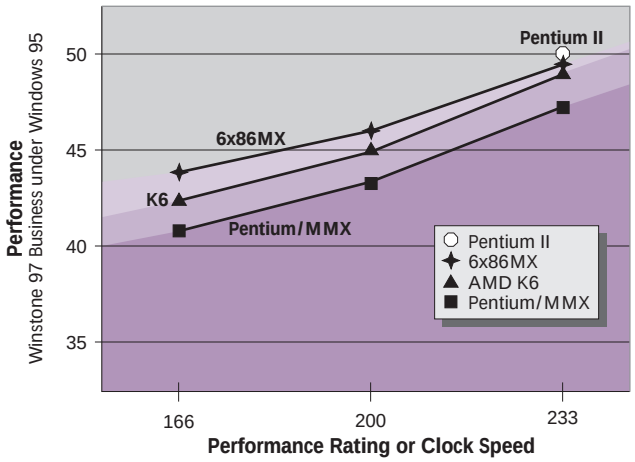

Figure 1. On the Winstone 97 Business benchmark running under Windows 95, the 6x86MX outperforms Pentium/MMX and AMD's K6. All processors tested with 512K of cache, SiS 5571 chip set (except 440FX for Pentium II), 32M EDO DRAM, Quantum Fireball ST32A011 hard drive, and STB Nitro 3D graphics accelerator with 4M of VRAM in 1,024 x 768 x 16 mode. (Source: Cyrix)

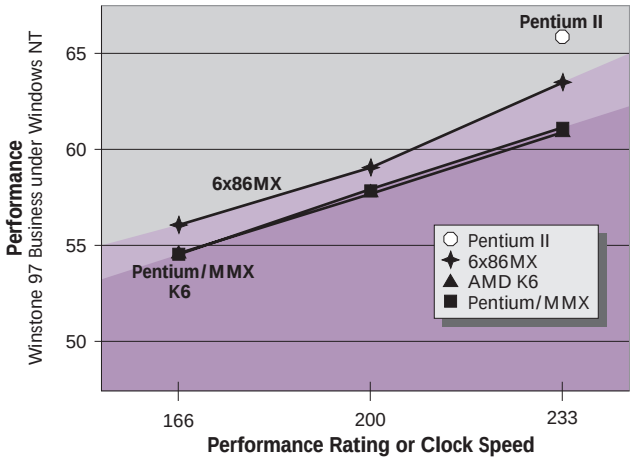

Figure 2. When tested under Windows NT, the 6x86MX has a smaller advantage over Pentium/MMX but still outperforms both it and the K6 on the Winstone 97 Business benchmark. A 233-MHz Pentium II outscores the Cyrix PR233 by about 3%. System configurations are the same as in Figure 1 except K6 uses Triton 430TX. (Source: Cyrix except K6 from *PC Magazine Online*)

	Cyrix 6x86MX	Intel P55C	AMD K6	Intel Pentium II
Clock speed	188 MHz	233 MHz	233 MHz	266 MHz
Pipeline	7 stages	6 stages	6 stages	12–14
Decode rate	2 x86	2 x86	2–3 x86	3 x86
Issue rate	2 x86	2 x86	6 ROPs	5 ROPs
MMX issue	1 instr	2 instr	1 instr	2 instr
Reorder buffer	None	None	24 ROPs	40 ROPs
Reg renaming	32 regs	None	32 regs	48 regs
Branch history	512 entries	256 entries	8K entries	>512?
Return stack	8 entries	4 entries	16 entries	4 entries
Cache (I/D)	64K unified	16K / 16K	32K / 32K	16K / 16K
TLB (I/D)	16 + 384 L2	32 / 64	128 unified	32 / 64
Core voltage	2.8 V	2.8 V	2.9/3.2 V	2.8 V
Max power	18 W	17 W	29 W	27 W*
Transistors	6.5 million	4.5 million	8.8 million	7.5 million
Die size	197 mm²	128 mm²	162 mm²	203 mm²
IC process	0.33µ 5M	0.28µ 4M	0.3µ 5.5M	0.28µ 4M
Mfg cost*	$80	$50	$70	$90
Availability	Now	Now	Now	Now
List price	$190–$320	$270–$598	$244–$469	$636–$775†

Table 1. The 6x86MX is less expensive than its rivals but delivers similar performance despite its lower clock speed. †includes 512K L2 cache (Source: vendors except *MDR estimate)

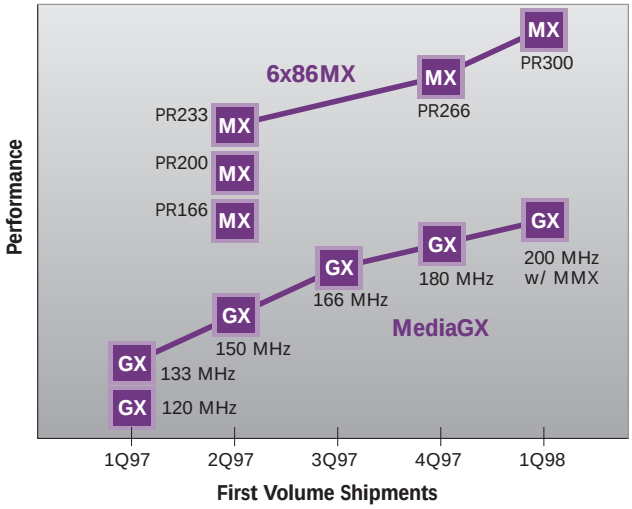

Figure 3. Cyrix's roadmap includes two process shrinks, the first resulting in a PR266 version and the second in a PR300 part. Improving process technology will also boost the MediaGX's clock speed over time, filling in the low end. (Source: Cyrix)

adjust the PR number to match up against Pentium II.

Performance on many MMX- and floating-point-intensive applications will lag the PR rating. A lack of accepted benchmarks in these areas hinders the comparison, but Cyrix released data showing the 6x86MX to be about the same as or slightly slower than Pentium/MMX on image manipulation (MMX) and 3D games that use floating-point math. Pentium II is significantly better than Pentium/MMX on most FP applications, so the 6x86MX is likely to fall well behind Intel's top of the line in this area.

Simpler Design Outperforms Complex Ones

Cyrix's figures show that a 166-MHz 6x86MX (PR200) outperforms a P55C-166 by 8–13% on Winstone 97, depending on the operating system. The Cyrix chip has two clear advantages over the P55C design. First, the 6x86 core features register renaming and an extra pipeline stage (see MPR 10/25/93, p. 1) that reduces stalls compared with the P55C. Second, the P55C spends a large percentage of its time waiting on the system bus; the 6x86MX reduces this wait time with its larger on-chip cache and TLB.

As Table 1 shows, the new Cyrix chip features 64K of on-chip cache, twice as much as the P55C. The unified design of the 6x86MX cache further improves its hit rate compared with the split instruction and data caches on the P55C. The 6x86MX also includes a generous 400-entry TLB.

The real surprise is that, on typical PC applications, the 6x86MX outperforms more complex designs such as AMD's K6 and Intel's Pentium II (PII) on a clock-for-clock basis. With both chips operating at 166 MHz and using a 66-MHz bus, the 6x86MX delivers 8% more performance than the K6 on Winstone 97, according to Cyrix.

Process Shrinks Will Boost Performance

Cyrix is working with IBM to apply more advanced process technology to the 6x86MX, resulting in two process shrinks, as Figure 3 shows. Around the end of this year, Cyrix plans to ship a PR266 version of the 6x86MX built in IBM's 0.25-micron CMOS-6S2 process (see MPR 9/16/96, p. 11). We expect this move will reduce the die size of the chip to about 120 mm² and boost the clock speed to at least 225 MHz, supporting a PR266 rating (comparable to PII-266). This version will retain the 2.8-V core supply.

A second process shrink, to CMOS-6X, will provide additional benefits in 1H98. The transistors in CMOS-6X are similar to those in CMOS-6S2, but the metal pitches are further reduced. In CMOS-6X, the 6x86MX could shrink to less than 80 mm². The new process would offer a slight boost in clock speed, allowing a PR300 part.

With the surprisingly good performance of the new 6x86MX, Cyrix has re-established itself as a strong competitor to AMD. Both companies will work together to extend the life of Socket 7 even as they compete with each other to fill that socket in midrange PCs. Although AMD was the first to market with an MMX-enabled part, Cyrix has come out swinging with lower prices. This could signal the start of a bruising price war among Intel's competitors. M

Note: this article is excerpted from Microprocessor Report's *in-depth article on the 6x86MX. For a copy of the full article, contact our customer service department at cs@mdr.zd.com or 707.824.4001 and ask to purchase a back issue of* Microprocessor Report, *June 2, 1997. The price is $29.*