Double the fun

Looking to save a few bob on a fast processor? Why not buy two slower chips, says Gordon Laing.

Hands up anyone who wants a faster computer without spending any money? The best way to achieve this free boost of speed is by over-clocking, the process of pushing your components that bit further than was originally intended.

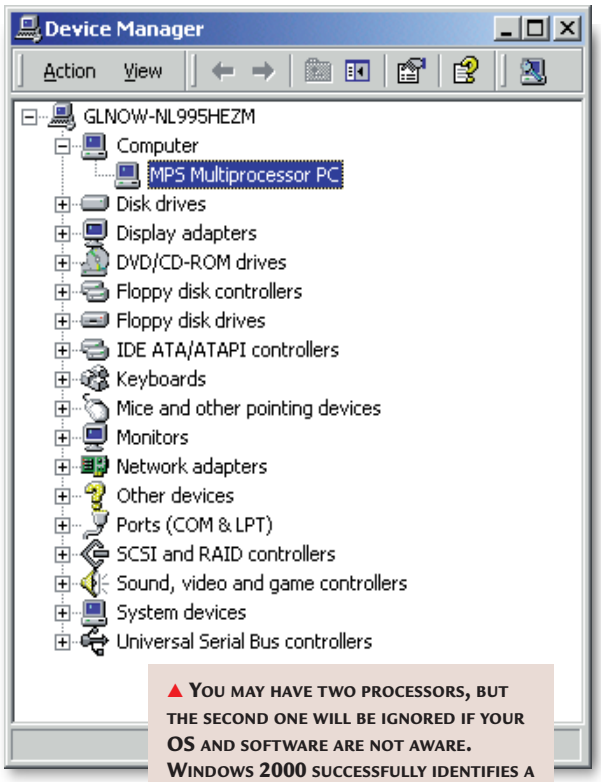
Every batch of PC processors is tested at a top speed. Those that pass are branded high-grade and are sold with a price tag to match, while those that fail in any way are tested at steadily slower speeds until they unconditionally pass and are labelled and sold accordingly. They were, however, all born from the same batch, and in theory the slower ones may be persuaded to run at the top speed after all.

In practice things can go wrong. An over-clocked system may not start at all or it could appear to work then randomly crash. Worse still, it could overheat the chip's insides to a point where it'll never work again. Scary stuff indeed, which is why most people leave over-clocking to enthusiasts armed with courage and a nifty line in cooling fans.

However, if you want to give it a try, the best place to head is to the Internet and its many PC hardware websites. Particular favourites include Anandtech, Tom's Hardware, BX Boards, Thresh's Firing Squad and Sharky Extreme. (*See the contacts box at the end for more details.*)

Celerons

Intel's budget Celeron processors have always proved popular with over-clockers. Their 128KB Level 2 cache may only be one quarter that of Pentium II and III chips, but unlike these premium products, the Celeron's L2 cache is on-die. This means it runs at the processor's core speed and, more crucially for over-clockers, was always designed to keep up with the speed of the main CPU itself. Also, the Celeron's much lower price tag makes it a more palatable experimental product – it's easier to stomach frying a £50 chip compared to inflicting possible damage on its £500 cousin.



▲ YOU MAY HAVE TWO PROCESSORS, BUT THE SECOND ONE WILL BE IGNORED IF YOUR OS AND SOFTWARE ARE NOT AWARE. WINDOWS 2000 SUCCESSFULLY IDENTIFIES A MULTI-PROCESSOR SYSTEM, MPS

Intel, however, has attempted to prevent over-clocking by locking the external multiplier on modern chips. The CPU's speed is derived by multiplying the external multiplier by the speed of the front-side bus (FSB). Most early Celerons work under an FSB of 66MHz, while PIIs above 350MHz and all PIIIs boast an FSB of 100MHz. Therefore, both the 366MHz Celeron and the 550MHz PIII share an external multiplier of 5.5 times, and this number cannot be changed.

Intel's Celeron processors have always proved popular with over-clockers

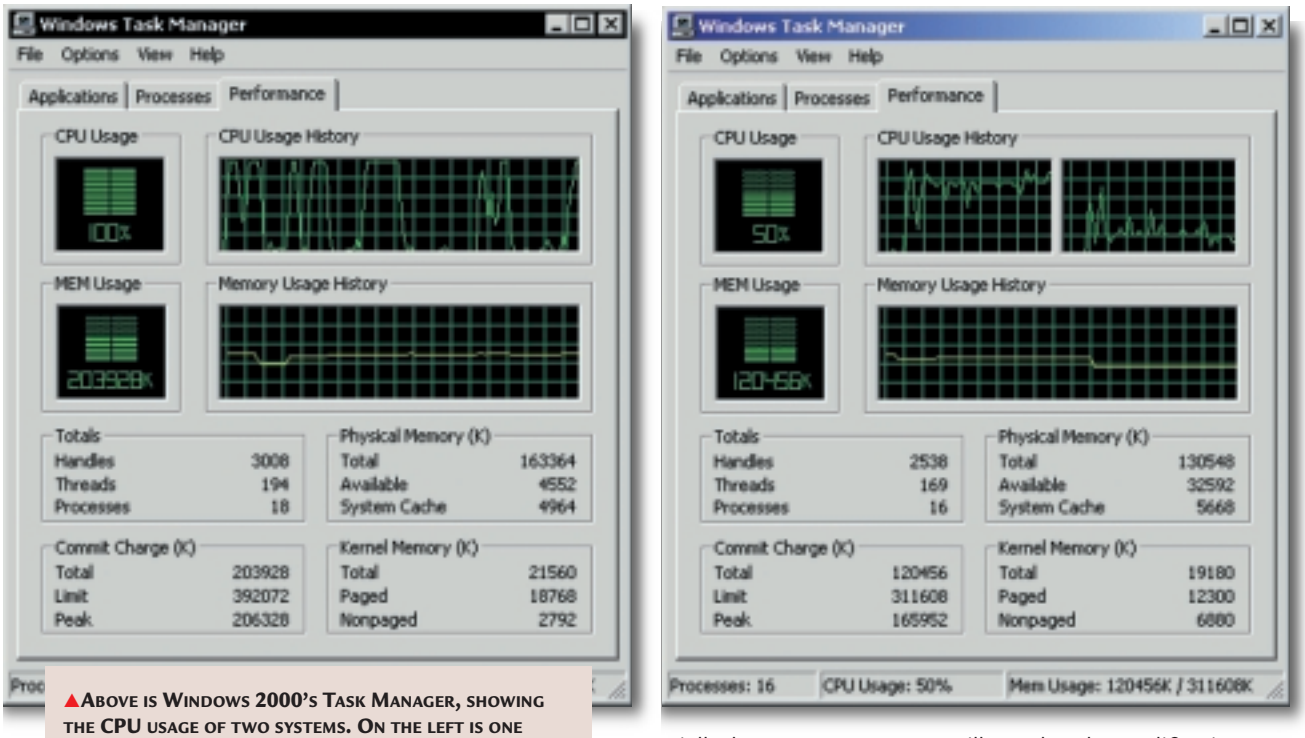
Most motherboards, however, allow you to change the FSB speed. Intel may want you to run its bargain-basement 366 Celeron with a 66MHz FSB, but what happens if you raise the FSB to 100MHz? The 5.5-times external multiplier will now force the processor to run at 550MHz, and in theory it might get away with it. Remember Intel uses the same 0.25 micron process to manufacture most of its current Celerons and Pentiums, and the good yields can handle speeds up to around 600MHz.

Now consider the 500MHz Celeron – designed for a 66MHz FSB, its CPU multiplier is a huge 7.5 times. Upping the FSB to 100MHz would result in an attempt to drive the chip at 750MHz, which is way too high for the 0.25 micron process. This is why the Celeron 366 is such a good bet for overclockers. Its 5.5 times multiplier will keep it in the realms of reliability at a variety of FSB settings, and it's also very cheap, at around £45 per chip.

Speeding buses

Intel recommends running the PCI and AGP buses no faster than 33 and 66MHz respectively. These are calculated as a fraction of the FSB, so at an FSB of 66MHz, the PCI bus is 1/2 and the AGP is 1/1, while an FSB of 100MHz should run the PCI at 1/3 and the AGP at 2/3. Over-clockers should watch out when slowly increasing their FSB from 66 to 100MHz to see how much their CPU can be pushed, as their system could fail due to the PCI or AGP buses being over-run.

Don't push your memory too far either. Most motherboards drive conventional SDRAM memory at the speed of the FSB. While new memory modules are rated at 100MHz, many older ones can only reliably be driven at 66MHz. If you're thinking of pushing the FSB above 100MHz, you should consider investing in PC133 memory, which will operate reliably up to 133MHz.



▲ABOVE IS WINDOWS 2000'S TASK MANAGER, SHOWING THE CPU USAGE OF TWO SYSTEMS. ON THE LEFT IS ONE BASED ON A SINGLE 550MHZ PENTIUM III, AND ON THE RIGHT IS ONE BASED ON A PAIR OF 366MHZ CELERONS. DURING AN ADOBE PHOTOSHOP SESSION, THE SINGLE PROCESSOR IS REGULARLY MAXED OUT AT 100 PER CENT WHILE CALCULATING FILTERS AND MODE CHANGES. THE SAME TASKS ARE SHARED BETWEEN CPUS ON THE DUAL-PROCESSOR SYSTEM, WHERE OVERALL PERFORMANCE IS OFTEN LIMITED BY THE SPEED AT WHICH THE HARD DISK CAN SUPPLY DATA

Seeing double

What really caught my eye on the hardware websites recently was the concept of building a dual-processor system. The idea of running two processors is to speed up heavy calculations such as rendering graphics. However, you will need both an operating system and applications which recognise dual-processing hardware. On the OS front, that means Windows NT/2000, BeOS, and various flavours of Unix – sadly Windows 95/98 will not recognise more than one chip. As far as applications are concerned, the heavyweight rendering packages such as Lightwave are multiple-processor aware, as are recent versions of Adobe Photoshop, the SETI@home screensaver, and even recent builds of Quake Arena.

You'll need a pair of identical chips. Intel says you can only build multiple processor systems using its premium Slot 1 Pentium II, III and Xeon CPUs, and states that the Celeron will only operate in a single-processor configuration. However, because the Celeron shares essentially the same core as these more expensive chips, many tweakers try it out in multiple-processor configurations.

The original Slot 1 Celerons required a bit of tricky modification with drill bits and solder, but the enthusiasts kick-started the practise – the accepted expert in this field is Tomohiro Kawada of Kikumaru Technical Laboratory, and his site explains what's entailed. However, the introduction of PPGA Celerons put a spanner in the works, as existing dual motherboards only featured processor slots and not sockets. The enthusiasts struck back again, however, with so-called Slocket adaptors costing around £30, which allowed Socket 370 PPGA Celerons to be mounted and popped into conventional Slot 1 motherboards. Better still was that the modification, which previously meant taking a drill to the Slot 1 Celeron, was now safer to perform on the cheap Slocket adaptors – some are even sold pre-modified.

The most exciting development, however, came earlier this year from Taiwanese motherboard manufacturer Abit. Its BP6 motherboard was the first, and still the only which features a pair of Socket 370s. Since Intel is still being cagey about the specification of future socketed Pentium IIIs, Abit's board was clearly designed with only one thing in mind: dual Celerons. Excited by the prospect of over-clocking a dual-Celeron system, I described the theory in November's *Inside Information* column. The response from *PCW* readers was amazing, so I decided to give it a go.

The system

I ordered the parts online from Dabs Direct <www.dabs.com>. The base

WARNING AND DISCLAIMER

Over-clocking pushes PC components beyond the range they were designed for. At best you'll lose any guarantee, and at worst you could permanently damage your system. Proceed with caution and remember that over-clocking is done for the fun of seeing how far you can push a PC, and should under no circumstances be used on a mission- or business-critical system.

An over-clocked system is for experimental testing only and we cannot take any responsibility for damage to hardware or data.

components were an Abit BP6 motherboard for £80, two 366MHz Socket 370 PPGA Intel Celerons at £47 each, and a 128MB stick of 133MHz SDRAM costing £165. The BP6 board supports UDMA-66 hard disks, so I fitted a single 13.6GB Quantum Fireball Plus KX for £86 – despite the fact the benefit of UDMA-66 only really comes in when multiple drives are firing simultaneously. An unbranded DVD ROM drive, case, power supply and floppy drive later and my system was complete for a total price of £540 – not bad considering a single Intel 600MHz Pentium III processor weighs in at £398 alone.

First things first: I fitted the parts together, and before even tweaking anything, the system successfully booted, recognising the presence of two 366MHz Celerons. Strangely it didn't like my old AT keyboard with PS/2 adaptor though. After fitting a modern PS/2 keyboard, I installed Release Candidate 1 of Windows 2000 (Build 2072), and it too recognised the Multi-Processor System, MPS. I could now quite happily use this system, safe in the knowledge none of the components was being unduly stressed.

Of course I wanted more. The Abit BP6 boasts one of the most comprehensive ranges of user BIOS settings, particularly within its Soft CPU section. Here you can manually set the external multiplier from two to eight times in half-times increments, alter the voltage supply to each CPU independently, and choose from a selection of FSBs from 66 to 133MHz, often in increments as low as 1MHz – great for cautious over-clockers.

The BIOS may allow manual settings of external multiplier, but the Intel processors will ignore it, and sometimes play up if you set it at anything different from what the chip's expecting – so for my 366s, 5.5 times it was. I then tried starting the system with steadily increasing FSBs, but it wasn't happy. I suspect this is due to the PCI and AGP bus running at non-standard speeds.

At an FSB of 100MHz, however, I could set the PCI bus to 1/3 and AGP to 2/3, thereby playing by Intel's rules. The system booted and indicated two Celeron processors at 550MHz each. Windows 2000 shot into life, but promptly hung the instant I tried to start an application. Back to the BIOS and I fed each chip an additional 0.05 Volts. Windows booted again, but failed a few seconds into a Word session. Back again to the BIOS and a further 0.05 Volts each. Now I was in business. The system operated absolutely fine, as did every application.

At this point, my Celerons were being fed 2.1 Volts each, a whole five per cent more than they were designed for. The result is an overheated chip with a reduced life expectancy. If you're going to run a system like this, you'll need to look into more substantial cooling fans and heatsinks than Intel supplies.

Results

I compared the dual system to my standard home-made desktop PC which employs a single Pentium III running at 550MHz. Keeping an eye on the performance graphs of Windows 2000 and NT's Task Manager (right click the task bar) revealed how the operating system used its processing resources.

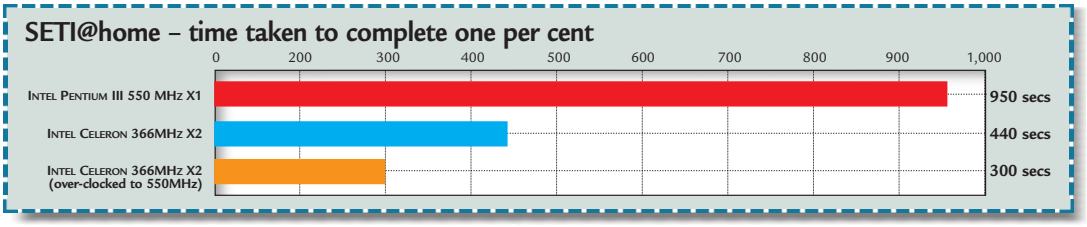
On the single PIII system, most tasks shot the processor usage up to 100 per cent, but this quickly dropped back down again. Heavy calculations like Photoshop filters and Acrobat redraws maxed the CPU out at 100 per cent until the process had finished – here the chip was the limiting factor in performance.

Swapping to the dual-Celeron system revealed that few applications used the second CPU at all, including Acrobat where again the first CPU maxed out at 100 per cent while the second idled. Photoshop was a different kettle of fish entirely, using both processors constantly, even during basic painting. Interestingly the processor hit dropped as soon as the disk was accessed on either system, and tests with slow drives significantly reduced the flow of data, which in turn became the limiting factor in overall performance. If you want to make the most of any chip, whether single or dual, you'd better make sure the rest of your system can quickly supply a constant flow of data to be worked on.

In general use, there was a significant difference between the dual system at its intended 366MHz and over-clocked at 550MHz. At 366MHz, the dual system felt substantially slower than the single 550MHz PIII unless it was running a dual-CPU-aware application. However, when over-clocked to 550MHz, the dual system leapt into life, with its full-speed L2 cache making all the difference in everyday tasks. The PIII did claw some ground back when running code optimised for its Internet Streaming Extensions, such as Photoshop's lighting filters, but it had met its match with the over-clocked Celerons.

The SETI@home screensaver proved particularly revealing, maxing out all available CPU resources at 100 per cent. The same work unit was fed to both systems and timed to complete one per cent. The 550MHz PIII completed it in just under 16 minutes, while the dual Celerons at 366MHz did the same task in just under 7.5 minutes. Most impressive of all was over-clocking the Celerons to 550MHz each, with a result of just five minutes – over three times faster than the single 550MHz PIII, which costs three times as much as two 366MHz Celerons.

It's still early days with the dual system, and while its price and performance are excellent, there is still the possibility that it could die in a matter of weeks, days or even hours.



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