
Understanding Intel's Pentium 4

The new Pentium 4 processor has plenty of potential, but the early versions seem to have more drawbacks than speed. We investigate.

By Phil Morris
Technical Writer

The eagerly awaited Pentium 4 processor (codenamed Willamette) was released to the general public in November 2000. This was the processor that, even in its slowest form, would run at a then blisteringly fast 1.3 GHz and cause everyone to upgrade from their slow old Pentium IIIs to the new chip. Or maybe not. Those who had read the preview benchmarks for the Pentium 4 would have realised that, in this case at least, a fast clock rate didn't equate to a fast processor. Why was this? Well, this was the first genuinely "new" Intel CPU for some time - the P6 core that was the foundation for the Pentium Pro, Pentium II, Celeron and Pentium III had been replaced in the Pentium 4 by Intel's new NetBurst micro-architecture, so comparing the clock rate of the Pentium 4 to a Pentium III was like comparing apples to oranges.

In this article I will give a brief rundown of the P4 specifications, address software and hardware support issues and whether it is worth upgrading to (or buying afresh) a Pentium 4 PC.

Specification Overview

The first obvious difference when comparing the Pentium 4 to the Pentium III is the size - the P4 has 42 million transistors compared to the PIII's 28 million, and both use the same 0.18 micron technology (this will change to 0.13 micron in future P4 variants). The motherboard socket type has also changed - the new type is Socket423 and accommodates the P4's 423 pins - 53 pins more than the PIII. Initially the P4 was available rated at three clock speeds - 1.3 GHz, 1.4 GHz and 1.5 GHz - but in April 2001 a new 1.7 GHz P4 was introduced. In order to obtain this faster clock speed the three existing P4s were replaced with 1.75 volt equivalents, and the core changed from revision B-2 to C-1. The 1.7 GHz P4 is also, of course, rated at 1.75 volts.

In terms of improvements, one of the problems with the PIII and Celeron was that the old flip chip package left the die exposed to possible damage from a poorly fitting heat sink; as a result of this the die of the P4 has gained a protective metal cover. The new NetBurst micro-architecture incorporates the new Hyper pipelined technology that doubles the stages in the CPU pipeline to 20; up to 126 instructions can be temporarily "stored", so avoiding time-consuming cache flushing and hence giving faster execution. Speaking of caches, the L1 cache (in the P4 called the Execution Trace Cache, a higher performing instruction cache) is 8 KB (the PIII L1 cache is 32 KB); the P4's L2 cache is the same size as that in the PIII, namely 256 KB. The system bus of the P4 is clocked at 100 MHz (64 bits wide) and is "quad-pumped", so giving the magic 400 MHz rating that will be seen in many an advertisement. Data can be transferred at 3.2 GB/sec.

Also featured in the P4 are interestingly named features like the Rapid Execution Engine (REE), which handles often-repeated tasks like basic mathematic instructions and allows them to be executed at double the speed of the rest of the CPU. This is accompanied by Advanced Dynamic Execution (ADE), which prioritises tasks by enabling the processor to recognize parallel patterns. SSE2 replaces the PIII's SSE; SSE2 (Streaming SIMD Extensions 2) is an extended SSE and MMX and incorporates 144 new instructions. However, to take advantage of SSE2, programs need to be written/compiled with it in mind. *[An official Excel file from Intel containing a list of optimized programs is on your PCSA CD-ROM this month, although the release dates mentioned therein are only tentative - Ed].*

The P4 requires a new chipset in order to function (hence a new motherboard, see

later in this article), in this case the i850. This new chipset comprises three parts: the 82850 Memory Controller Hub (MCH), the 82801BA I/O Controller Hub 2 (ICH2), and finally the 82802AB/82802AC Firmware Hub (FWH). The MCH is connected to the ICH2 via the 8-bit hub interface which runs at 66 MHz and has a total bandwidth of 266 MB/sec. Among the features ICH2 offers there is Ultra ATA/100 support via two IDE channels, and a 10/100 LAN connect interface. Up to six PCI or CNR (Communications and Network Riser) slots can be supported with a total bandwidth of 133 MB/sec (see Figure 1 for a Block Diagram of the chipset). By nature of the design of the P4 there is no multiprocessor support - in its current form it is single-processor only. Also, if bought separately, the P4 is boxed with a heat sink and fan.

Software Support Implications

For Windows users there don't appear to be any P4-related software compatibility issues, either with operating systems or applications. However, some Linux users were affected - in December 2000 it was reported that only Red Hat and Turbo Linux could be installed on P4 PCs. This was caused by the absence of P4 information in the CPUID databases for those Linux distributions which wouldn't work. These issues should all be resolved by now in the more recent distributions.

Hardware Support Implications

If an upgrade of an existing ATX PC is being considered then think carefully - a bit more than a new motherboard will be needed this time around. For starters a new motherboard will be required that has the i850 chipset and a Socket423 for the P4 itself. A new ATX PC case that conforms to the ATX revision 2.03 standard is also needed due to physical support requirements for the large and heavy heat sink and fan. Four holes are needed in the tray for mounting the heat sink - the screws go through prefabricated holes in the motherboard which are then secured to the tray. For those wishing to fit the new motherboard into an older ATX case the application of a suitable sized drill bit to an existing ATX motherboard tray may be possible for those with DIY skills. I have read that some motherboard manufacturers are starting

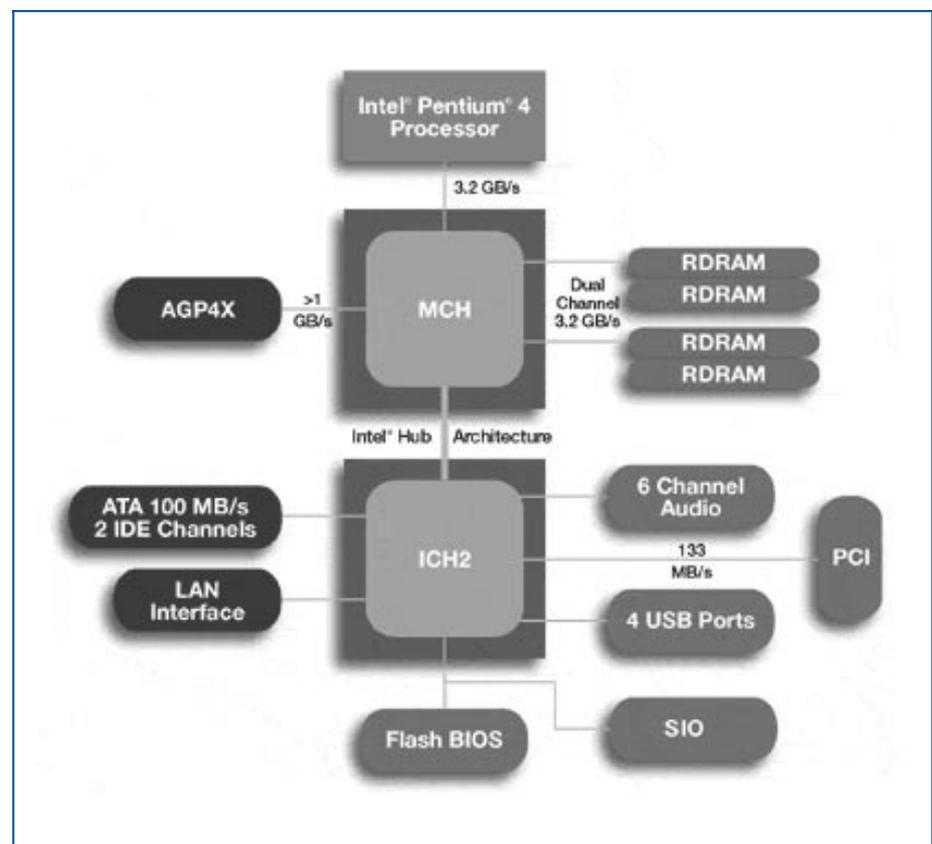


Figure 1 - i850 Chipset Block diagram.

“The first obvious difference when comparing the Pentium 4 to the Pentium III is the size - the P4 has 42 million transistors compared to the PIII’s 28 million.”

to incorporate special supports on their P4 motherboards for the hefty cooling, so maybe that new case may not always be needed - check before you buy. An ATX12V Power Supply (ATX revision 2.03) is also needed as it has an additional 4-pin motherboard connector. This connector provides extra power to the board - without it the system would be unstable or maybe even non-functional due to the higher power consumption.

For those of you still wishing to upgrade an existing PC then there's more bad news - your old SDRAM will need to be put to another use. In order to support its increased clock speeds the P4 requires another type of RAM called RDRAM (which you may also see written as Rambus DRAM, Rambus RDRAM, dual-channel RDRAM, DRDRAM or RIMMs.). This RAM runs at a higher clock speed than SDRAM - current available speeds are 600 MHz, 700 MHz and 800 MHz. By comparison, SDRAM and its variants run at 66 MHz, 100 MHz, 133 MHz, 200 MHz and 266 MHz. RDRAM uses a 16-bit wide interface, whereas SDRAM and DDR-SDRAM use a 64-bit wide bus. To equate this to something more meaningful, 800 MHz PC800 RDRAM will give the same bandwidth as 200 MHz PC1600 DDR-SDRAM. If the purchase of new RDRAM is likely to be a problem then all is not lost - the newer "Brookdale" chipset will support SDRAM, but you'll also need the newer P4. See later in this article for details.

Chipset Bug

It is also worth noting that in December 2000 Intel notified customers of a bug that was discovered in the i850 chipset and which affected P4 PCs that used PCI graphics cards and dual monitors - to be more specific, latency was introduced if large amounts of data were passed over the PCI bus. It manifested itself by causing unexpected slowdown of the PC by an undetermined amount. The Intel approved "fix" was to use an AGP video card with dual-head capabilities, for example the Matrox G450. This really shouldn't be an issue as most new PCs are fitted with AGP video cards, but it seems a shame that something like this should slip through the system. Please note that this should only affect earlier boards; newer revisions will have a revised chipset fitted to alleviate the fault.

The final problem relates to anyone wishing to use an existing ISA adapter card: by default the new I/O Controller Hub 2 on P4 motherboards will not support ISA. This could be solved if any motherboard manufacturer included a PCI-to-ISA bridge chip, but at the time of writing I am not aware of any such boards. This shouldn't be a problem in most cases, but some will no doubt find it a nuisance if, for example, an old and out-of-production ISA adapter is required to be installed in a P4 PC.

Worth The Investment?

Is the Pentium 4 a worthwhile investment, especially if deciding between it and the PIII? At the time of writing I would have to say not really. Why? Well, to start with the available clock speeds may look very nice, but don't let that fool you - the amount of MHz that can be squeezed out of a CPU is only relevant when comparing CPUs from the same family. As the P4 belongs to a whole new family (in this case using the new NetBurst micro-architecture) it is unfair and misleading to say that a 1.3 GHz P4 is faster than a similarly-clocked PIII. What many benchmark tests have proved is that, overall, a 1.3 GHz P4 is not that much faster than a 1 GHz PIII, and is in some tests actually slower per clock than the PIII.

Of course, the 1.7 GHz P4 produces much more favourable results, but then you have to look at the issue of value for money. The AMD Athlon in one of its faster guises is a good alternative, as is the new 0.13 micron 1.13 GHz PIII (whose codename during development was Tualatin) which was released mid-April 2001 (and let's hope this one isn't withdrawn as quickly as Intel's earlier attempt at a 1.13 GHz PIII). This new PIII should also become available in a 1.26 GHz form. There is, however, one problem with this new PIII - it won't run in many "older" PIII motherboards due to its lower voltage requirement of 1.2 volts, and a change in the design of the processor bus clock.

Besides the relatively poor benchmark results the P4 is also disappointing when it comes to upgrading existing PCs - when buying a new processor I would expect there to be the possibility of needing to purchase a new motherboard, but having to also buy a new case and PSU is taking things a little too far. Okay, so upgrading

"A new ATX PC case that conforms to the ATX revision 2.03 standard is also needed due to physical support requirements for the large and heavy heat sink and fan."



Figure 2 - Pentium 4, MCH and ICH2.

from an AT motherboard with an older 486 processor to a Pentium III and all the ATX necessities was no mean task either. However, it seems a shame for current ATX PC owners that the aforementioned P4 upgrades are only necessary because the P4 is more power-hungry and has a heat sink and fan so large and heavy that, along with the P4, they cannot be attached to a motherboard unsupported. The required i850 chipset can of course only be obtained by purchasing a new motherboard, but that would be an easier pill to swallow if no other upgrades had to be purchased.

Returning to the question of whether it's worth buying a new P4-based PC, I would recommend waiting until at least the third quarter of 2001 - not only will prices have inevitably come down, but a new P4 now waiting in the wings will hopefully be released by then. This new P4 is codenamed Northwood and will feature new 0.13 micron technology plus a 512 KB L2 cache; release is currently scheduled for Q3 2001, but could of course change. This new P4 is expected to be released at a speed of 2 GHz with the capability to go beyond that and, with the inevitable price cuts, should eventually result in a P4 that is a worthy purchase.

There is, however, one drawback for existing P4 owners who may wish to upgrade - Northwood requires another new socket, the mPGA478. Yes, if you've already upgraded to the "older" P4 then you'll need to buy yet another new motherboard. It also requires a new chipset (codename Brookdale) which will incorporate support for good old SDRAM (and DDR-SDRAM in 2002). All this makes the current 0.18 micron P4 look like nothing other than a stopgap measure.

Conclusion

The thing that really adds to the cost of the P4 is the requirement for RDRAM - and this especially affects those wishing to upgrade who might then have some spare SIMMs on their hands. RDRAM is also more expensive than its SDRAM equivalent, so adding yet more to the cost.

Intel is also laying down some good foundations for the P4 with Northwood, which will eventually be followed by the "Foster" P4 server, supporting multiple processor configurations. To summarise, there is the potential for the P4 to have a better future, it's just a pity that the early incarnations are not as fast and cost-effective as was first hoped.

Web Resources

Intel Pentium 4:
www.intel.com/home/pentium4/tech-info.htm

Tom's Hardware Guide P4 articles and benchmarks:
www4.tomshardware.com/cpu/00q4/001120/index.html
www4.tomshardware.com/cpu/00q4/001122/index.html

The Tech Report benchmarks:
www.tech-report.com/reviews/2001q1/p4-vs-athlon/index4.x

PCSA

Copyright ITP, 2001

New Reviews from [Tech Support Alert](#)

[Anti-Trojan Software Reviews](#)

A detailed review of six of the best anti trojan software programs. Two products were impressive with a clear gap between these and other contenders in their ability to detect and remove dangerous modern trojans.

[Inkjet Printer Cartridge Suppliers](#)

Everyone gets inundated by hundreds of ads for inkjet printer cartridges, all claiming to be the cheapest or best. But which vendor do you believe? Our editors decided to put them to the test by anonymously buying printer cartridges and testing them in our office inkjet printers. Many suppliers disappointed but we came up with several web sites that offer good quality cheap inkjet cartridges with impressive customer service.

[Windows Backup Software](#)

In this review we looked at 18 different backup software products for home or SOHO use. In the end we could only recommend six though only two were good enough to get our "Editor's Choice" award

[The 46 Best Freeware Programs](#)

There are many free utilities that perform as well or better than expensive commercial products. Our Editor Ian Richards picks out his selection of the very best freeware programs and he comes up with some real gems.