Understanding CPU Upgrades

In theory, one way to increase the performance of a PC with little effort is to upgrade the CPU. Surely it can't be that difficult? Actually there's lots to think about.

By Phil Morris
Technical Writer

It seems that every time a new software product is released the system requirements are increased - everything from the hard drive capacity and CPU speed to the required RAM. One of the apparently obvious ways to gain a speed increase is by upgrading the CPU. But such an upgrade isn't always cost effective and in some cases simply increasing the available RAM can help considerably to boost the apparent speed of the PC. Sometimes though the best (and maybe only) option is to upgrade the CPU, although this can be a more involved process than it might at first seem due to socket / motherboard incompatibilities, differing CPU and RAM speed requirements, cooling problems and inevitably assorted knock-on effects causing the upgrade to be anything but cost effective. Also, it is worth remembering that just because the replacement CPU has, for example, double the clock rate of the old unit doesn't necessarily mean that the new one will increase the processing performance of the PC in question by anything like 100%.

This article looks at some of the options for upgrading the CPUs in existing systems. It is extremely unlikely that recent processors like AMD's Duron (and forthcoming Hammer) and Intel's Pentium 4 and Itanium will require upgrading for some time, so I will omit those in the context of this article. Also, this article isn't intended as a step-by-step CPU upgrade guide - its main intention is to document the main features of a possible upgrade which will influence the purchase of any new hardware.

CPU Upgrade Options

There are many types of CPU upgrade: a straightforward CPU replacement, ie, remove the old and replace with a new CPU; daughtercard upgrades, which involve replacing the existing CPU with a new one on a card with the requisite pins to fit the appropriate motherboard socket; piggyback upgrades, where the replacement CPU is fitted on top of the old one; and the "CPU on a card" option, a processor on an expansion card that plugs into a PCI or ISA motherboard socket - such cards are in many respects miniature motherboards as they also make provision for RAM, chipset and newer, faster bus technologies.

The straight CPU for CPU replacement is usually the most popular option, and the simplest to carry out. It should though not be forgotten that there is a less-used additional option that is applicable to older motherboards with fixed (therefore soldered on) CPUs, and that is to utilise the Overdrive socket. As for actually removing the old CPU and inserting a new one, many motherboards today provide ZIF (Zero Insertion Force) or LIF (Low Insertion Force) CPU sockets, so making replacement a relatively simple process. This is not always the case with some machines produced by some of the larger PC manufacturers as they often have proprietary hardware, so upgrading can be made rather difficult and not at all cost-effective.

Processor Identification

Your first task is to identify the current processor in the machine that you wish to upgrade. To many who are proficient in PC support this isn't a particularly difficult task but it is one that can be made a little easier by use of diagnostic software. Normally the processor can be identified after the POST but this only gives very rudimentary details. Delving inside the PC to examine the processor itself can be time consuming and maybe even fiddly, but this will usually only tell you the make,

model and speed of CPU anyway. Delving into the BIOS and examining the settings often bears the most fruit in terms of useful information such as the currently set multiplier, Bus Speed, Core Voltage, frequency etc. Some motherboards (usually the older ones) will have this information set via Jumpers and DIP switches, so the manual will need to be found before the settings can be interpreted.

To make life simpler, various CPU diagnostic programs can be found on the Web, often for free. A good one to start with is WCPUID. Also, SiSoft Sandra incorporates useful CPU info alongside all its other bells and whistles. PowerLeap (producer of specific CPU Upgrades - see below) also has a utility called CPU Control Panel, while a German company (Dr. Hardware) produces a similarly useful product. See the Web Resources section below for details of these and more.

CPU Fans

When replacing a CPU, some consideration should also go towards suitable cooling for the new chip. Today's chips run faster and consequently hotter than their older counterparts, so they will rarely be able to use the older CPU's heat-sink and fan combination (some 486-based PCs might even just use a heat-sink and no fan at all). A suitable case fan should also be considered depending on the replacement CPU - if the case is relatively small (compared to the average mini tower) then a new, fast CPU with large heat-sink and fan will quickly warm up the inside a the case that doesn't have adequate cooling and ventilation. If the case doesn't have any provision for installing a case fan then some DIY will need to be carried out or a new case purchased. Sudden unexpected system crashes, especially in warm weather, are a common sign that the processor is overheating.

Motherboards

If a straight CPU replacement is the preferred upgrade option then consideration should be given to the existing motherboard, voltages available, supported FSB speeds, overall supported clock rates and its support chipset. On older motherboards the provided CPU voltages will normally be adjusted via jumpers, but newer boards will normally use data accessible via the CMOS setup menu (Softmenu II or III for example). The required chipset will vary from CPU to CPU, so it is worth consulting the manual or a suitable Web site to determine whether the new CPU will work in the existing board. The same applies to the FSB and CPU clock rates. If the only desired replacement CPU is incompatible with the existing motherboard then a new board should be considered, but bear in mind that this might have some knock-on consequences such as the possible need for a new case, PSU, memory if the old RAM (for example, 30-pin SIMMs) isn't provided for on the new 72-pin SIMM-only motherboard, and even expansion cards. The latter could need replacement if for example they are older ISA-based cards and the new motherboard has little or no provision for ISA slots. The costs could then start to mount noticeably, and it is at this point that it is worth considering whether the upgrade is cost-effective and if the old PC shouldn't simply be replaced.

"If a straight CPU replacement is the preferred upgrade option then consideration should be given to the existing motherboard, voltages available, supported FSB speeds, overall supported clock rates and its support chipset."

Slots And Sockets

Because there have been so many processor types released over the past few years, most with different numbers of pins, varying sizes, numerous support chipsets, differing power requirements etc there are quite a number of sockets and slots in the millions of PCs installed the world over. To make things even more complex, the two main desktop processor manufacturers (Intel and AMD) naturally use different methods by which to connect their CPUs to the motherboard.

It's worth knowing about some of the most common sockets: first there was the 80486 socket which accepted the 168-pin square 80486 Intel CPUs; socket 4 was designed for the early Pentium 60 and 66 CPUs; next is the Socket 5 which accepted 296 or 320 pin Pentium CPUs (up to 133 MHz); then we have Socket 7 which is designed to accommodate all the Pentiums (except the Pentium II) and AMD's K6-2. Socket 7 is in fact one of the more versatile upgrade sockets as various AMD processors (such as the K6) can give a good and relatively cheap performance boost without having to replace any other hardware. Super Socket 7 was AMD's enhanced version of Socket 7 which was designed for their newer processors of the time. Socket 8 is designed purely to accommodate the Pentium Pro.

Intel then changed the rules and introduced a new type of processor interface using a slot instead of a socket and, unsurprisingly, called it Slot 1 - this was designed for Pentium II, III and the earlier Celerons. Later Celerons then took a backwards step by going back to using a socket, in this case Socket 370 supporting the 370-pin Celeron CPUs. The newer AMD Athlons were catered for with the Slot A design, a slot that in appearance is identical to Intel's Slot 1 but electrically it is somewhat different. It's worth noting here that it is not possible to use newer AMD processors on motherboards designed for Intel processors.

Also worth a brief mention is the larger, 330pin Slot 2 connector that is designed for processors like the Pentium II Xeon which is aimed at high-end multi-processor workstations and servers. Let's also not completely forget the Cyrix range of processors (Cyrix was purchased by VIA in 2000) which was once used in a number of PCs and is now enjoying a new lease of life with the VIA Cyrix III. You will undoubtedly come across the older Cyrix CPUs in quite a few old (and maybe not so old) machines.

BIOS Updates

Before upgrading a CPU on a potentially suitable motherboard it is worth verifying whether the motherboard requires a BIOS update - such an update is often required in order for the motherboard to recognise the new CPU. The Web Resources section below contains a link to a useful site that provides links to many motherboard manufacturers' sites.

Laptops And Notebooks

The older laptop is a piece of hardware that is notoriously hard to upgrade if you want to do much more than add more memory. Some make it easy to swap out the hard drive, but beyond that very little can be easily carried out. CPU upgrades are certainly out of the question for older laptops unless you have the relevant surface mount soldering skills and tools or feel like replacing the whole motherboard - an option that would probably not be cost effective. Even if that hurdle was overcome then heat dissipation could be a major issue. Some newer laptops are a little more CPU-upgrade friendly, but they are the exception rather than the rule.

Modern notebooks are somewhat easier to upgrade due to the provision of various replacement CPU solutions such as Mobile Module-1 and Mobile Module-2, Mini-Cartridge, BGA-1 and BGA-2 and Micro-PGA1 with its newer sibling Micro-PGA2.

"There will be times when you wish to replace an older CPU with one that won't physically fit into the existing motherboard's slot or socket."

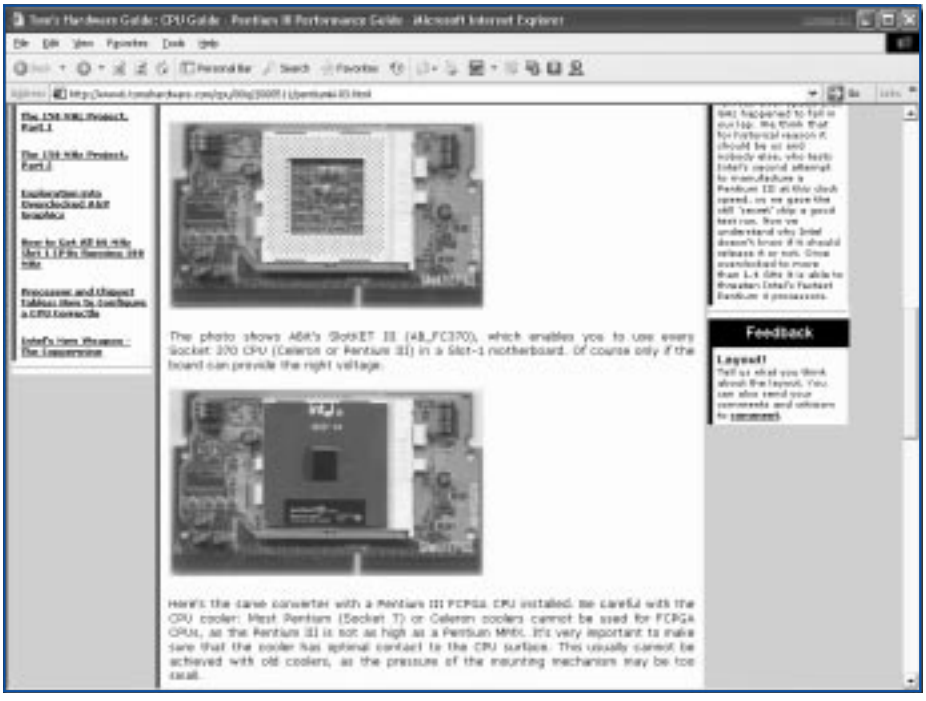

Figure 1 - The Abit Slotket III.

For a general guide on Mobile CPU upgrades, Tom's Hardware has produced a guide along with a Mobile CPU Matrix (although this dates back to November 2000). A link is provided in the Web Resources section below.

Socket Adapters

There will be times when you wish to replace an older CPU with one that won't physically fit into the existing motherboard's slot or socket. Often this is for a good reason (it may not be supported by the motherboard's chipset and general design for one example) but there will be times when it is possible to do so with a suitable adapter. Various manufacturers produce adapters that will allow CPUs designed for Socket370 to be plugged into a motherboard with a Slot 1 connection. One example is the SlotKet III from Abit (see Figure 1) which enables a PPGA or FC-PGA 370-packaged processor (such as a PPGA Celeron, designed for Socket 370) to be fitted onto a motherboard with a Slot 1 connector. Similar adapters are produced by manufacturers such as IWill and MSI.

PowerLeap also produces a range of adapters to allow certain processors to fit into sockets not designed for them. For example, there is the PowerLeap Neo S370 which accepts a Pentium III "Coppermine" CPU and enables it to be plugged into a motherboard with a Socket 370 designed for a Celeron. Among its other adapters, the company also produces one for upgrading 486-based PCs to the AMD AM486DX5-133 CPU (which is in fact part of the adapter).

Specific Processor Upgrades

Because of such things as voltage incompatibilities between older motherboards and newer CPUs, some manufacturers produce special processor upgrades which invariably consist of the CPU, heatsink and small daughterboard with the necessary voltage regulation circuitry. Some examples of these are upgrades from the aforementioned PowerLeap, but other companies like Evergreen Technologies produce a good range of specific CPU upgrade products. Kingston used to also have a range of CPU upgrade products, but has now left that particular market area. Intel has in the past produced a number of Overdrive processors but the only one that now seems to be produced is the Pentium II Overdrive, designed to upgrade certain Pentium Pro systems. Some very cheap Cyrix CPU upgrades can also still be found, such as the 333 MHz MII.

Alternatives To CPU Upgrades

Depending on the PC, type of motherboard and make/model of CPU it might be possible to boost the CPU speed by a fair percentage by overclocking it. Various guides to CPU overclocking can be found on the Web (overclockers.com is a good place to start), but one of the most overclockable ranges of processors has to be Intel's Celeron range. The Celeron 300A can usually be made to go up to at least 450 MHz, while the Celeron II 600 will usually quite happily manage 900 MHz.

AMD's processors, especially Athlon and Duron, are also very good at running at higher clock rates than were originally intended and many buyers now choose these in preference to Intel if buying specifically to overclock them. Always remember that the purchase of a new CPU heat-sink and fan will probably be called for if overclocking - additional case cooling might also be required.

Increasing the CPU speed can of course result in a fried CPU, so do some reading if you haven't tried it before. Also bear in mind that some components on older motherboards aren't designed to operate so well with the CPU running at a greater speed than was originally intended, such as RAM and even some expansion cards.

Web Resources

Tom's Hardware on Mobile CPUs
www6.tomshardware.com/cpu/00q4/001107/index.html

Overclockers
www.overclockers.com

Abit
www.abit.com.tw

Powerleap
www.powerleap.com

Evergreen Technologies
www.evergreennow.com

Intel Overdrive
www.intel.com/overdrive

Various BIOS Updates
www.motherboards.org/biosup.html

WCPUID
www.tweakfiles.com/processor/wcpuid.html

SiSoft Sandra
www.sisoftware.demon.co.uk/sandra

Dr. Hardware
www.dr-hardware.com/Default.htm

PCSA

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.