

# MICROPROCESSOR REPORT

THE INSIDERS' GUIDE TO MICROPROCESSOR HARDWARE

## Digital's 21164 Reaches 500 MHz *Alpha Regains Performance Lead, Leaves Pentium Pro in Dust*

by Linley Gwennap

Six months ago, Intel for the first time surpassed the integer performance of all available RISC processors, its Pentium Pro reigning as the king of the hill. Digital, caught in a manufacturing transition, lost the lead for the first time since the debut of its Alpha architecture in 1992. Now the tables have turned: Digital has regained the performance lead with a vengeance as Pentium Pro appears stuck in neutral, waiting for a new design, code-named Klamath, to boost speed. Digital's 500-MHz 21164 should protect Alpha's performance lead even as Intel rolls out Klamath in 1997.

The new speed grade uses the same 0.35-micron die as the 400-MHz 21164 (see [1003MSB.PDF](#)), which recently began shipping. The new chip dissipates 25 W (peak) at 2.0 V, competitive with other high-end processors. Digital expects its 500-MHz chip to reach volume production in 3Q96, but the vendor's definition of volume is somewhat different from most; while a few 500-MHz systems may ship in that quarter from vendors such as Deskstation, Digital itself probably won't ship 500-MHz servers and workstations until the following quarter.

These systems will not be cheap: Digital did not announce a list price for the 500-MHz device, but it is likely to be more than \$2,000. In addition, 4M of external cache is required to obtain maximum performance. Ah, but the rewards are sweet: an estimated 13 SPECint95 and 18 SPECfp95 (base). As Figure 1 shows, this integer score leads those of all other processors expected in the same timeframe. The floating-point score matches that of the 180-MHz PA-8000, the fastest processor shipping today.

### Alpha Crushes Pentium Pro

For those keeping score at home, Digital's Alpha performance has increased by an impressive 70% since the company was embarrassed by Pentium Pro last fall. In the meantime, PPro's performance has risen only 7%, as Intel has been unable to boost the clock speed of its device beyond the 200-MHz versions shipping since the beginning of this year. After

its brief reign, PPro trails the 500-MHz 21164 by 35% in integer performance and 60% in floating-point performance, based on SPEC95.

Intel's announcement of a 200-MHz Pentium Pro caught the industry by surprise and vaulted the x86 vendor into the performance lead, an unaccustomed position. The announcement was a change in Intel's traditional strategy of rolling out one clock speed per quarter, slowly building to a crescendo. By that plan, the 200-MHz PPro would have been rolling out about now. Unfortunately, by that plan, Intel never would have come close to the performance lead.

By pulling in the 200-MHz PPro announcement, Intel gained enormous publicity but left itself without a new high-end product for 1996. As we predicted (see [100101.PDF](#)), this strategy enabled other vendors to quickly surpass the performance of Pentium Pro. Indeed, today Intel is third on the integer performance chart, and by year's end the company

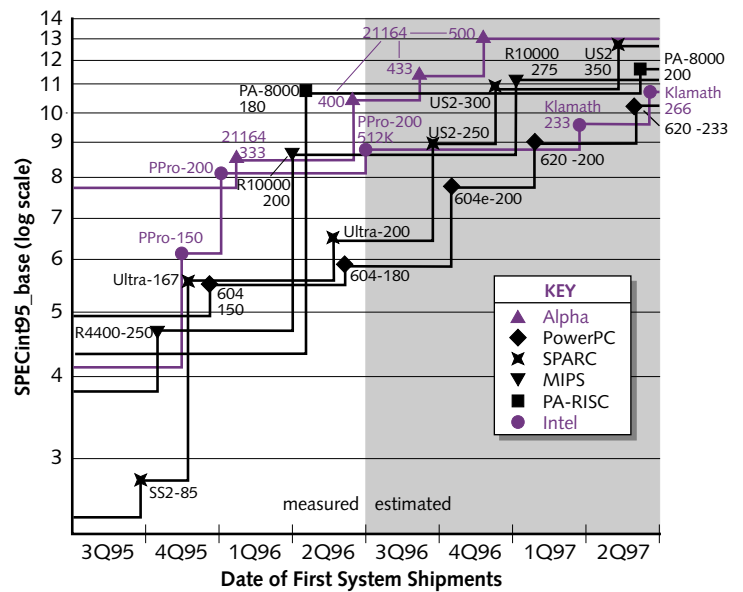


Figure 1. Digital's 500-MHz 21164 should keep the integer performance lead through at least mid-1997. (Source: historical data from vendors; future data from MDR estimates)

could be behind all the major RISC architectures.

Alpha lost the performance lead last fall because it had not yet brought up its 0.35-micron manufacturing process, while Intel had been shipping 0.35-micron parts since 1Q95. Despite its architectural handicaps, the 0.35-micron Pentium Pro, at 200 MHz, outperformed the 300-MHz 0.5-micron 21164 on integer code due to this manufacturing advantage.

Now Digital has its 0.35-micron process in full production, pushing the clock speed of its 21164 as high as 500 MHz. This process transition provided most of the aforementioned 70% gain in performance. In contrast, Intel is waiting for its Klamath design to be completed so it can move the P6 core to a 0.28-micron process; although the new process is available today, Klamath won't be ready for production until early next year.

### Digital Set to Fend Off All Competitors

The initial Klamath won't be enough to challenge Digital's performance lead. Intel's 0.28-micron CMOS process (see [1009MSB.PDF](#)) offers only a modest speed increase over its 0.35-micron BiCMOS process. Klamath will reach 233 MHz; faster clock speeds will probably require a move to Intel's 0.25-micron process. This process should enable clock speeds of up to 333 MHz, which would put the P6 core close to the 500-MHz 21164 in integer performance. Although some 0.25-micron P6s will ship in 2Q97, we don't expect a 333-MHz part until late next year. By that time, Digital is hoping to launch its next-generation 21264 processor.

Forthcoming devices such as the 300-MHz UltraSparc-2, the 275-MHz R10000, and the PowerPC 620 are unlikely to exceed the performance of the 500-MHz Alpha chip. A 0.25-micron version of UltraSparc-2, due in 1H97, could approach the 21164-500, as could a 200-MHz PA-8000, expected around mid-97. But Digital appears likely to retain the performance lead for at least the next 12 months.

At this point, PowerPC is Alpha's weakest competitor in performance. The PowerPC 620, when it emerges, is expected to boost SPECint performance only slightly over the 604 line. IBM's P2SC (see [1004MSB.PDF](#)), a single-chip POWER processor due late this year, should have impressive performance but is not PowerPC compatible. The PowerPC 630, which should reduce the performance gap, isn't due until about the same time as the next-generation 21264. We expect PowerPC performance to continue to lag behind that of Intel and most, if not all, the RISC vendors, at least until the next generation of PowerPC chips emerges in 1998.

### Pushing the 21164 into the Mainstream

In addition to the 500-MHz part, Digital announced a 433-MHz speed grade at a list price of \$1,492. The company skipped the 466-MHz point, as it would have yielded less than a 10% performance gain over the 433-MHz part. In fact, to simplify its lineup, Digital will now sell the 21164 at speeds

### Price & Availability

Digital's 433-MHz 21164 is now in production; 500-MHz 21164s are now sampling, with volume production slated for 3Q96. In quantities of 1,000, the 433-MHz chip is priced at \$1,492; Digital has not announced a price for the 500-MHz part. For more information, contact Digital Semiconductor (Hudson, Mass.) at 800.332.2717 or 508.628.4760, by fax at 508.626.0547, or on the Web at [www.digital.com/info/semiconductor](http://www.digital.com/info/semiconductor).

of 300, 366, 433, and 500 MHz, offering a 15–20% boost between speed grades. The 333-MHz and 400-MHz parts will be dropped over time.

Digital's current pricing strategy is to reserve its fastest chips for expensive servers and workstations while positioning its other speed grades for midrange desktop systems. The introduction of the 500-MHz part allows Digital to reduce the price of its lower speed grades to somewhat more reasonable levels. The price of the 366-MHz version has been cut from \$1,602 to \$950, while the 300-MHz 21164 now carries a \$695 price tag.

The lower prices will help move the 21164 into more mainstream systems, but Pentium Pro systems retain a sizable price/performance advantage. A 200-MHz PPro delivers about the same integer performance as a 300-MHz 21164 for about the same price: \$707. But the Intel price includes 256K of cache; the 21164 requires the addition of 4M of expensive cache chips to match the performance of the Pentium Pro processor. Without this large cache, the 21164's performance suffers dramatically.

Thus, the 21164 is likely to be used only in systems that sell for \$4,000 and up. These systems will appeal to those who need the extra floating-point performance of the 21164 or the maximum possible integer performance delivered by the more expensive versions of the chip.

Digital is working on a low-cost device, the 21164PC (see [1005MSB.PDF](#)), designed to reduce Alpha system prices to as little as \$2,500. This device, along with FX!32 translation technology (see [100302.PDF](#)), is needed to compete effectively with Intel's P6 processors. Compatibility with x86 applications and lower system costs offer the potential for a significant increase in Alpha's volumes.

The 500-MHz 21164 serves a different purpose: keeping Alpha in the performance lead. This status gives Alpha its *raison d'être* and gains it mindshare even among people who may never buy a 500-MHz CPU. The new device shores up Digital's performance lead at least through 2Q97. In the longer term, the forthcoming Intel/HP architecture may provide the toughest competition, but Digital will not give up its preeminent status without a fight. 