PowerPC 750 Sets MacBench Records

"Arthur" Powers New Macintoshes; PowerPC 604e Hits 350 MHz

by Linley Gwennap

The PowerPC vendors launched two powerful new chips today, but which is the more powerful is subject to dispute. In one corner is the reigning champion, the PowerPC 604e, which is now available from IBM and Motorola at clock speeds of up to 350 MHz. In the other corner is the new PowerPC 750, weighing in at just 266 MHz but wielding a speedy backside bus.

The winner is determined by the benchmark. The 604e fares better on the workstation-based SPEC95, but the 750 is the clear winner on Macintosh benchmarks. The difference is the extra bandwidth of the 750's backside cache bus. In fact, this bandwidth will probably make the 750 a better choice for workstation applications with larger instruction and data sets than those in the rather paltry SPEC95 tests.

Mach 5 Reaches 350 MHz

The fast 604e parts are based on the Mach 5 design (see MPR 7/14/97, p. 4), a shrink of the classic 604e chip to a true 0.25-micron process that Motorola calls PPC4. Since the 604e reaches speeds of 233 MHz in the older PPC3 process, we expected the new process to allow speeds up to 350 MHz, and the companies have come through. At 350 MHz, the new 604e delivers up to 13.8 SPECint95 (base) and 8.6 SPECfp95 (base), according to the chip makers.

These scores would put the 604e about 20% ahead of a 300-MHz Pentium II on both integer and floating-point code. In the past, however, the 604e's SPEC95 estimates have degraded by as much as 15% when the chip was actually tested in a shipping system with a shipping compiler. IBM expects its 350-MHz RS/6000 workstations, due to be announced within the next 90 days, to meet or exceed the performance estimates given above.

	SPEC95_base (estimated)		MacBench (CPU)*	List Price (1,000s)	
				Motorola	IBM
604e-350	13.8 int	8.6 fp	780	$695	$995
604e-300	12.2 int	8.1 fp	670	$495	$800
604e-250	10.5 int	7.4 fp	560	$395	$720
750-266	11.8 int	8.0 fp	1,040	$568	$595
750-233	10.5 int	7.7 fp	910	$443	$395
750-200	9.0 int	7.3 fp	780	$378	n/o
740-266	10.9 int	6.6 fp	n/a	$549	n/o
740-233	9.7 int	6.4 fp	n/a	$424	n/o
740-200	8.5 int	6.0 fp	n/a	$359	$310

Table 1. The 750 delivers the best MacBench 4.0 scores, but the higher-priced 604e scores better on SPEC95. n/a=not available; n/o=not offered (Source: Motorola, IBM, except *MDR estimates based on Apple, Power Computing measurements)

Arthur Becomes PowerPC 750

The new PowerPC 750 is based on the "Arthur" design (see MPR 2/17/97, p. 10), an improved version of the PowerPC 603e core that includes a second, separate bus for the external level-two cache. The 604e (and other PowerPC chips), in contrast, uses a single bus to access both the L2 cache and main memory. The 750 is currently being built in the older PPC3 process, limiting its clock speed to 266 MHz.

With the severe clock-speed disadvantage, the 750 falls behind on SPECint95 (base), posting a score of 11.8. This metric does not stress the memory bandwidth of the processor, however; on typical Macintosh applications, in contrast, the 750's backside cache bus provides a big performance boost. As Table 1 shows, the 750-266 has an estimated score of 1,040 on the MacBench 4.0 processor benchmark, versus 780 for the 604e-350.

The high score for the 750 is based on Power Computing's PowerTower Pro G3 system, which includes 1M of L2 cache running at the same speed as the CPU, thanks to high-speed SRAMs from IBM. In contrast, Apple's forthcoming Mach 5 system, code-named Kansas, combines a 604e-350 with a 100-MHz inline cache. ("Inline" means the cache and system bus share the same port into the CPU.)

The 750-based system has nearly three times the cache bandwidth of the Mach 5 system and, since the system bus isn't shared with the cache, much better main-memory bandwidth as well. These advantages translate into outstanding application-level performance.

The 750 also benefits from extensive research into Mac application performance. Whereas the original 604 design was tuned to do well on SPEC benchmarks, Arthur was optimized for Macintosh. By the time the Arthur project was started, there was plenty of data about how well (or poorly) Mac applications ran on the 603 and 604 cores, and this tuning has paid off in the new design.

The vendors also announced a new part called the 740, which uses the same processor core as the 750 but does not support the backside bus. This change allows the 740 to plug into a 604e motherboard, providing an easy upgrade, albeit with lower performance than the full-blown 750 offers.

750 Will Supersede 604e

As Table 1 shows, both vendors are charging a premium for the 604e despite its weak MacBench scores, although Motorola's premium is much smaller than IBM's. IBM, on the other hand, offers better prices for the slower speed grades of the 750 and 740. Vendors that want the best SPEC95 performance, or need the MP capability that the 750 lacks, will probably be willing to pay more to get the 604e.

The fast 604e has another advantage: it is now shipping in volume, whereas the 750 isn't projected to achieve volume shipments until September. Apple, for instance, will tomorrow announce systems based on the 604e-350 but is holding off on 750-based systems. Power Computing (*www.powercc.com*), on the other hand, is ignoring the 604e and going straight to the 750, although it won't be able to ship its newly announced systems until late this month.

Once the 750 is shipping in volume, however, it should become the processor of choice for high-end Macintoshes. The 604e is likely to be used in workstations for a longer period of time, due to its better SPEC95 ratings and its support for multiprocessor systems, which the 750 lacks.

We expect IBM and Motorola will, within the next year, move the 750 to the same 0.25-micron process as the 350-MHz 604e. Since the current 750 is running slightly faster than the PPC3 version of the 604e, a PPC4 version of the 750 should reach 350 or even 400 MHz. At that speed, and with its backside bus, the 750 should post far better SPEC scores than the 604e-350. To put the final stake in the 604e, the chip vendors may add multiprocessor capability to the 750 at that time.

The current 750 measures only 67 mm^2, and a shrink to PPC4 could take the die size below 40 mm^2, smaller than the 47-mm^2 Mach 5. These chips are almost too small; adding a 512K L2 cache would boost performance and still keep the die size down to a reasonable 120 mm^2 or so. Look for a PowerPC chip with an integrated L2 cache in 1H98.

The two new PowerPC offerings strengthen the high end of the product line and allow Mac vendors to offer performance competitive with that of Pentium II–based PCs. Mach 5 represents the final day in the sun for the 604e; once the 750 reaches the PPC4 process, there will be little reason to keep the 604e in the lineup, leaving Arthur the new PowerPC king. M

Price & Availability

Both vendors are shipping the PowerPC 604e in volume at clock speeds of up to 350 MHz. Both vendors are sampling the 740 and 750 at speeds of up to 266 MHz, with volume shipments expected in September. See Table 1 for list pricing.

Contact your local IBM or Motorola sales office or access the Web at *www.chips.ibm.com/powerpc* or at *www.mot.com/powerpc* for more information.