Work and play

Roger Gann looks for the first time at plug-and-play. Marketing gush says you plug it in and you're instantly ready to go. But is it that easy in reality? The hardware hardman checks it

I've been wittering on about hardware and upgrading for the past 18 months or so and managing to avoid answering readers' questions in print. But no more! Starting this month, about a third of the column will be devoted to the more interesting or challenging readers' questions. If you have a toughie and need some help, please drop me a line care of *PCW* or email me at hardware.pcw.co.uk. I can't promise to answer all your problems but I'll do my best.

Okay, back to work. This month I'll be looking at the minor miracle of plug-and-play. For the past year and a half I've been largely ignoring this major improvement to PC upgrading, preferring to show you how to install hardware from first principles, but I feel the time has now come to shed some light on the black magic of plug-and-play.

Bus route

Microsoft, Compaq and Intel originally defined the bus-independent plug-and-play (PnP) standard as long as four years ago. The goal of plug-and-play is to turn a PC into a user-friendly device, as easy to use as a domestic appliance. A user can simply attach a new device ("plug it in") and begin working ("play"). For plug-and-play to work properly, it requires support from three areas: the add-on hardware, the operating system and the supporting software such as drivers and BIOS. The BIOS specification was published on 1st November 1993.

When it works properly, two principal benefits should flow from plug-and-play. First, ease of use: an obvious gain really, but plug-and-play makes it easy to install and configure add-on devices with little or no user intervention. After you've plugged the device in, the BIOS and/or operating system will carry out all the graft.

Second, reduced support costs: this may not seem important to the home user but it is still relevant because hopefully you won't need to hang on the phone quite so often when plug-and-play is in full swing. It can also reduce wasted time and frustration. Multimedia vendors find that most of the sound cards returned to them as defective actually work perfectly. It's just that end-users find installing and configuring them far too complicated.

The plug-and-play standard is not operating system specific and will appear in other operating systems in due course, but for the moment Windows 95 is the only operating system that fully supports it. Both Windows NT 4.0 and OS/2 Warp 4.0 currently lack plug-and-play support, but future versions of both operating systems will support it.

A major benefit of plug-and-play in Windows 95 is "event notification of changes to the system state". This neat trick permits dynamic changes in the installed hardware to prompt an automatic reconfiguring of the operating system and its device drivers. For example, if you were to undock a notebook, not only would the operating system realise it was coming off the network and so should unload all the network drivers, but it would also alert any apps that had files open on the server, that those files ought to be saved.

Going live

Plug-and-play is also a "live" feature and, while you can't hot-swap PCI cards, you can do this with PC Cards. Whenever you insert a new PC Card, Windows 95 detects it automatically, and will try to automatically configure it and install any required device drivers. If it doesn't have the correct drivers, it then prompts the user for them. And all the user has done is slide in a PC Card!

How it works

When a new plug-and-play card is installed in a PC with a plug-and-play BIOS and then powered up, the BIOS will detect the new card and set a flag. When Windows 95 boots, it picks up this flag and launches its hardware detection software to identify just what has been installed. Each bus (PCI, ISA, PC Card and so on) is interrogated by its own bus enumerator; they also inspect each card to see whether it's PnP and, if so, what range of hardware resource settings it can accommodate.

Once data has been collected from all the cards, a Windows 95 arbitration algorithm allocates the available IRQs, DMA channels and I/O ports in the most efficient manner. This data is then written to the PnP cards. If a legacy (i.e. non-PnP) card is detected, an attempt will be made to identify the card from the Registry database and its default settings assumed. The PnP cards can then be configured, using the remaining free resources.

If a SCSI bus is detected, a second pass is made once the SCSI chipset has been identified, to enable the SCSI enumerator to interrogate the SCSI to find out what SCSI devices are attached. The same occurs with PCMCIA slots and PC Cards. This process is transparent to the end-user: all they'll see is a Windows 95 dialog saying it's detected new hardware and that it's installing the drivers for it. If the drivers aren't included with Windows 95, the user will be prompted for a floppy disk containing them.

On legacy PCs, the information stored in the centralised Registry is used to notify the

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Question time: Playing with Fireball

Q I recently bought a Quantum Fireball 1280Mb HD and connected it to a PCI motherboard with onboard EIDE and AMI WINBIOS. I used "auto detect C" (I did not alter setup to enable LBA) and then started to load DOS which formatted the disk to 503Mb, so I re-read your Hands On article on hard disks which mentioned the DOS limitation. I approached various sources without success, including two computer service/upgrade/repair houses, one of which had supplied the disk. They apparently don't have the problem but both offered to reformat the disk for me. While this would have solved the disk problem, I prefer to understand and do things myself rather than remain ignorant for future occasions. So I re-read the article in more depth and noticed the bit about logical block addressing in modern boards — then found this in my BIOS, "Enabled" it, and tried again, but DOS would only confirm the existing format and re-format to the same 503Mb. Is there a way out of this problem? Incidentally, the article mentions Logical Block Addressing and IDE address translation: are they the same thing?

Bill McGregor

A No, they're not, Bill. Address Translation refers to an IDE drive's chameleon-like ability to adapt to a drive geometry (its cylinders, heads and sectors) different to its native geometry. So long as its capacity isn't overstated, an IDE will be happy with just about any geometry you care to throw at it. Let's say drive X actually has 100 cylinders, two heads and 50 sectors per track (spt) — that's a total of 10,000 sectors (100 x 2 x 50). Address translation allows you to specify a different geometry: e.g. 50 cylinders, four heads and 50spt. This way of describing the layout of the hard disk, often abbreviated to CHS, is unsuitable for dealing with the large IDE drives we see today and so the LBA method is used instead. If your PC's BIOS supported large hard disks then FDISK would be able to see more than 503Mb, so the only conclusion I can draw is that your PC, as it stands, is incapable of directly supporting IDE drives larger than 503Mb. Why should this be? It's down to a clash between the drive geometries supported by the PC's BIOS and IDE. DOS errs on the side of caution and picks the lowest common denominator from each. Check out the table shown below.

So we know the cause of the problem, but what can be done about it? Most hard disk manufacturers have anticipated this problem and supply their larger drives with special device driver software that permits the PC to recognise the entire capacity of the drive. This is a cheap solution which makes it very easy to completely prepare a drive for use. However, the downside is that this solution can cause problems with Windows 95: unless it comes with a 32-bit Windows driver, Win95 may run its file system in 16-bit MSDOS compatibility mode, which is a bit slower than its normal 32-bit disk sub-system. I'm surprised your Quantum didn't come with this software so check back with your supplier.

A better solution is to upgrade your PC's ROM BIOS. For older PCs this is easier said than done. ROMs are large, socketed chips and are relatively easy to swap out. But the cost is prohibitive and getting hold of them is another matter; it can work out cheaper to replace the motherboard with one that has newer ROMs. Your PC may have a BIOS that resides in Flash memory, making it possible to upgrade the BIOS from software for free. I upgraded a Gateway 486 in this manner. Or you can invest in an EIDE interface card: this will come with BIOS on-board, will cost you about £25, and is a direct replacement for the £10 multi I/O cards fitted in most popular PCs. Taking the drive elsewhere and formatting it on another PC may work, but it's not recommended. It is safer from a date point of view if the drive is configured in the PC in which it is going to be used.

	BIOS	IDE	Lowest value
Max cylinders	1,024	65,536	1,024
Max heads	255	16	16
Max sectors per track	63	255	63
Capacity in bytes	8,422,686,720	136,902,082,560	528,482,304
Capacity in megabytes	8,032.5	130,560	504

user of a potential resource conflict when configuring a peripheral. It is used to perform device detection using the known resource information. Suppose the user wanted to install a new, but non-PnP, device on a legacy PC system such as one that requires IRQ 5. But a legacy network card is already installed on the PC and this already uses IRQ 5. In this situation, the system tells the user that a device is already using IRQ 5 and a different IRQ setting should be chosen.

All the pieces that go to make plug-and-play feasible are now in place. All PCs sold these days feature a plug-and-play BIOS. The Pentium is now the entry-level processor and as a result PCI is commonplace. As all PCI cards adhere to the plug-and-play standard, this means machines less than three years old are the ones that will make a perfect match for the new operating system.

PnP isn't a panacea for all hardware configuration ills: it won't resolve duplicated hardware clashes, for example. When I installed an Adaptec plug-and-play SCSI card, PnP didn't draw my attention to the fact that there were two floppy disk controllers in the system. The automated configuration didn't disable the controller on the Adaptec; that had to be done with a DIP switch. Never lose sight of the fact that a PC has only a finite number of free IRQs and DMA channels, and when you've used them all up, all the plug-and-play in the world won't help you.

■ *Next month: Troubleshooting PnP.*

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Sounds easy...

…and it is easier than you think, with the advances that have been made in plug-and-play technology. Roger Gann takes you through fitting a sound card.

It is almost a year and a half since we previously dealt with installing a sound card. A lot has happened since then, so it's high time we returned to the subject.

Back then, I installed the granddaddy of all sound cards, the Mk I SoundBlaster, a mono card with FM synthesis and 11 MIDI voices. This time I've laid my hands on the latest in PC audio hardware, the SoundBlaster AWE64, which represents the state of the sound-card art. It has come a long way from the original card that bore the name. This one offers 64-voice polyphony; 32 controlled in hardware and 32 in software.

Like its predecessor, the AWE32, the AWE64 is backward-compatible with all DOS games and supports the full General MIDI instrument set as well as Creative's SoundFonts. The AWE64 Gold also features gold-plated RCA connectors and an SPDIF digital output, and comes with 4Mb of RAM as standard, although both cards can accommodate up to 28Mb with Creative's SIMM modules.

This latest generation of SoundBlaster also features an all-new synthesis engine using E-mu's multiple-point wavetable interpolation algorithm — the same technology found in its Emulator professional-level product. This technology produces more realistic sounds by interpolating the curve between sample points, rather than connecting them with a straight line (the method used by the AWE32, and the actual standard for most consumer sound cards).

Step by Step — installing a sound card
Installation falls into two distinct phases: fitting the actual card in the PC and then configuring it and its software. Last time, we had the dubious pleasure of configuring the hardware resource settings (IRQs, I/O addresses and DMA channels) by hand. But this time we'll be putting our feet up while plug and play does all the resource allocation donkey work. Most modern sound cards support plug and play and the SoundBlaster AWE64 is no exception. Thanks to this, installing a card should rival falling off logs for simplicity.

Hardware installation
1. Electrical safety is important so take the usual precautions of switching off your PC at the wall socket. Leave it plugged in however as this will provide an earth circuit for the PC. Unplug everything attached to the system unit; typically, the keyboard and screen. All micro-electronics are sensitive to static and the kind of static discharge that gives you a very mild electric shock can be fatal to micro-electronics, so take the precaution of earthing yourself, by, say, touching some metal plumbing, before handling the new sound card. Or better still, invest in an earthing wrist strap.
2. Remove the casing lid by undoing the screws at the back.
3. Take the cover off. It's probably secured by four self-tapping Phillips screws at the rear. Put the screws and cover in a safe place. You can now see the innards of your PC.

At the bottom is the motherboard and this will have as many as eight expansion slots, a mixture of 16-bit ISA and 32-bit PCI slots along its rear edge. Unless you've got a highly integrated motherboard, one or more of these slots will already be filled, by cards such as your graphics accelerator.
4. Choose a free expansion slot. Almost all sound cards are 16-bit ISA devices so your sound card will have to go into one of these slots. If the sound card has an IDE interface for a CD-ROM drive, try to pick a slot close to where the drive is going to go. Sound cards can be susceptible to RF noise generated by other PC hardware and you may have to shuffle your cards around to rid yourself of annoying buzzes or hums. Sometimes it helps to site it as far away as possible from the PC's power supply.
5. Undo the bolt securing the blanking plate at the end of the expansion slot and remove the plate. Hold the card by its top edge and press its connector edge firmly into the expansion slot. This may be a tight fit and you may have to use a modicum of force.
6. Tighten the bolt to stop the card from flapping around. If you have a CD-ROM drive fitted, install the CD audio cable between the drive and the sound card. This will let you play audio CDs through your PC speakers.
7. The AWE64 has a digital output so plug this in to the SPDIF socket on the card and fit the blanking plate that holds the phono output socket in a spare position. Unusually, it comes complete with proper MIDI cables, so hook this to your keyboard.
8. Replace the system unit cover, do up the screws and plug everything back in.
9. Plug in any speakers to the sound card, plus any microphones or line connections. Powered speakers will have a volume control, so make sure this is turned up!
10. Power up the PC and make sure everything is working as it was before (to check that the sound card isn't interfering with anything). If you do have a problem, see the section below on troubleshooting.

Software configuration
If all is well with your PC, the next step is to install the software for your card.
- If you have Win95 your first stop should be the "Add new hardware" wizard in Control Panel. If you have a "full" plug-and-play PC, then Win95 ought to automatically identify the new hardware the next time you boot. In any case, you should let Win95 try to auto-identify your new card.
- When it does, you'll be prompted for the Windows 95 installation disks or the manufacturer's driver disks. You can then check it's correct installation by clicking on the "System" in Control Panel, then on the "Device Manager" tab and selecting the "Sound, video and game controllers" entry on the device tree.
- Finally, click on your sound card and the "Properties" button.
- However, if Windows 95 can't detect it or mis-identifies it, you should then install the Windows 3.1x drivers supplied with the card; Windows 95 comes with a reasonable range of sound card drivers but lacks, for example, drivers for Turtle Beach, Orchid and miro cards. Often, these drivers or more up to date versions can be pulled down from dial-up services such as CIX, CompuServe or AOL, or direct from the manufacturer's web site.
- If you're still running DOS+Windows 3.1x, install the drivers that come with the card. As well as drivers, the AWE64 comes equipped with a raft of audio utility software supplied on a pair of CDs. I had the 8Mb RAM upgrade and this came with yet another CD containing the SoundFont samples, so you should install this software.

The end is nigh... Or is it?
Recent increases in bus bandwidth and processor speed have made host-based audio processing a possibility. The PCI bus, running at 33MHz and supporting burst-mode 32-bit bus mastering, can easily support many channels of digital audio: a 16-bit stereo 44.1KHz channel will consume just 385,437 PCI cycles/second, or just over one percent of the total bandwidth of a 33MHz PCI bus.

The speed of host processors has increased to an extent that many audio-processing tasks, like music synthesis, can be performed easily, even on low-end PCs. The programmer no longer has to use obscure techniques to force general-purpose CPUs to behave like DSPs: MMX and other similar technologies offer DSP-like instructions and the promise of host-based DSP function libraries. Much of the work handled by dedicated hardware on the sound card can now be offloaded onto the CPU and performed in software.

Host-based is best
Ensoniq has implemented such an architecture in developing its host-based AudioPCI sound card. The main advantage of such an approach is that the hard disk and system memory can be used to store wavetable samples. It is these samples that determine the quality of synthesised music.

Host-based audio processing also allows PC users to select from an array of optional post-processing algorithms, such as chorusing, reverberation and stereo enhancement, without dedicating expensive hardware sub-systems to those tasks.

Basic troubleshooting

■ If you don't hear sounds from Windows, there are at least four things to check:
■ Make sure the sound card works in DOS, using diagnostic software supplied with the card.
■ If it doesn't, the problem is probably physical, so check the card is seated properly, that the volume control (if any) is turned up, and that the connections to external speakers are firm.
■ If you can't play music CDs through your system, check that the CD audio cable is fitted.
■ Check the Control Panel to see whether system sounds are available. If you double-click on the Sounds icon and all your choices are greyed-out, reinstall the Windows sound driver. While you're there, make sure the necessary WAV files are in your Windows\Media folder.
■ Did your sound card come with a mixer? There's probably a simple software control that lets you adjust volume, bass, treble, and other output settings. If the volume is set too low here, that explains the silence.
■ A direct memory access (DMA) conflict can cause digital audio to be distorted or not to play at all. It can also cause your system to lock up, spontaneously reboot, or generate parity errors.
■ To change the DMA setting, check the sound card properties in Device Manager, or if you use Windows 3.1x, check the Setup dialog of the Control Panel's Drivers utility.

Troubleshooting in Windows 95

■ During the installation of an expansion card using the Add New Hardware utility, Windows 95 will scan your computer and try to identify the card or peripheral and its resource requirements, then locate an appropriate driver from the Windows 95 database.
■ If it detects a resource conflict, it will notify you and offer to start the Conflict Troubleshooter. This is an interactive Windows Help file that takes you to Device Manager and walks you through the process of identifying and resolving a particular conflict. Even if installation completes with no sign of trouble, you should still confirm that all is well.
■ Open Device Manager and click the plus sign next to a device class icon on the hardware tree. A list of all the relevant components for that type of device will appear.
■ If there is a problem, Device Manager displays one of two warning flag types:
1. The first is a yellow circle with an exclamation point. Just double-click the offending entry, click the Resources tab, and make a note of the information given in the Conflicts box at the bottom of the Properties dialog box.
2. The second warning flag is a red X, which indicates that the device is not working: either the BIOS reports the device as disabled by hardware (a jumper or switch, say) or a user has manually disabled it in Device Manager; it is disabled if the "Current" box at the bottom of the General tab is unchecked.
■ Things are pretty iffy if Windows 95 launches in Safe mode: this means it has detected a problem that prevents it from running properly. Once in Safe mode it is up to you, the user, to go into Device Manager and correct the problem. You can start up in Safe mode by pressing <F5> when the "Starting Windows 95" message appears during the boot-up sequence.

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Da-do, RAM, RAM

In this sequel to upgrading installed RAM, Roger Gann explains the options and gets down to the real nitty-gritty: a step-by-step guide to the practical process of plugging it in.

Welcome to the second part of my piece on upgrading your RAM. A quick recap: in last month's column I discussed the whys and wherefores of upping your installed RAM. I also looked at the differences between 30-pin and 72-pin SIMMs. This month I will complete my overview of RAM technology and show you how to install extra memory.

Choose the right RAM

It is important to choose the right type of RAM when buying your extra memory: essentially, you should buy more of what is already installed on your PC.

How can you tell? Well, not by looking at it, unless you are a rocket scientist. Unfortunately one SIMM looks much like another; peas in a pod, in other words. You have several options. You can check the documentation that came with the PC when you bought it and this should contain the full specification of your personal computer. Sometimes, the BIOS "signs on" at boot time with a panel of hardware information where the type of memory is listed. Or you can remove an existing SIMM and take it with you to the dealer.

DRAM

Dynamic RAM has to be continually "refreshed" so the charges that hold the bits of information do not fade away. The refresh speed is expressed in nano-seconds (ns) and it is this figure that represents the "speed" of the RAM.

Most Pentium-based PCs use 60 or 70ns RAM. The process of refreshing actually interrupts/slows down the accessing of the data but clever cache design minimises this. However, as processor speeds pass the 200MHz mark, no amount of cacheing can compensate for the inherent slowness of DRAM; other, faster memory technologies have largely superseded it.

Fast-page memory is a type of DRAM which allows for repeated memory accesses with minimum waiting for the next instruction. Ordinary DRAM technology is now obsolete and most modern PCs now ship with faster types of memory.

EDO

Extended Data Out RAM is a fairly recent memory technology and provides a speed gain of between five to ten percent in the memory sub-system. EDO RAM provides a wider effective bandwidth by offloading memory pre-charging to separate circuits. As a result it offers a ten percent speed boost over DRAM, while Burst EDO RAM offers another 10-20 percent.

It is cheap to make/buy and its low power consumption makes it attractive to notebook makers. Fast-page memory, by contrast, has to wait between these charging cycles, thus causing delays. EDO has not been around long but despite its popularity it is already being ousted by SDRAM. In order to use EDO RAM, your PC's BIOS and chipset must explicitly support it.

SDRAM

Compared with EDO DRAM, Synchronous DRAM is capable of transmitting data on every clock cycle, conferring a peak system-performance improvement of about ten percent over EDO.

SDRAM is a solution for fast (i.e. <66MHz) motherboard designs: the same clock drives both CPU and RAM. It offers four times the throughput of conventional DRAM and is easier to run at speeds as fast as 80MHz.

Parity and non-parity

Parity checking is a process that enables the system to detect single-bit errors and halt the system. A ninth memory chip is used to hold checksum data on the contents of the other eight chips in that memory bank. If the predicted value of the checksum matches the actual value, then all is well. If it does not, then the contents of memory is corrupted and unreliable. So the PC is halted.

However, today's memory chips are highly reliable and parity checking is no longer required by most systems. Some motherboards allow you to choose between parity and non-parity RAM. Both EDO and SDRAM use non-parity RAM.

It is easy to distinguish between parity and non-parity RAM on 30-pin SIMMs: if they have two chips or eight chips then it is non-parity, while 3- or 9-chip SIMMs have parity. Seventy-two-pin modules are more difficult to categorise but, in general, if they have four, eight, 16 or 32 chips on them, they have no parity.

Error Checking and Correcting (ECC) memory is more sophisticated and more costly. It automatically corrects single-bit errors, which account for most RAM errors, without halting the system. In addition, the system will halt when 2-, 3- or 4-bit errors are detected.

But ECC memory is relatively slow — it requires more overhead than parity memory for storing data and causes around a three percent performance loss in the memory sub-system. ECC memory is only really needed in critical situations like on servers, for instance.

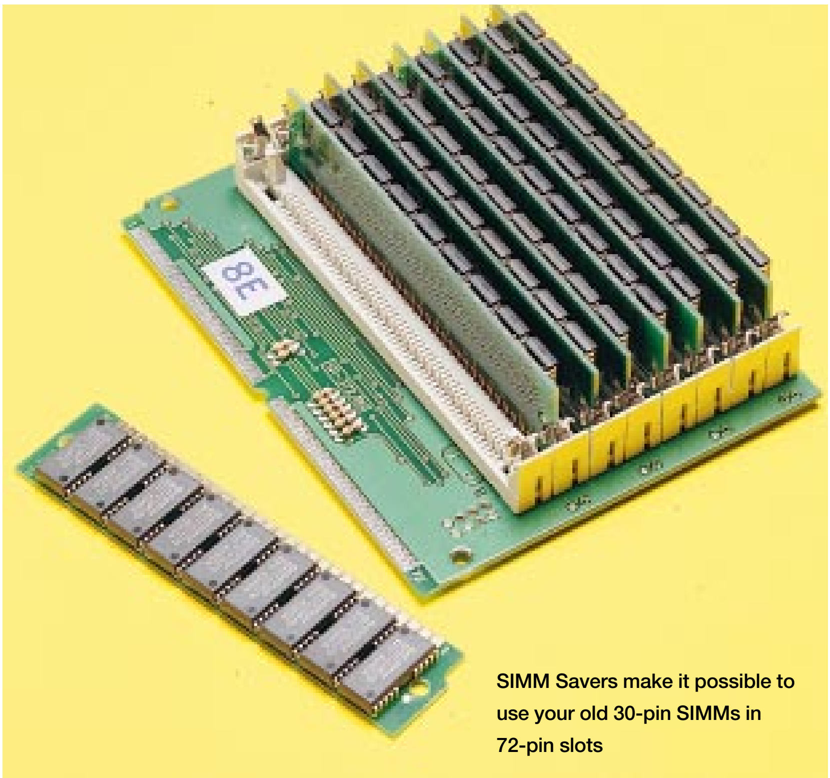
SIMM Savers

The change-over from 30-pin to 72-pin SIMMs has left many people with perfectly good RAM that just cannot be used in a new machine. Consider those with a 486 motherboard with 16Mb of 30-pin SIMM RAM fitted: they upgrade the motherboard, buying a Pentium design, and then find that because the new motherboard has 72-pin SIMM sockets, all their old, expensive yet otherwise perfectly usable RAM is now rendered unusable. They can always sell it off, I suppose, but that would cost them plenty as the second-hand value of SIMM RAM is laughable, thanks to the rapid decline in the price of RAM.

One answer could be the SIMM Saver, a small circuit board with four or more 30-pin SIMM sockets on it which plugs into a single 72-pin SIMM socket. I was dubious about using one at first but have now got an old 486 PC upgraded with a Pentium OverDrive that has a pair of SIMM Savers holding a total of 32Mb of 30-pin RAM, and the system works perfectly.

A couple of points you should bear in mind, though. Firstly, although they've recently fallen in price, RAM prices have fallen more, and at about £20 a four-way SIMM Saver is still a bit dear. Don't forget that if you have a Pentium motherboard, you will need a pair of these devices. You will also need eight 30-pin SIMMs with which to fill them; because of this, SIMM Savers make more economic sense when used with late 486 motherboards which can take single 72-pin SIMMs. In the end, you might think it better to invest in new memory and flog off your redundant SIMMs.

Secondly, SIMM Savers are relatively tall gizmos and you should check your motherboard to make sure you have plenty of clearance above the SIMM sockets. And, if you are going to buy a pair of SIMM Savers, make sure you buy a "handed" pair — that is, one with front-facing sockets and the other with rear-facing sockets.



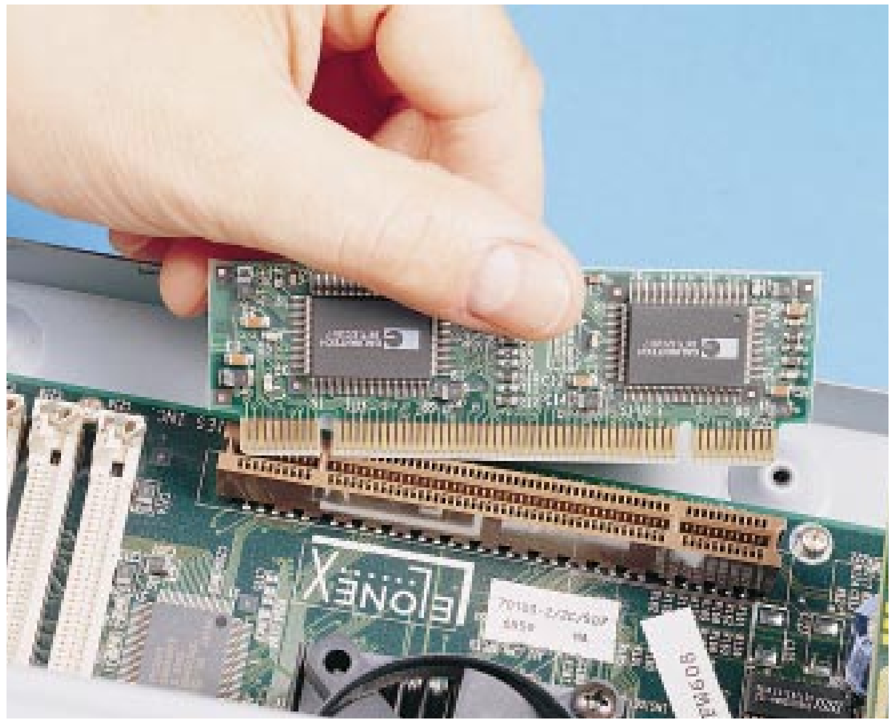
SIMM Savers make it possible to use your old 30-pin SIMMs in 72-pin slots

Cache upgrades

Most modern Pentium motherboards ship with 256Kb of Level 2 "pipeline burst mode" cache on the motherboard. This special type of memory is used to cache memory accesses by the CPU, which would otherwise be delayed by the relatively slow response times of DRAM memory.

Typically this cache is supplied on a COAST (cache on a stick) module, which resembles a SIMM but is a little shorter. This plugs into a COAST socket, which is normally located close to the processor and looks a bit like a PCI expansion slot.

Installing a bigger cache module is as simple as plugging in an expansion card. A bigger cache will improve performance and a 512Kb cache module costs about £60, which makes it a relatively dear form of memory. Note that while the upgrade is not particularly expensive *per se* and is easy to perform, the overall performance gain will be modest; probably less than five percent.



In between RAM and the CPU is the cache. This "cache on a stick" (COAST) module fits into a slot close to the CPU

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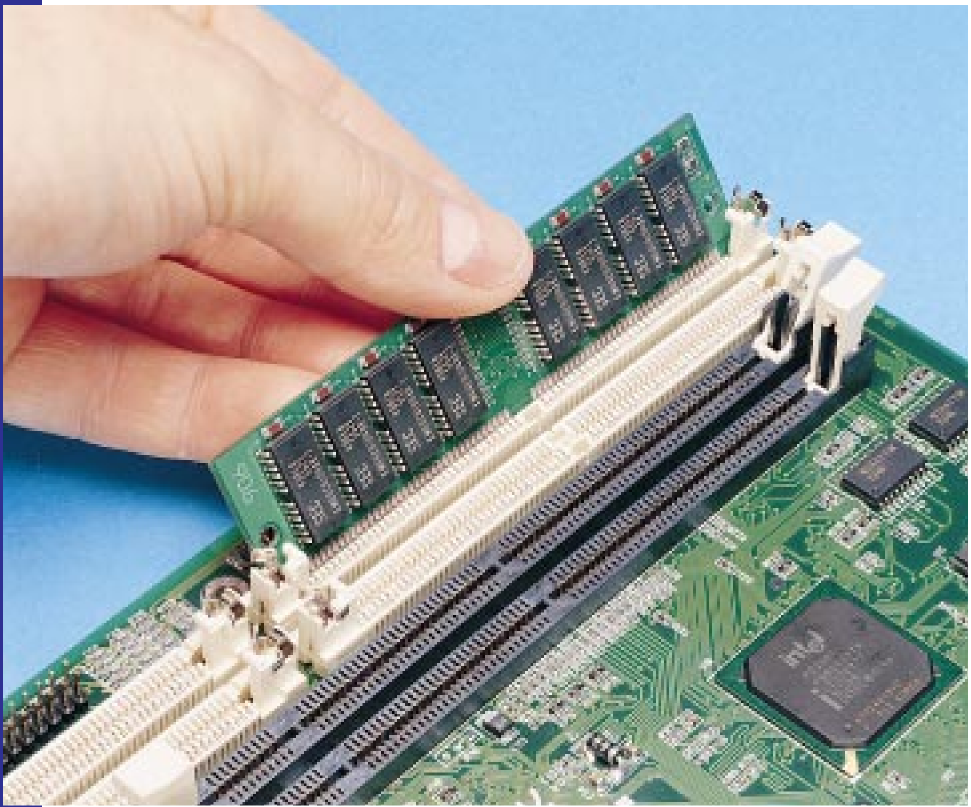

SIMMs will only fit in one way. Make sure the tabs click firmly into place at each end

Step-by-step SIMMs

Before you install your new SIMMs, take a few elementary precautions. Like all other micro-electronics, SIMMs are sensitive to electrostatic charges so before handling them you should ground yourself and discharge any static charges you have built up. You can do this by turning off the power to your PC at the mains socket, leaving the lead plugged in and touching an unpainted metal part on the case of the computer.

If you are feeling ultra-cautious you might even want to purchase an anti-static wristband when you buy your SIMMs.

Be very careful when you handle your SIMMs. Avoid touching the silicon or the contacts along the edge, and do not bend a SIMM or try to force it into a socket.

1. Power down and unplug the PC from the mains and disconnect all other leads. Remove the lid from the PC. Four or five self-tapping screws will be holding it on and you will most likely need a Phillips screwdriver to undo them. Keep them in a safe place.

2. Next, locate the SIMM sockets. If you have any problem identifying them, consult your system manual. Some may be easy to get at but others will be awkwardly located: adjacent to the power supply or under a nest of cables, for example. If necessary, temporarily remove expansion cards and unplug any cables in order to improve access to the SIMM sockets.

3. Now it is time to plug in the first SIMM. You should note that owing to the way you insert SIMMs there is a certain order to the way you put them in. Typically, if you put the rearmost one in first, you will not be able to install the one in front of it, so you must begin with the socket at the front of the bank and work backwards.

Next, work out which way round the SIMM fits. It is “handed” — one edge has a cut-out shoulder which prevents you from fitting the SIMM back to front: the correct orientation will look and feel right; the wrong one will not. If you get confused check out the SIMMs already installed, to use as a reference point.

4. The typical SIMM socket requires you to insert the SIMM at a shallow angle and then rotate it upright to lock it into place.

A small spring-loaded tab will click into the holes at each end of the SIMM. This holds the electrical contacts firmly together, ensuring reliable performance. It is important that these spring-loaded tabs lock into place.

5. Repeat as necessary. On a modern Pentium machine you will probably only have to insert one more SIMM.

6. To insert a DIMM module, flip back the catches at each end of the DIMM slot and slide in the DIMM, vertically. A DIMM module is symmetrical (that is, not “handed”) and so it can go in “either way” around. Gradually lift up the catches until they click into place — they will gradually push the DIMM down into the slot as you do this.

7. Reassemble the PC, replace the cover and power up. If the installation was successful, the memory count that is displayed as your PC boots up will show the total amount of memory installed. If not, you may get an error message or a blank screen. If you do, go back and re-seat the SIMMs — that is, remove and reinstall them. Or, try putting them into different slots. If this doesn’t work, take them back to your dealer and get them replaced.

Most modern BIOSes will accept the additional memory without further ado but some older versions will beep at this point and automatically enter CMOS Setup. If this happens, there is no need to enter or change any values; simply save the current settings and reboot.

Future RAM technologies

On the horizon are two competing RAM technologies: Rambus DRAM (RDRAM) and Multibank RAM.

RDRAM is a totally new RAM architecture, complete with bus mastering (the Rambus Channel Master) and a new pathway (the Rambus Channel) between memory devices (the Rambus Channel Slaves). A single Rambus Channel has the potential to reach 500Mb/sec in burst mode; a 20-fold increase over DRAM.

Unlike traditional DRAM, Multibank organises its internal 256Kb banks off a narrow central bus which allows access to each bank, individually. This design can complete a burst to, or from, one bank and then begin a burst to, or from, another — all in a single clock cycle. Multibank RAM has already appeared on some graphics accelerators.

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Slam in the **RAM**

Would you like to run bigger programs? Run more of them? Increase your system's power? It's not difficult. Roger Gann explains what you can do with RAM, SIMMs, DIMMs and pins.

There's an old computer industry adage which goes: "You can never be too rich, too slim or have too much installed memory." Well, actually I just made that up. But the gist of it is undeniably true. Like death and taxes, insufficient computer memory is a perennial problem, and the way things are going it looks set to become chronic.

Maybe the forthcoming Network PC and Java revolution might result in lower levels of memory being needed, but for the time being the popularity of vast, monolithic applications and operating systems, typified by Windows 95 and Office 97, make it almost inevitable that sooner or later you will be forced to add more RAM to your system. Users have grown accustomed to the luxury of running multiple apps with in-place OLE editing plus rich multimedia content, and you can't do this on a PC with 8Mb of RAM — not unless you enjoy watching paint dry.

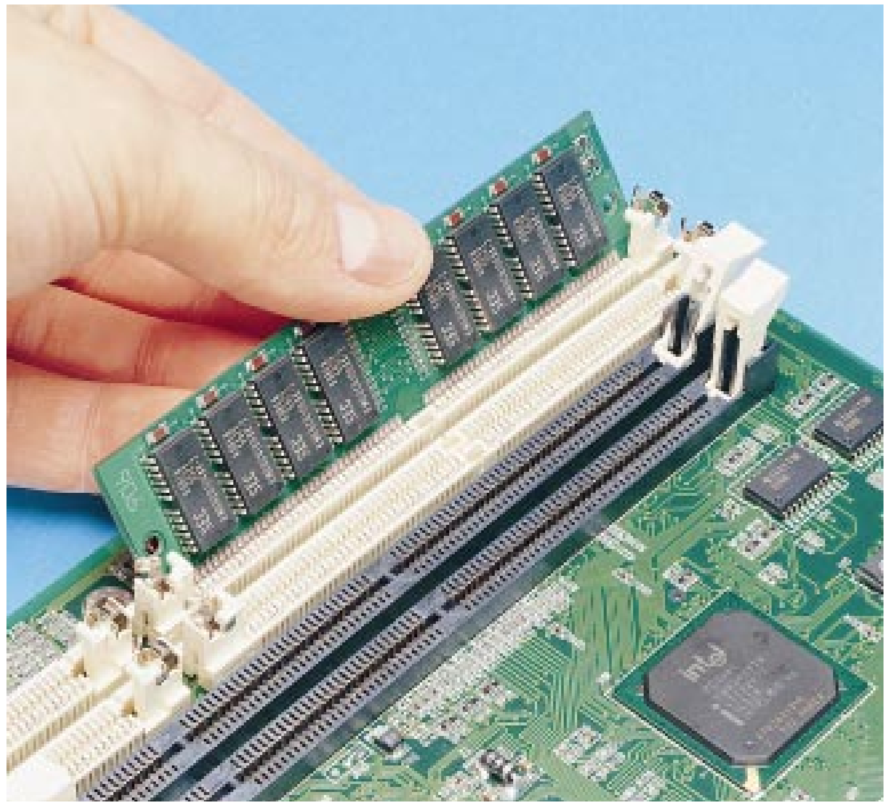
So, this and next month's column will be devoted to memory upgrades. This month's instalment covers the reasons for upgrading RAM and takes a first look at selecting the right sort of memory for your PC. Next month's column will complete this and go through, step by step, the task of actually adding the RAM.

RAM defined

Random access memory, RAM for short, constitutes your computer's work space. When you launch an application or open a file from your hard disk, the files and data are read from the disk and copied to RAM. Because the data is held as a series of small electrical charges, these can be rapidly accessed by the CPU so it can do its job without having to pause while the data it requires is delivered to it. What's more, because the data is stored as an array of electrical charges, it can be accessed randomly (as opposed to serially) and the CPU can locate, change or erase any single byte, in any order, among several million.

I like to use the analogy of a library when describing how a computer handles data. In my computer "library", the shelves are the hard disk storage and the reading desk is the RAM. Now, although the library may have hundreds of shelves and millions of books (the files and programs), if your desk is only large enough to take one book, then that's as much as you can read or work on at any particular time.

But supposing you got a bigger desk (added more memory)? Now you'd be able have several books open at a time. Adding RAM doesn't just give you more workspace, however. It also improves performance. Windows users who try to multitask several applications on 4Mb of RAM will be painfully aware of this.



You can get up to 64Mb RAM on a single SIMM: just clip it onto the motherboard to give your system a massive performance boost

And that's why memory plays such a key role: if you have too little, your PC can be, literally, unusable. But RAM is just like any other part of a computer, a plug-in component, and so it is relatively easy to increase the amount of memory installed in your PC.

There are two principal reasons you should add memory: to enable you to run bigger or more programs, and to increase system performance. The big question is, "how much"? The answer will vary from user to user but it is possible to lay down some broad guidelines. There exist so-called "sweet spots" in installed memory, above which installing additional RAM doesn't improve performance or functionality.

Life is sweet

The sweet spot for your machine depends mainly on the operating system you're using. For example, if you're only using DOS, 1Mb is probably enough (or 4Mb if you want to play games). If you want to use Windows 3.1x, 4Mb should be viewed as an entry-level quantity of RAM and 8Mb as the sweet spot.

Windows 95's sweet spot is 24Mb, with 16Mb as a realistic entry threshold. There's also a ceiling, above which adding more RAM doesn't make much difference. For example, I have two P166 Windows 95 PCs: one with 32Mb, the other with 64Mb. The latter doesn't run any faster than the former. So, unless you want to handle exceptionally large data files such as 24-bit colour scans in Photoshop, consider 32Mb to be a reasonable maximum value.

One final thing to remember about Windows 95 and memory: under this operating system the concept of "free memory" is largely meaningless. No matter how much RAM is installed, Windows 95 will take most of it for cacheing purposes, leaving you with perhaps just a few megabytes of physical memory free. Finding this out when you've just filled your PC to the gunwales with RAM can be a little disconcerting, to say the least. Luckily, Windows 95's hold on physical memory is not very strong and it relinquishes memory as applications demand it.

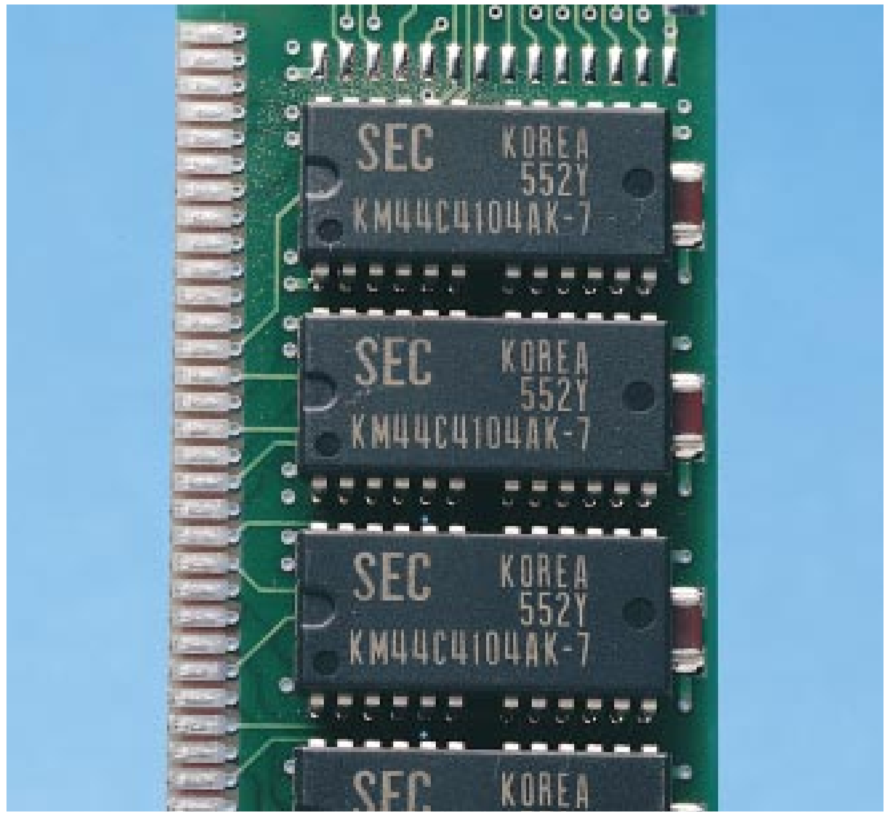
How does RAM speed things up?

It's easy to understand how adding memory lets you run more or bigger applications, but how does it speed up the system? Well, extra RAM reduces Windows' tendency to use virtual or disk-based memory. All versions of Windows make use of a swapfile (on disk) in which to dump the contents of real memory, and whenever it runs low on memory it reads this data back into memory when next required, thus simulating more memory than it actually possesses. But reading and writing to a hard disk is far slower than reading and writing to RAM chips. It is this "disk churn" that slows down Windows so much.

Windows 95, which makes particularly aggressive use of virtual memory, exacerbates the problem. It uses dynamic virtual memory to swap programs from RAM to disk and back again as the amount of available memory changes. Load a large application or two (like Word 97 and Outlook) and Windows 95 will obediently make room for it by flushing everything else to disk: in return, you get to watch paint dry, even on a fast, 16Mb system.

The more memory you dedicate to Windows 95, the less swapping you will have to endure and the faster your system will appear. In fact, in certain situations, adding RAM can be a more cost-effective performance boost than fitting an overdrive processor.

The good news is that memory prices are at long last affordable. For more years than I care to remember, RAM seemed to be stuck at about £30 per megabyte, but in the past 18 months or so RAM prices have been in free-fall. In January 1996 the price of a 16Mb EDO SIMM was £480. One year later, you could buy them for one tenth of this (just £48). In the past few months,



SIMMs are not always easy to identify. Here, the last digit (-7) represents 70ns

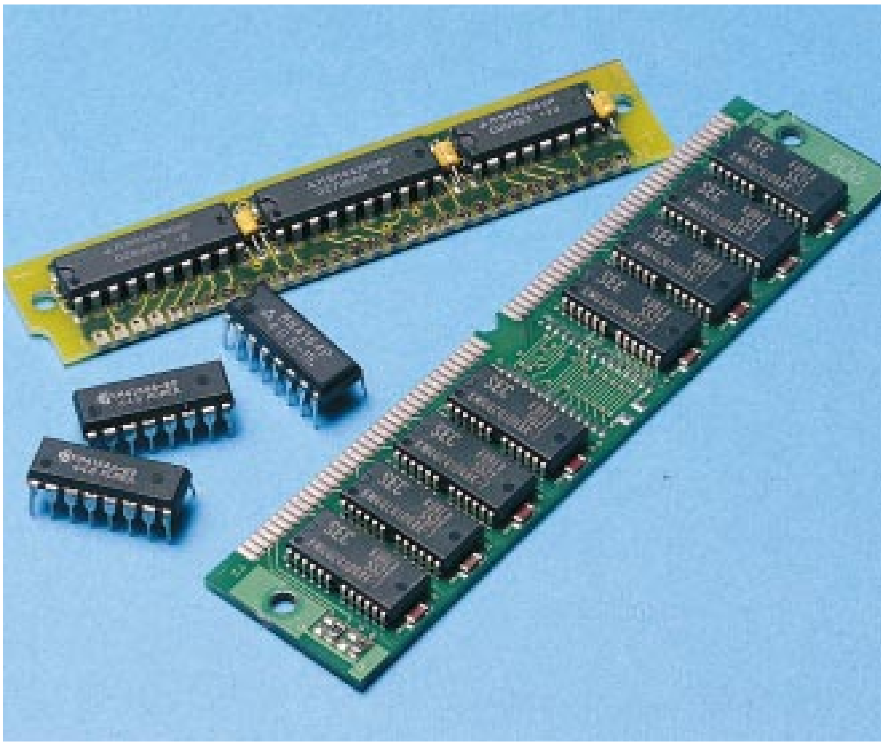
though, RAM prices have started to pick up and that same SIMM now goes for about £55. Even so, it's still excellent value for money and if you need extra RAM there's no time like the present to purchase it.

Types of memory

Upgrading memory on older 286 and 386 PCs used to be a nightmare, requiring dozens of tiny DRAM chips, each with 16 spindly legs, to be plugged in to equally tiny DIP sockets on the motherboard. These days, installing RAM rivals falling off logs in simplicity: memory chips are soldered onto Single In-line Memory Modules (SIMMs) which plug into special sockets on the motherboard. You can get up to 64Mb of RAM on a single SIMM, so fitting a large amount of memory requires you to clip just a couple of SIMMs onto the motherboard — easy or what?

SIMMs come in various sizes and speeds: 1Mb, 4Mb, 16Mb, 32Mb and 64Mb, with speeds of 90, 80, 70 and 60 nanoseconds (ns). The lower the number, the faster the SIMM. It's important to get the speed of the SIMM right when upgrading but unfortunately there's no easy way to make sure you're getting the correct SIMMs for your PC.

p270 ➢



Here are the three major types of RAM: 72-pin (at the front), 30-pin (at the back) and the old-fashioned DRAM chips in the middle

Perhaps the simplest and most foolproof ways to determine the speed of the RAM you require are: read your manual to find the specifications for the system, call your dealer's technical support people, or actually examine the existing RAM in your system. Often, the last digits of the number on the chip or module represent the speed, and usually the chip makers use only two digits to indicate it. For instance, an 80ns chip will have an 80 (or –8), whereas a 150ns chip will have a 15.

Unless you have an eye to the future, don't buy RAM that's faster than you need. It won't hurt, but then neither will it speed up your system. This is because the system defaults to the slowest memory installed. By all means put fast RAM into a slow PC, but never put slow RAM into a fast PC.

Additionally, if you own a PC, avoid mixing chips of different speeds or from different manufacturers in the same memory bank of SIMM sockets: chip companies don't make their chips to exactly the same electrical standards, and the differences could confuse your system. If you must mix chip types, insert the chip with the slowest access time into the first bank. The rest of the chips will then run at the speed of the first.

Making contact

Another thing to watch is the type of contacts: you should choose the SIMM to match the contacts in the SIMM slot. If your SIMM slots have tin connectors, use SIMMs with tinned edge contacts. If they have gold, then use gold. There have been reports of corrosion where tin and gold have been used together.

30-pin vs 72-pin

The most significant difference between SIMMs is in their "pin-out": some have 30 pins, others have 72. The original SIMMs had 30 but for the past couple of years the 72-pin variety has predominated. Of course, the two types of SIMM are incompatible, physically and electronically.

Thirty-pin SIMMs are typically 8- or 9-bit devices with the ninth bit performing an integrity check on the eight data bits. Thirty-pin SIMMs are often advertised as x8 or x9. By contrast, 72-pin SIMMs are 32-bit devices (or 36 bits with parity) and are advertised as x32 or x36.

Many Pentium PCs dispense with parity checking these days (or provide a BIOS option to disable it). Modern DRAMs are far more reliable than their forebears and less liable to corrupt data, so this feature is less than essential. One benefit of disabling parity is that your computer will run faster. If your PC requires parity-checked SIMMs, make sure this is what you get.

Most 486 systems support 32-bit memory addressing, which means that with 8-bit (or 8+parity) 30-pin SIMMs you'll need a matching set of four identical SIMMs to create a bank of 32-bit memory. Systems typically have two or four banks of SIMM sockets, each of which must either contain four matching SIMMs or remain empty.

The requirement to completely fill 30-pin SIMM banks often poses problems when upgrading. Say you've filled both of your four SIMM banks with eight 1Mb SIMMs. Unfortunately, you won't be able to upgrade this configuration to 16Mb simply by buying another 8Mb of memory. To expand this configuration, you would have to ditch half your existing memory (four 1Mb SIMMs) and replace them with four 4Mb SIMMs (16Mb), forcing you to jump from 8Mb to 20Mb in the process.

Systems that use 72-pin SIMMs do not suffer from these restrictions. Because each 72-pin SIMM is a 32-bit device, each memory bank consists of a single SIMM socket on a 486. Pentiums, on the other hand, have a 64-bit data path and so 32-bit SIMMs have to be installed in matched pairs to establish a 64-bit data path.

Pentium motherboards with eight 72-pin SIMM slots are fairly rare and most come with just four slots, so the same "memory ceiling upgrade" problems can recur — even with modern motherboards.

DIMM – the latest thing

The latest version of the SIMM is the 64-bit Dual In-line Memory Module, or DIMM. We are just beginning to see these appear in the latest high-end Pentium PCs. DIMMs have 168 pins in two (or dual) rows of contacts; one on each side of the card. With the additional pins a computer can retrieve information from DIMMs, 64 bits at a time instead of the 32- or 16-bit transfers that are usual with SIMMs.

DIMMs are a bit longer and taller than SIMMs, with a couple of clamps at either end, and are fitted vertically into their sockets. PCs typically have just one or two DIMM slots.

Next month I will be examining the various memory technologies available and writing about actually fitting the memory.

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Upgrading by the book

Notebooks are an attractive option, but obsolescence can strike faster than crowsfeet or a receding hairline. Roger Gann takes a look at upgrading your personal power unit.

Notebook PCs are awkward and expensive to upgrade. This is largely due to one thing: all notebooks sold today are essentially one-off proprietary designs. As a result, they're all different and share very few common, standard parts. Sure, they'll have standard Intel CPUs and RAM, but beyond that, they will all use unique casing designs and motherboards.

Size precludes the incorporation of items like standard PCI slots or drive bays, or even relatively small features like SIMM slots. Often, the only way to upgrade a notebook is to make use of its PC Card slots or invest in a docking station that will feature expansion slots and a drive bay or two. You see, from an upgrading perspective, the architecture of a notebook is largely a closed book (*ha-ha!*).

Other factors conspire to make upgrading awkward and uneconomical. The pace of technological change in the notebook industry often makes it less expensive to buy a new machine after a few years than to upgrade an existing one: that new notebook computer you just pulled out of the box could be obsolete within a year. Technology in the notebook computer market is changing so rapidly that product life cycles last six months or less.

You might be hesitant to buy a notebook for fear of obsolescence. But take heart: there's a lot you can do to extend the life of your portable system.

A word of advice: if you want to upgrade, don't delay — do it as soon as possible after buying your notebook. As I've mentioned, notebooks have a depressingly short product life and are essentially proprietary designs. If you do want to buy an add-on for your notebook, a docking station for instance, you may not be able to obtain one 18 months down the line. And because of its unique design, you won't generally be able to use an alternative.

What's possible

So, *nil desperandum*... It is possible, with a little bit of ingenuity, to upgrade a limited number of notebook features. So what exactly is possible? Obviously, all modern notebooks will have one or two PC Card slots and these are the equivalent of the standard PC expansion slot. You can fit a wide variety of cards, from network cards, to SCSI cards to sound cards. And if you're feeling particularly flush, you can even fit tiny PC Card hard disk drives.

So the PC Card option has to be your first port of call when upgrading. It might be a relatively expensive solution, certainly compared to a similar upgrade performed on a normal desktop PC, but it's very quick and easy to install; particularly if you're using Windows 95, which has turned PC Card software support from a nightmare into a dream.

One upgrade which is common among desktop PCs but is almost without exception impossible on notebooks is the CPU upgrade. Unfortunately, most notebooks use CPUs that are hard-soldered to the motherboard and so cannot easily be removed. A few notebook brands do feature socketed CPUs and so, in theory, they are upgradeable, but I would be very careful about dropping in a faster Pentium, say, unless that notebook explicitly supported a faster CPU. Overheating is a very real problem in the close confines of a notebook, and simply fitting a faster Pentium is a recipe for notebook meltdown. Height restrictions (caused by the integral fan) will probably preclude you from fitting a Pentium overdrive, too. So one way or another, CPU upgrading is a no-no, as is upgrading other permanent parts of the system like sound and graphics.

OK, so what's left? The RAM and the hard disk: these are both upgradeable.

Memory upgrades

Perhaps the best way to improve your notebook's performance is to add more memory. Your applications will run faster and smoother, while more RAM will even extend the amount of time you get out of a battery charge.

Nowadays, many notebooks are supplied with 8Mb of RAM which is considered insufficient for running Windows 95: 16Mb is a more appropriate figure. Unfortunately, SIMMs and DIMMs are just too big for the latest slimline notebook designs. So, instead of using what has become a generic commodity, the SIMM, notebook users are forced to buy RAM cards made specifically for their notebook. The recent slump in RAM prices has taken the edge off notebook memory prices: for example, a 16Mb upgrade for a Toshiba Portege or Satellite Pro can be had for about £85; contrast this with what I paid to add a meagre 4Mb of RAM to my Dell, which set me back a cool £140 about two years ago.

Plan your RAM upgrade carefully, because the number of RAM expansion sockets in your notebook will be limited. You may have as few as two spare RAM sockets and if you buy, say, 8Mb and find it to be insufficient for your needs, you may have to junk your existing RAM to install 16Mb. What I' m saying is: if at all possible, buy more RAM than you actually need because you're bound to need it next year.

Installing the memory modules is easy, much easier than the corresponding task on a desktop PC — normally, you remove a clip-on panel, either above or below the keyboard, plug in the modules, replace the cover and power up the notebook. End of story. But one word of caution: these memory modules often use quite flimsy PCBs, so treat them gently.

Hard disk upgrades

Notebooks are no different from desktop PCs when it comes to storage; there's never enough! Luckily, swapping a hard disk is not an insurmountable problem. The vast majority of notebooks use 2.5in IDE hard disks, which are just smaller versions of the familiar 3.5in IDE drives we see everyday. Apart from size, these tiny drives differ from their larger peers in that they have a single connector that carries both power and data. To all intents and purposes they are identical, and installing a larger IDE drive in your notebook is in theory no different to that of installing one in a desktop PC. Sadly, the practice is somewhat different. The problem lies in gaining access to the drive itself.

This is not a problem if the drive itself is removable and slides out of the notebook casing after a catch is released. All you have to do is dismantle the plastic shell surrounding the drive, *very carefully* disconnect the thin ribbon cable, extract the old drive and replace it with the new one. With the drive installed, you then load CMOS Setup to get the notebook to auto-identify the drive, and away you go.

Note that some older notebooks have BIOSes that can't handle large drives, i.e. those bigger than 540Mb. And as it's now virtually impossible to get 2.5in drives smaller than 810Mb, it means that older notebooks cannot easily be upgraded. If your notebook has a Flash BIOS, it's worth checking out the manufacturer's web site in case BIOS upgrades are available. For details of commissioning the drive, installing an operating system and so on, refer to my Hands On column in *PCW* August '96.

In many notebooks, the drive isn't removable and is buried inside the notebook. Accessing these types of drive is hard work but by no means impossible. Be careful: if there's any warranty left on your notebook, you'll probably invalidate it by doing this. Notebooks are not easy to open. I can't begin to describe the various dismantling permutations for all the different notebooks, so what follows is only a general guide.

1. The plastic casing will be held together by a number of tiny screws. Some will be visible and others won't because they'll be hidden! For example, the rubber feet on the underside of a notebook often conceal screw holes. Likewise, adhesive labels above the keyboard may disguise the presence of screws. The first job is to locate all these screws and remove them, making a careful note of which screw went where.
2. The casing top should now separate from the bottom. You may have to unplug a couple of thin, delicate cables that link the two halves: examine the plug at one end and slide down the sleeve to release the cable. Watch out, too, for a tiny micro-switch that is depressed when you close the lid; this is vulnerable.
3. The old hard disk will probably be held in a metal clamp, secured by a pair of screws. Release the drive and carefully pull the ribbon cable off the rear. Install the new drive and, as they say in all the best car repair manuals, reassembly is the reverse of disassembly!

A final note: transferring the contents of the old hard drive to the new is a problem in notebooks. VisionTek offers an interesting solution to this problem — Drive Exchange. It consists of a Type II PC Card plus cables and software. You plug the new drive into the PC Card, then insert this into the notebook. The software takes a complete copy of the old drive. When it's done, you simply install the new drive.

Screws can be hidden under adhesive labels

Alternatives

You don't necessarily have to go down the PC Card route to upgrade: there are other ways to connect peripherals to your notebook, especially physically-large devices such as CD-ROM drives or tape streamers.

■ **Parallel port devices**
The parallel port is a useful fallback if all your Card slots are spoken for. For example, you'll be able to hook up an external CD-ROM drive — the Micro Solutions' Backpack 4X CD-ROM (around £140 on the street) is a quad-speed, 250ms, 3.5lb, mains-only drive which is solidly constructed and works with both standard and the newer, faster, enhanced parallel ports. Installation with the included software takes less than a minute. A printer cable attaches to the throughput connector on the back of the drive. An 8-speed version is available (about £240) and both models can have sound, too, which adds about £80 to the final bill.

■ **Docking Stations**
A desk-based docking station adds desktop PC-like expansion opportunities to notebook computers, as they often feature expansion slots and drive bays to which you'd fit ordinary common-or-garden expansion cards and CD-ROM drives. The downside is that docking stations aren't cheap and can cost several hundred pounds. They are not designed with too much portability in mind, either.

■ **Direct Cable Connection**
This is a low-cost way of networking your notebook to a desktop PC to enable you to access its hard disk or CD-ROM drive as though they were directly connected to your notebook. The Windows 95 Direct Cable Connection lets you make what is, in effect, a network connection to another PC via a parallel or serial cable to access shared resources on that machine, such as a CD-ROM drive. Direct Cable Connection is part of Windows 95 and is free — all you need is a cable, which will set you back around £15. DOS and Windows 3.1x users can use the slightly less sexy InterLink facility instead.

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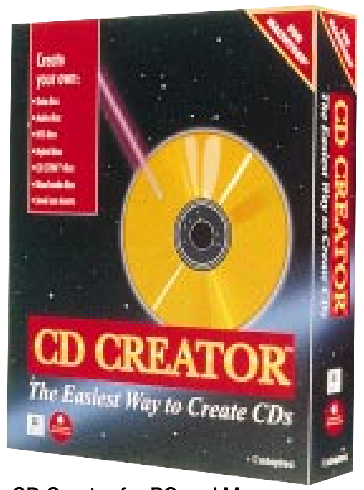
Fasten your seatbelts…

...let's go for a drive. Roger Gann gets in gear and sets off to explore CD-R, the storage disc set to leave the CD-ROM drive standing. Choosing, installing and running, it's all here.

With the first DVD-ROM drives now on sale at more reasonable prices, the writing is on the wall for the humble CD-ROM drive. And with so little profit margin left for the CD-ROM drive makers, their attention will switch to producing something more profitable; I think *that* something is the recordable CD-ROM drive (CD-R).

CD-Rs have been around for years, having first appeared in the rarefied world of hi-fi at astronomical prices. They eventually made the crossover to the PC market, but then prices came down a bit. The original HP SureStore 4020I, which then cost £700, today costs under £425. "Bare" CD-R drives can be bought for much less (some, at street prices below £300).

Cooking your own CD-ROM discs is now fairly affordable. But who needs home-brewed CD-ROMs? Anyone with a modern, well specified PC. CD-R is cheap bulk storage: at around £7 each, a 650Mb CD-ROM disc works out at about 1p per megabyte. CD-R is a good choice as a storage or backup device for several reasons. Firstly, the ubiquity of CD-ROM drives; your disc will be readable on many PCs. This also makes CD-R an excellent medium for transferring large files; you can even use it to back up expensive CD-ROM based reference works. Secondly, unlike tape, CD-R is a random-access device, which makes it fast to get at archive material. The discs are more durable, too: they have a longer life span than tape cartridges, they're physically durable, and they can't be wiped by coming into contact with, say, a magnetic field.



CD Creator for PC and Mac

It's true that CD-ROM drives aren't storage speed demons compared with modern hard disks, but they're fast enough for running infrequently used applications and for accessing historical data. The CD-ROM is thus a perfect medium for today's big multimedia data files. Also, you can store just about any form of data on a CD-ROM: you can mix and match video, Photo-CD images, graphics, sound and conventional data on a single disc.

Choosing a CD-R drive

There's a reasonable choice of CD-R drives available from companies like Hewlett-Packard, Mitsumi, Sony and others. Prices start at under £300 (ex VAT), rising to around £600 (ex VAT). You can choose between external models which sit on your desktop, or internal models that sit in a spare 5.25in drive bay. Although they have the special ability to write to CD-R blank discs, these drives otherwise behave like ordinary CD-ROM drives. Almost all are SCSI devices so you'll need a SCSI host adaptor card, but parallel port drives are also available and work surprisingly well.

Perhaps the most important feature of a CD-R drive is the speed at which it can write, as "burning" a full 650Mb CD-R disc can be a slow process. For example, audio CDs are 1x, 150Kb/sec devices and can hold 74 minutes of music, so this is how long a single-speed burn will take (a 2x will take half this time, and so on); the faster the CD-R, the quicker you can burn your discs.

Hewlett-Packard P SureStore CD-Writer 6020

Although CD-ROM drives are now hitting 16x, with peak data transfer rates in excess of 1,800Kb/sec, you won't find any CD-R drives offering this kind of performance. While most can read at 4x or 6x, the vast majority of CD-R drives are 2x writers. That is, they can write to disc at a speed of 300Kb/sec. Some CD-R drives can manage to write at 4x (600Kb/sec) but these are about 50 percent dearer and you need a well-specified PC to keep a 4x CD-R happy. Finally, check just what mastering software is included in the deal.

Installing a CD-R drive

If you've installed an ordinary SCSI CD-ROM drive, installing a CD-R version won't come as a great shock as it will install in a similar way. If you already have a SCSI host adaptor installed, all you have to do is connect the new CD-R drive to a spare connector on the SCSI cable if it's an internal drive, or plug it into the socket on the SCSI host adaptor card if it's an external), having first given the drive a unique SCSI ID number (say, between two and six) and turning termination on if it's the last device in the SCSI daisy-chain. An external CD-R drive is a good choice if you plan on using it to back up different PCs.

Some CD-R drives will be bundled with their own private SCSI card and there's a compelling reason for installing these even if you have a SCSI host adaptor already installed. The second card ensures the CD-R drive gets the highest possible data throughput. It's important to use a bus-mastering SCSI host adaptor as this will improve throughput, which is the name of the CD-R game. If you have a high-spec SCSI host adaptor to start with, you can get away with just using the one card.

The simplest CD-R drives to install are those which make use of your PC's parallel port. These drives install in minutes: plug in the cables, power-up the drive, install the software drivers and you're away. I keep emphasising the importance of good data transfer rates and that goes double for parallel ports; you must have a PC with an EPP or ECP parallel port. This is important because a standard/4-bit parallel port may not have a fast enough data transfer rate to keep the CD-R satisfied. Parallel port CD-R drives are available from HP and others.

Hardware requirements

Unlike CD-ROMs, you can't fit a CD-R drive into any old PC and expect it to work consistently. Successful CD-R burning needs a PC capable of providing a fast, consistent, data flow during the burning process. The biggest problem you'll come across in CD-authoring is running out of data during a burn. A CD-R disc has to be written to in a contiguous, track-by-track fashion, writing the data in a smooth, uninterrupted stream. The write session has to be closed properly. If, for any reason, there's a glitch in the data flow during the burn and the unit is momentarily left with nothing to write, the data buffer empties and a "buffer under-run" occurs. That £7 CD you're trying to write to then becomes useless and you'll have to start again.

So what's the solution to this problem? A good start is a fast, well-specified PC. Some CD-R makers recommend a 486 with 8Mb of RAM or better but in my experience it's the "better" that you need. I'd say nothing less than a P90 with 16Mb RAM, especially if you want to do track-at-a-time or multi-session recording. Make sure you buy a CD-R drive with a decent-sized on-board buffer of about 1Mb. You'll need a big, fast, hard disk, too. Although you can successfully burn CD-Rs using Enhanced IDE/PIO Mode 4 hard drives, most makers recommend a SCSI hard drive with at least 1.3Gb free; this is the minimum space needed to create a full 650Mb CD, especially if your mastering software needs a disk image of the CD-R to be created first.

Sony Spressa 920

For serious CD-R authoring you're looking at fitting a second SCSI hard disk, dedicated solely to the CD-R mastering task. Avoid drives which feature thermal recalibration on-the-fly as this interrupts data flow. It's best to use so-called AV (audio-visual) drives, which are designed to deliver fast, sustained transfers. Another tip to ensure a smooth data flow is to defrag your source drive first. During the burn session it's probably better *not* to put Windows multitasking to the test, so don't run anything else at the same time. And run ScanDisk too, just to make sure all the files can be read. If, after this, you still get continuous buffer under-runs, you'll probably have no alternative but to drop the write speed, from quad- to double-speed, or from double- down to single-speed.

Buffer under-runs aren't the only reason discs get ruined. The final, lengthy stage in the recording process closes out the disc with a table of contents which consumes about 13Mb of space per session. If the CD-R drive and software aren't set up properly, or if the proper SCSI termination isn't in place, it's possible to get through most of a recording session but have the closing process fail and the disc ruined at the last moment. Beware if you're intent on making good use of a CD-R's multi-session capabilities: the 13Mb overhead soon mounts up if you burn many sessions onto one disc. It's for this reason that multi-session CD-R is unsuitable for incremental daily backups; you may back up just a few megabytes of data but then sacrifice another 13Mb to close the session.

Mastering software

When buying a CD-R pay close attention to the mastering software that comes with it. This is the utility that lets you arrange and format the data to be burned onto a CD and is as important as the drive itself. Just as fax modems are bundled with "lite" versions of full-blown fax programs, so the odds are that you'll come across a lite version of one of the mastering packages sold by Corel, Incat Systems and Elektroson in the box. These will provide enough functionality to let you perform basic mastering chores but will lack the bells and whistles found in full versions. Mastering involves marshalling many files, so these packages will include File Manager-like interfaces for routine tasks like backup and archiving. The full versions will offer multi-session and full audio CD capabilities. They will all support the ISO 9660 standard, a CD-ROM data format readable by PCs running DOS or Windows, by Macs running System 6.x or 7.x, and by almost every flavour of UNIX. This is a limited standard in some ways, but Microsoft's Joliet CD-ROM formatting standard expands on 9660 by allowing semi-intelligent truncation of long filenames, and it is beginning to be supported by the new generation of CD-R software.

Some packages will first create a physical image file of the entire CD-ROM on the hard disc; a time-consuming process. This is a complete, bit-for-bit mirror image duplicate of all the files to be burned to a CD-R disk in a recording session. If you have a fast PC, you might be able to dispense with the time and bother of a complete physical image by using a virtual image file method instead. This is smaller, and carries a set of pointers to the files on your hard disk to be sent to the CD-R drive.

Finally, if you're bothered about buffer under-runs, most packages allow you to run a dress rehearsal of a burn session but without actually writing to the disc. This is a slow process, but could save you time and money in the long run.

PCW Contacts

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CD Creator; Adaptec 01276 854500
SureStore CD-Writer; HP 0990 474747
Spressa 920 CD Writer; Sony 01932 816000

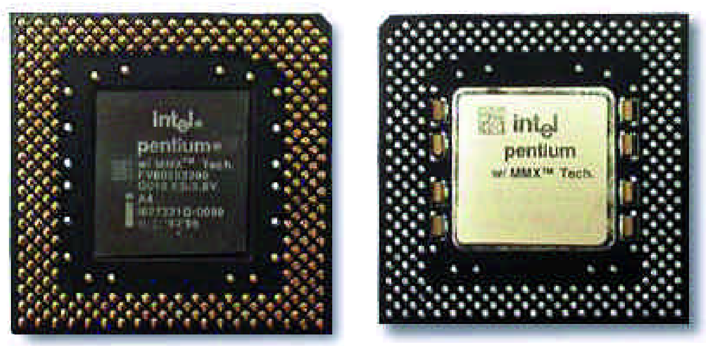
Still waters…

… run deep: Intel has been quietly working away on processor developments, some with curiously watery codenames. Roger Gann anticipates a deluge of new products to come.

A river runs through it — Intel's future processor strategy, that is. For some time now, Intel has codenamed its future processor development projects after local rivers. The watery names have replaced the traditional Pnn scheme that Intel used for a decade.

Last year wasn't particularly busy for Intel. Even though it sold Pentiums by the shipload and hoovered up the cash, its new product release schedule was quite relaxed. After the introduction of the 150 and 166MHz Pentiums in January '96, the only new products were the 200MHz Pentium (July) and the 150MHz Mobile Pentium.

This year promises to be hectic. The launch of the Pentium with MMX Technology will be swiftly followed by OverDrive versions and a special version for notebooks, and we'll see the launch of an MMX-enabled version of the Pentium Pro. So this month I'll take a break from the toil of upgrading and instead gaze into my crystal ball at Intel's road map of future processor products.



The new MMX Pentiums are pin-compatible with their predecessors, but to gain maximum benefit you will need MMX-enabled software

Klamath

The Pentium now has the benefit of MMX technology, but what about the Pentium Pro? You won't have long to wait: Klamath is a cost-reduced version of the Pentium Pro intended to bring Pro performance to mainstream PCs this year. Although still based on the P6 core used in the Pentium Pro, Klamath will add the MMX multimedia extensions already seen in the new Pentiums. Klamath will initially run at 233MHz and later at 266MHz. These new, faster clock speeds are made possible by Intel's new 0.28-micron CMOS process. This will be slightly faster than the 0.35-micron BiCMOS version of the Pentium Pro, allowing Klamath to outperform it but at a lower cost. The new processor will come with a large, 512Kb, L2 cache.

Klamath's most visible difference will be its packaging: it won't resemble existing Pentium and Pentium Pro chips. The new processor will be housed in a new package, the Single Edge Connector (SEC) cartridge, a plug-in design that will require a complete motherboard redesign and which will function in much the same way as a CPU daughtercard. The SEC cartridge will probably ship in a metal case that provides for thermal transfer as well as electro-magnetic shielding.

Although the Pentium Pro was the most powerful processor Intel makes, it added little to its profits: Intel shipped fewer than three million Pentium Pros during 1996, compared with more than 60 million Pentiums. For Klamath to sell in the vast quantities that Intel would like, it must be cheaper to fabricate than the existing Pentium Pro.

The Pro broke new ground by coupling the microprocessor chip with a secondary or Level 2-cache chip in a single package. This solution, although providing good performance, was expensive and consumed too much of Intel's manufacturing capacity. The SEC design allows Intel to employ cheap, off-the-shelf, conventional SRAM chips (normally used for external caches) for its "internal" L2 cache; a move that offers considerable cost savings. The downside of the SEC is that its new packaging means there'll be no Pentium Pro MMX OverDrive upgrade. If you want Klamath, you'll need a new motherboard, too.

Initially, the SEC daughtercard will be designed to direct I/O traffic. Later on, Intel is expected to incorporate microcontrollers, DSP technologies and even some analogue devices into the card, making the prospect of full-screen, full-motion MPEG-2 or DVD-playback a distinct possibility.

It's now looking like Klamath will ship towards the end of Q2 this year, later than originally expected. So, it's more than likely that AMD will beat Intel to the draw by launching its rival K6 processor early in April. A minor fly in the ointment in the impending launch of Klamath is that its new motherboards will use the old 440FX PCI chipset which lacks support for advanced features such as SDRAM, Intel's Advanced Graphics Port (AGP) and 33Mb/sec EIDE transfer rates. An enhanced chipset, likely to be called the 440LX, won't be available until the second half of this year.

Two types of user will derive the most benefit from Klamath. First in line are the users of 32-bit operating systems such as Windows NT 4.0. These business users will see a big performance boost from the chip. Secondly, home users will just love Klamath as it will be great for 3D gaming. The Pentium Pro's floating-point unit is much faster than the Pentium's and thus most 3D programs will be dramatically faster.

Klamath will be a desktop-only processor: there will be no notebook version of the MMX-enhanced P6 processor, simply because it runs too hot. It's likely that Intel will skip a beat and jump to a notebook version of its next-generation processor, code-named Deschutes. So, although Pentium MMX notebook processors will be introduced and enhanced this year, there will be no Intel Pentium Pro-class notebook processor until 1998.

Deschutes

The Klamath architecture will support up to two processors and will be aimed at the workstation and entry-level server markets. The existing Pentium Pro supports Symmetric Multi-Processing (SMP) to the tune of four processors, maximum. This limitation will be overcome by Deschutes, a version of Klamath specifically designed for network servers. Intel is rumoured to be developing an eight-processor motherboard using the Deschutes architecture. And, some reports claim that the new architecture will feature a new bus interface that will allow manufacturers to build systems with up to 32 processors.

The processor itself will be a refinement on Klamath and will probably be a shrink of the Klamath design using the forthcoming 0.25-micron process. The die size of Deschutes will shrink markedly as a result: from 690 mils (0.69ins) for Klamath, which will use 0.35-micron technology, to 400 mils (0.4ins) for Deschutes; enough to allow high-volume, low-cost production.

Similar to the Klamath design, Deschutes will offer a CPU based on the Pentium Pro core but with separate components, such as a larger Level 2 cache and a modular CPU-to-cache bus on an SEC daughterboard. CPU speeds will range from 266MHz, 300MHz and 333MHz for Deschutes.

Some sources have predicted that Intel may also be moving to develop a 75MHz bus to run the Deschutes. Although that would require a new motherboard and related components, they noted that the faster bus might also be necessary. In common with Klamath, Deschutes will be configurable, capable of handling multiple cache memory types such as static RAM or multibank DRAM, the Advanced Graphics Port controller or a communications director for managing high-speed communications. Deschutes might appear towards the end of the year but 1998 is a far more likely timeframe.

In order to realise the full impact of Deschutes, you'll need a network operating system that can handle lots of processors. The current release of Windows NT Server will scale to eight processors but will need to support even more than this in future to take full advantage of Deschutes.

Katmai

Okay, so Katmai isn't a river, it's a volcano. But allow me a little artistic licence here!

Katmai will most likely surface late in 1998 or early '99, about six months after Deschutes. It will essentially be a Klamath MkII, with revamped and enhanced MMX technology, dubbed MMX 2 in the US. This version of MMX technology will significantly improve 3D graphics performance, making it an absolute must-have for serious gamesters. It concentrates on boosting 3D graphics performance — something not specifically addressed by the first version of MMX.

To recap, MMX cleverly re-uses the CPU's floating-point registers for its own highly optimised multimedia tasks. Obviously, programs can't use both FP and MMX instructions within the same routines as both share the same register set. This is rarely a problem, since most programs don't use FP at all. Those that do, typically use these calculations to generate data, while MMX is typically used in separate routines that display data.

For 3D graphics, Intel recommends that geometry calculations remain in floating point while MMX is used to accelerate 3D rendering routines. Each time the processor swaps the FP registers between FP and MMX, a time-consuming "context-switch" is required. Hence Intel's admission that 3D rendering doesn't benefit dramatically from MMX, although applications that take advantage of Microsoft's Direct3D programming interface will see some improvements. MMX2 will have additional instructions and a larger cache compared with the first release of MMX.

Merced

Also referred to as P7, Merced will be the first CPU to be released which supports IA-64, the new 64-bit architecture jointly developed by Intel and Hewlett-Packard under the codename Tahoe. Merced, which appears to have slipped into 1999, is likely to serve primarily the workstation and server markets, while Willamette, a cut-down version of Merced, will drive high-end personal computers.

It is early days, however, and very few hard facts are known about this processor. Intel has been tight-lipped about this particular project. It seems that the processor will comprehensively address many of the limitations of its 32-bit forebears. The chip is a joint Intel/HP venture and will not only support x86 binaries but also HP's PA-RISC binaries for its UNIX workstations.

Presumably, x86 support will be provided by way of emulation, in much the same way that PowerPC Macs can run 68K code. The key in both cases is sheer speed; the PowerPC was so fast anyway that the speed penalty imposed by emulation was unnoticeable. The same will probably be true of Merced.

Tillamook

Conspicuous by its absence from the MMX launch was the 200MHz version of the Pentium MMX for notebooks. Don't worry, though: Intel is planning something special for later in the year.

Codenamed Tillamook, this CPU will be among the first to be built on an Intel-developed pop-out module for notebooks, called MMO. It will include a processor, Level 2 cache, a voltage regulator, a clock and a PCI chipset called the 430TX. Instead of plugging a new processor onto the motherboard, users will plug the MMO processor module into the MMO socket.

So, for the first time, notebook users will have a CPU upgrade path. Fabricated using the new 0.25 micron process, the new CPU will not only be smaller than the Pentium MMX on which it is based but it will draw significantly less juice; down from 2.45v to 1.8v. A 233MHz version will follow.

And just for the record, Tillamook is a town, not a river. So there.

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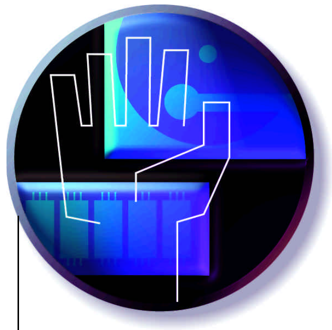
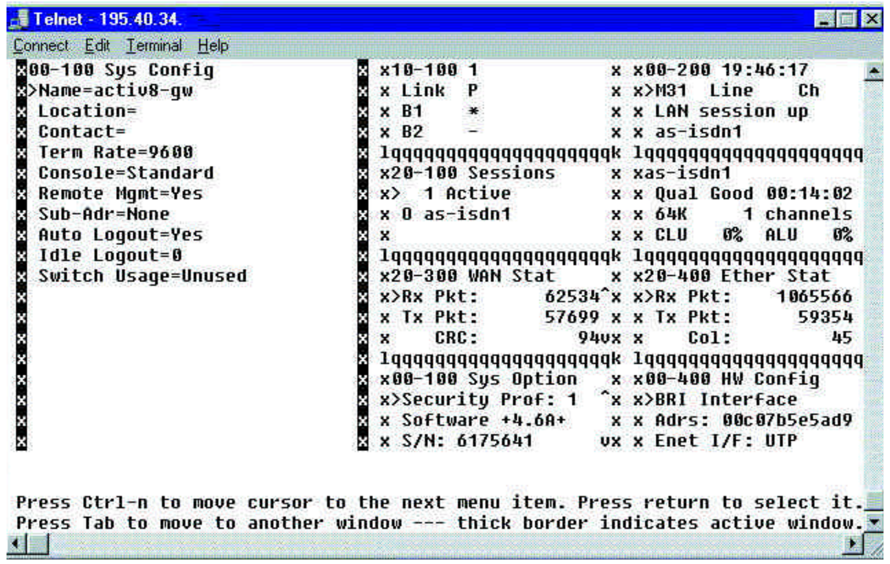


Fraught in the net

Getting connected to the internet can be a risky and potentially expensive business. Roger Gann takes the worry out of it with a back-to-basics brief on what's what and where to get it.

I guess a reasonably high proportion of *Personal Computer World* readers regularly access the internet from their PCs at home, using a V.34 modem and a normal phone line. Such an act would have been rocket science a few short years ago, but today it's a routine event. For single users, this method, a modem plus a conventional phone line, is the most cost-effective internet access solution. But what if you wanted to give internet access to a group of users, say those on a small network? Well, there's absolutely nothing to stop you from scaling up the single-user solution and applying it to everyone on the network, buying them all a modem, giving them all a phone line and their own ISP account. It's feasible, but it's a less than desirable solution. Not only would it be a nightmare to configure and administer, but it would also be expensive to implement.

No, a much more elegant solution is to integrate internet access into your network. The good news is that, depending on your precise needs, you may not have to fork out for expensive new kit in order to do this. In fact, for most companies the expense will be relatively trivial. There are basically two choices available: email-only or full-blown internet connectivity.



Complicated or what? You can telnet in to your ISDN router once it's been configured, but as you can see, configuration isn't straightforward

Email only

I suspect most companies, even small ones, running even modest networks, rapidly appreciate the benefits of email, often provided as a standard feature in their NOS (e.g. Windows 95 or Windows for Workgroups 3.11) and soon find themselves making heavy use of internal email. So it makes a lot of sense to consider extending the existing email connectivity to embrace the internet — sending an email is probably the cheapest method of global communication available.

For email purposes you don't need instant or continuous access to the internet, nor do you need a particularly fast connection: emails tend to be reasonably compact and the throughput offered by a 33.6Kbps modem will be perfectly adequate for most email traffic. However, if you get much email with large attachments, a faster connection is maybe worth considering. So, your hardware costs will be negligible. You'll also need a mail system that supports internet mail. A good, ubiquitous example of such a system is good old MS Mail, which offers basic email services and is supplied free with both Windows 95 and Windows 3.1x. It's possible to configure MS Mail to initiate a connection to your internet service provider via the modem at regular intervals, say every hour or so, to deliver new outgoing emails and to receive new incoming messages. To do this you simply add the optional "Internet Mail" service to the Exchange Inbox client in Windows 95.

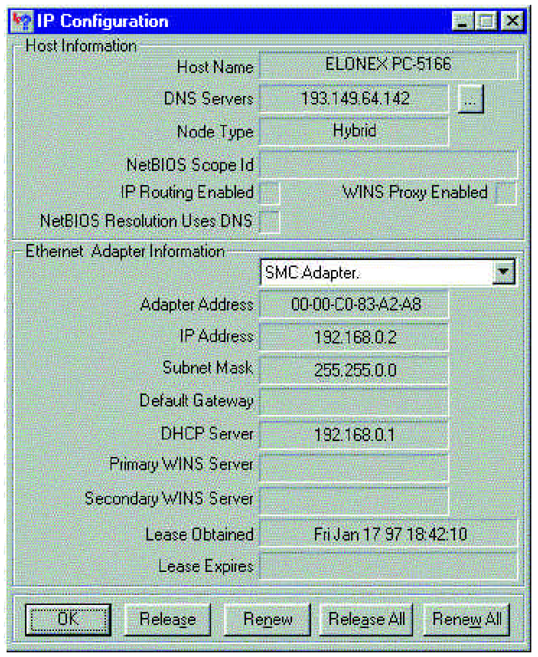
Such a setup is just dandy for standalone machines collecting their own personal email but it can't handle multiple internet email addresses on the network. What MS Mail needs is a bolt-on external mail package, one that can cope with POP3 (Post Office Protocol 3) and SMTP (Simple Mail Transport Protocol) mail systems offered by most ISPs. With such an add-on, every time MS Mail connects with the ISP's mail server, it downloads everybody's mail in one lump and then sorts it, placing the appropriate messages in the appropriate mailboxes. The result is transparency between internal and external email.

There are a number of these add-ons on the market. The European Microsoft Windows NT Academic Centre (EMWAC) based at Edinburgh University has developed EMWAC Internet Mail Services for Windows NT (along with a whole slew of other useful internet goodies). IMS is a suite of server programs which lets you use Windows NT as a mail server for internet mail. IMS isn't perfect — it requires Windows NT, of course, and can be a bit daunting to set up, but it does have the redeeming feature of being freeware. All the EMWAC goodies can be found at emwac.ed.ac.uk/.

Another alternative worth investigating is SLMail, developed on Bill's doorstep by Seattle Labs. This is available for all the Windows platforms, and a Windows 95 version (limited to six accounts) is available free from www.seattlelab.com/ (and is also on this month's cover CD). Like IMS, SLMail95 offers a complete implementation of the Internet SMTP and POP3. With SLMail installed, your PC can function as a post office for popular internet mail clients such as FreeAgent, Pegasus, Eudora, Navigator and MS Mail/Exchange (with the Internet Mail add-on). The full-blown Windows 95 version costs $189: the Windows NT version costs $325. So, the software cost needn't be great either.

So we've now got our internet mail software in place but there's still one variable to determine — does your existing email account with your internet service provider permit multiple email addresses? The type of email account varies from ISP to ISP. Some, for example, allow up to 99 mailboxes from the one common-or-garden "tenner a month" account. This is certainly a cheap and cheerful solution but the principal drawback is cosmetic, the lack of a personalised email address — it would be, say, rgann@company.demon.co.uk rather than the more impressive rgann@company.co.uk. Private domains cost extra of course, and you'll have to talk to your service provider about what types of account it has on offer and proceed from there.

In terms of hardware configuration, a network email system will be similar to a normal standalone internet connection: you'll just need a phone line and a fast modem. Commissioning the connection would be much the same too. Note that as only the server accesses the internet, it will be the only machine on the network that needs to run TCP/IP. The workstations would continue to collect their email in the usual way, via NetBEUI or IPX. This makes life much easier for the network administrator and also prevents the workstations from accessing the internet during connections.



This undocumented goodie is supplied with Win95 and displays your PC's IP configuration, useful if you use DHCP on the server to allocate IP addresses

Full internet connectivity

In some ways granting complete internet access to the network isn't much more complicated than setting up global email. Just two extra things are required — an IP address for each workstation (which will almost certainly require a "corporate"-style access account with your ISP) and rapid access to the internet. A permanent leased-line connection offers instant connection while a V.34 modem takes about 20 seconds to connect. The former is expensive and fast; the latter is cheap and slow. A popular compromise solution is offered by ISDN which offers the best of both worlds — a fast 64Kbps service (with the possibility of 128Kbps) with the economy of demand dialling, plus fast connections, typically just a few seconds, certainly a lot faster than the time taken by your browser to load! For occasional internet traffic, ISDN is very cost effective, offering the speed of conventional leased lines at a fraction of the cost. However, once you spend more than about four hours per day online, a leased line becomes viable.

You would use an ISDN terminal adaptor or TA to connect a single PC to an ISDN but for networks you'd fit a single ISDN router instead. This device sits anywhere on the network, watching the TCP/IP traffic that

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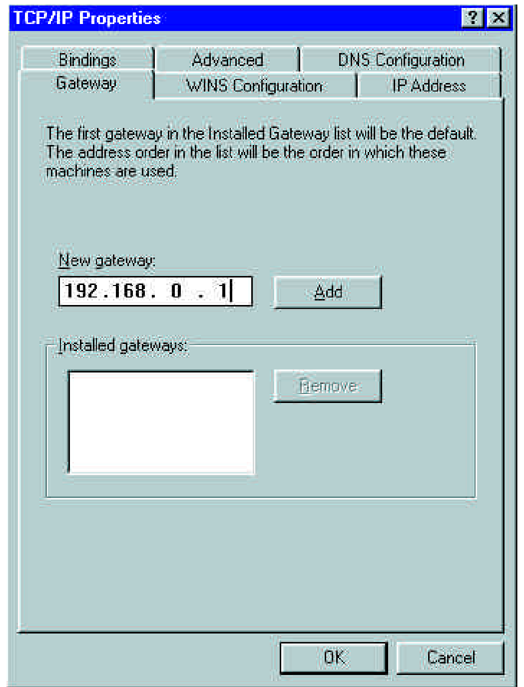
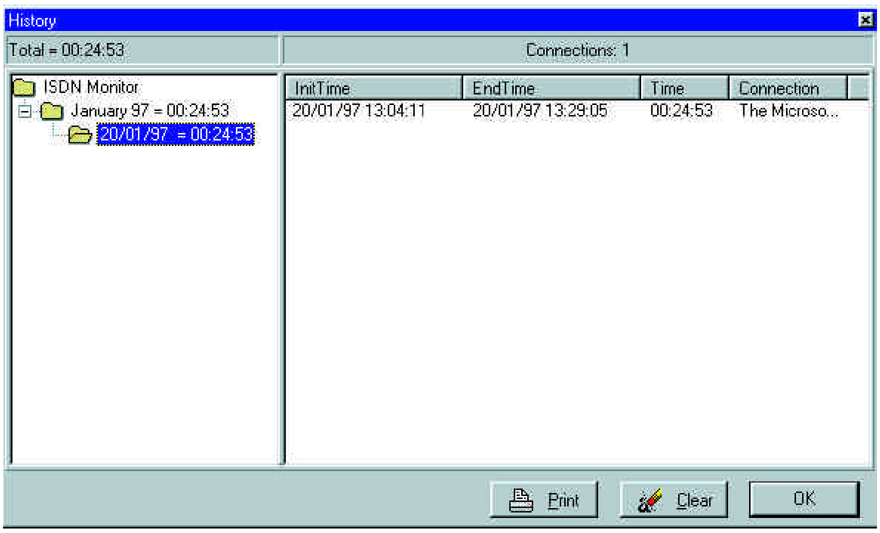


The ISDN router now becomes your gateway to the internet — so don't forget to add the IP address of the router to the Gateway tab of TCP/IP properties

Router alternative

Installing TCP/IP on a lot of workstations is enough to make a network administrator cry. Luckily, Bay Networks has an alternative internet access solution for those wedded to the NetWare standard. Instant Internet 3.1 is an IP/IPX gateway server package, a hardware/software combination that allows NetWare users to access the internet without having to worry about configuring TCP/IP on top of an IPX stack. It effectively permits workstations to access the internet using just the NetWare IPX stack — only the Instant Internet server uses TCP/IP. The downside is that it's not particularly cheap — a 50 concurrent user ISDN version is priced at £4,329 and it can be awkward to configure. www.baynetworks.com/



Keeping a tight control on ISDN line charges is crucial. This little utility, ISDN Monitor, specifcally monitors ISDN usage. It's on the cover disk!

passes by. It ignores traffic destined for IP addresses on the internal network but as soon as it detects a network packet aimed at an external internet address, it initiates a call to the ISP and sets up an internet connection. The line is dropped when the connection is no longer required or times out after a specified period of inactivity.

Users are spoiled for choice when it comes to ISDN routers, although you shouldn't necessarily buy the cheapest. Prices vary from about £750 to £1,500, which may sound dear but don't forget to divide the price by the number of users to get the cost into perspective. How do you go about choosing these exotic bits of kit?

ISP at your service

A good place to start is your local friendly internet service provider — what routers do they recommend or support? For example, many ISPs use Ascend routers at their end and so to simplify things they naturally recommend that you use something like an Ascend Pipeline 25 or 50 at yours. However, there are other equally good if not better alternatives, for example the £1,415 Gandalf XpressConnect LANLine 5250I or the excellent £750 Shiva AccessPort. If at all possible choose one that has an analogue phone socket (or two) — this lets you use the ISDN line as a normal phone line for fax machines or ordinary modems, for example.

Connecting an ISDN router to the network is the easy bit: you just plug the ISDN lead into the ISDN phone socket and plug in the network cable. Beware — this is usually a 10Base-T RJ45 which is the same as the ISDN (or "WAN" socket), so don't get these two mixed up. Routers tend to be disarmingly small boxes, no larger than a modem, and so can often be tucked away in a comms cabinet or next to the server.

Configuring an ISDN router is a different matter and can be a particularly daunting task. They come with a range of tweakable settings wide enough to make any network techie jump for joy. However, if you've cut your internet teeth by manually setting up a connection using, say, Windows 95 Dial-Up Networking, you'll already be halfway up the learning curve. Even communicating with the router can be painful. Once configured, most routers let you telnet in to them for management and configuration tasks, but not usually the first time around.

Most routers therefore typically feature a serial port which lets you hook up a dumb terminal or a PC running a terminal program which lets you access the router's text-based configuration menu. One router I installed wouldn't even talk to good old Windows Terminal: I had to download ye olde Procomm Plus for DOS, circa 1987AD, before it could be configured. Luckily, some routers are a bit easier to configure — the Digi Retoura ST has an LCD control panel and keypad for direct configuration, while the latest Ascend Pipelines have Java applet-based configuration firmware, making them configurable from a browser. Most user-friendly of all is probably the Windows-based Shiva Monitor software supplied with the AccessPort.

Once connected to your router you'll need to enter such crucial details as the ISDN number it has to dial, the IP address of the router or gateway at the other end, the IP address of this router, the DNS IP address, logins, passwords and security levels. This is just a basic list of data you can enter; more sophisticated users will want to configure things like the PAP and CHAP security protocols, data compression and bandwidth on demand.

Checking that the installation works is fairly straightforward and most include comprehensive diagnostics in the firmware as standard. Once the installation has passed this test you can use conventional internet tools, such as ping or even a web browser, to make sure that calls are being initiated and terminated as required.

The final step is to roll out TCP/IP to the workstations, a relatively easy task if you're using Windows 95, less so if you're still using Windows 3.1x. Your internet service provider will have allocated you a range of IP addresses, say 192.168.0.1 to 192.168.0.25, and you then manually dole out one of these IP addresses to each workstation. This tedious chore can be greatly simplified if you're running Windows NT on the server, as you can install the DHCP (Dynamic Host Configuration Protocol) service. This lets you define a pool of IP addresses that are then dynamically allocated to each workstation as they log on to the network. So instead of specifying a "static" IP address for each workstation, you'd obtain the IP address automatically from the server.

Silence is expensive

A final word of warning: ISDN is completely different to the usual PSTN phone system we hook our modem up to, and it's easy to rack up excessive ISDN phone bills unless you keep a close eye on it. The main problem is ISDN's inscrutable "silence": the absence of the usual audible clues such as dial tones and negotiation whistles and noise means you're entirely dependent on software to tell you if the line is up and data is flowing correctly, which is a scary prospect. If you don't want phone bills that resemble telephone numbers (ho-ho, weak joke) it's essential to get BT to supply you with completely itemised bills for your ISDN line so you can see exactly what your router gets up to when you're not looking.

PCW Contact

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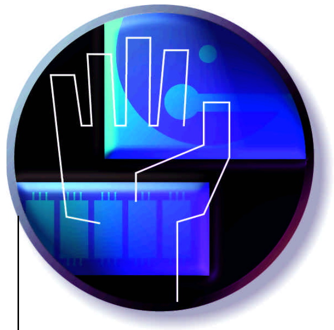


Serial solution

Roger Gann shows you how to maximise comms speed by making the most of that unsung PC hero, the serial port. Plus, do *you* know the difference between baud rate and bps?

This month I'm taking a look at that unsung hero of the internet, the humble PC serial port — without it, where would modems be? I'll be showing you various ways to ensure you're squeezing every last drop of performance out of it, so that it doesn't bottleneck your modem and mar your surfing "experience".

The first port of call

The original PC serial interface used the 8250 (later 16450) Universal Asynchronous Receive/Transmit or UART chip. The 8250 UART has only a one-byte receive buffer, which means that after the 8250 receives a character, it has to be retrieved before the next character arrives or it's overwritten, i.e. lost. This leads to CRC errors, with consequent retransmissions and an inevitable impact on throughput.

At 1,200bps, a new character arrives about every 8ms — plenty of time for an interrupt handler to fetch the character from the UART and store it in a receive buffer. But at 19,200bps, a new character arrives about every 0.5ms, and at 115,200 baud (the maximum speed of the standard PC COM port) about every 90 microseconds. Depending on your CPU speed, there may not be enough time to reliably service one interrupt per character. As a result, the effective throughput ceiling of an 8250 UART is 38,400bps.

The superior 16550A or AFN UART overcomes many of the limitations of the 8250 and is reliable at speeds of up to 115,200bps. It has two main improvements over the 8250. Firstly, it has a pair of 16-byte send and receive buffers, thus giving it 16 times the buffering capacity of the 8250. Secondly, it has a First In, First Out (FIFO) buffering scheme, which can dramatically improve performance on modem transfer speeds of 9,600bps or higher.

To see which UARTs are installed on your system, exit Windows and run the MSD utility included with DOS 5.0 and later by entering MSD at the DOS prompt. Once in the program, press C to see your COM ports. The type of UART installed for each of your ports appears on-screen.

Serial port upgrades

If you have an 8250 UART you have two choices: you can either upgrade to a 16550A or buy a third-party card, such as the Hayes ESP II. Note that if you have an internal card modem, it will most probably have its own 16550 UART aboard, so upgrading your PC's UARTs won't be necessary.

Upgrading 8250 UARTs

If you have a pretty old I/O card in your PC, the chances are it's got a 40-pin socketed 8250 UART. In this case, upgrading is simple. The 16550A is pin-compatible with the 8250, so all you've got to do is obtain a 16550AFN UART from somewhere like Maplins or Radio Spares, unplug the 8250 and replace it with the 16550A. However, if the 8250 is soldered in or you've got a more modern I/O card with a multi-function ASIC chip, then it's much less hassle to buy a £20 replacement I/O card.

Hayes ESP

Hayes Optima V.34 modems use a bigger "data dictionary" than their rivals and this enables V.42bis data compression to achieve 8:1 compression ratios, twice as much as normal. On a 28.8Kbps modem this would give you a maximum potential data transfer rate of 230Kbps, way beyond the capabilities of a "fast" 16550 serial port. So Hayes offers its own serial-card solution, the Hayes ESP Communications Accelerator. This 16-bit ISA card is outwardly 16550-compatible but features a co-processor plus a pair of 1Kb send and receive buffers designed to eliminate buffer overflow problems. The ESP has had a spot of bother on the driver front over the years and the NT drivers have yet to emerge from interminable beta, but the Windows 95 drivers work just fine. The ESP II single port card goes for around £60 plus VAT. If you're serious about high-speed comms, this is the card to use.

Software tweaks

As well as upgrading your serial port hardware, there are a number of software tweaks you can make to improve data throughput.

■ Flow control

With today's fast data transfer rates it's essential for the computer to be able to exercise some control over the flow of data to and from the modem, in order to prevent data loss. After all, there's no point in sending more data if the last lot hasn't been dealt with. This process is called flow control and there are several ways of doing it. The slowest way is software flow control, which makes use of two special characters, XON (Transmit on) and XOFF (Transmit off). When software flow control is in effect, sending a modem an XOFF character stops the flow of data. Sending the modem an XON character causes data to flow again. This is an inefficient method, significantly reducing bandwidth by adding two control characters for every eight sent.

The alternative is hardware flow control or RTS/CTS, which is more responsive and efficient. This uses a set of pins in the serial port, "Ready to Send" and "Clear to Send", and depending on their "state", data is either sent or paused. A minor caveat: you will need a decent, fully-wired serial cable with the CTS/RTS wires in place for hardware handshaking to work. Note that this type of flow control isn't the exclusive preserve of external modems — internal modems can also take advantage of it.

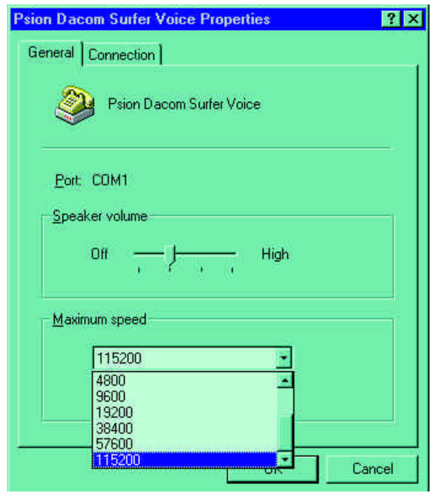
So how do you choose hardware flow control? In Windows 3.1x open Control Panel, then double-click on the Ports icon. The resulting window offers an icon for each COM port. Double-click on the icon of the port you want to configure, then click on the Settings button. Select Hardware from the Flow Control list box, and then click on OK. In Windows 95 click on the Modem applet in Control Panel, highlight your modem and click on the Properties button. Click on the Connection tab and then on the Advanced button. Check the "Use Flow Control" box and select Hardware (RTS/CTS). Click OK a few times to back out.

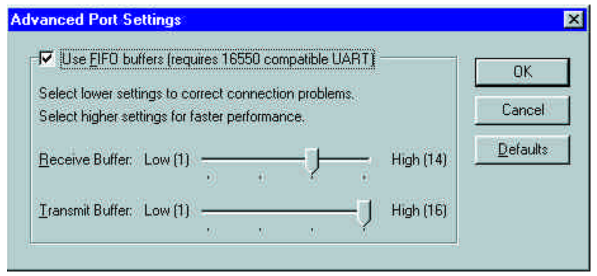
You may also need to tell your comms apps to use hardware flow control. For example, if you use WinCIM 2.01, simply add the line

```
FlowControl=3
```

to the [Connector (CIS Connection)] in the CIS.INI file.

You'll also need to tell your modem which type of flow control to use. Check through its "initialisation string" and see if you can see "&K3", the usual Hayes command for turning on hardware flow control. You'll need to do this for DOS and Windows 3.1x comms apps; under Windows 95, provided you've installed the modem correctly, turning on the hardware flow control via the Control Panel modems applet is sufficient.





Top Windows traditionally errs on the side of caution when it comes to modem line speeds, but it's normally quite safe to throw caution to the wind and crank it up to its maximum speed: 115,200bps in the case of V.34 modems

Above Once again, Windows errs on the side of caution when it comes to the FIFO buffers in the 16550 UART. Experiment by upping the Receive Buffer from 14 to 16

■ Windows 3.1x

Windows 3.1 was the first version of Windows to support the FIFO feature of the 16550 UART for Windows-based applications. (DOS apps running under Windows 3.1, 3.11, or Windows for Workgroups 3.1 don't support the FIFO feature.) However, Windows for Workgroups 3.11 does give DOS comm apps access to the FIFO feature. An upgrade for the Windows for Workgroups communications driver SERIAL.386 is available which can also use the transmit buffer (TX) of the 16550 UART. Previous versions of the communications driver use the receive buffer (RX) only. Check the Microsoft KnowledgeBase on the web for WG1001.EXE, which contains the updated driver.

You may be able to improve throughput without the need for new hardware, simply by adjusting a couple of Windows SYSTEM.INI settings. Incoming data is held in an internal buffer by COMM.DRV, the Windows 3.1x serial port driver, until it's retrieved by the comms program you're using. However, it's not always possible for the comms program to retrieve this data in a timely manner. If the buffer isn't cleared, then data can get overwritten. Luckily, it's possible to adjust the size of the buffer. By default, this is set to 128 bytes.

By simply adding a line to the [386enh] section of your SYSTEM.INI file, you can create a buffer as large as 10,000 characters. Actually, since the COMM driver maintains a separate buffer for each of your PC's COM ports, you can add up to four lines, each controlling the size of a particular port's buffer.

The syntax looks like this:

```
COMxBuffer=num
```

where x is the COM port number, i.e. a number between 1 and 4, and "num" the buffer size. Thus:

```
COM4Buffer=1024
```

sets the size of the buffer for COM 4 to 1,024 bytes. Don't forget that you've got to exit and restart Windows for the change to take effect.

How big should your COMM buffer be? If characters are being dropped from incoming data transmissions, create a new buffer of at least 2,048 bytes. If problems

Universal Serial Bus (USB)

Luckily, in the nick of time, a solution to the inherent inadequacies of the serial port has arrived: the Universal Serial Bus (USB) which, by the end of the century, will probably replace both serial and parallel ports on PCs. With speeds of up to 12Mbits/sec, USB is aimed at simplifying and standardising the interconnection of PCs with peripherals such as modems, printers, mice, keyboards, digital speakers, joysticks, gamepads, telephones, telephone networks, scanners and digital cameras.

USB uses a tiny four-pin connector (two for data, one for power and one for ground). In fact, there are two types of connector: "Series A", a plug for a peripheral and a socket for a PC platform, is for applications permitting the cable to be moulded into its peripheral, while "Series B" is used for applications requiring a removable cable. The two-connector series is keyed differently to avoid mis-matching. PCs will most likely feature a USB "expansion hub" built into the keyboard or monitor, which will allow peripherals to be daisy-chained together — USB can connect up to 127 different devices to a single PC.

Instead of relying on the intelligence embedded in the host PC, the USB detects which devices are added or removed, automatically determines what host resources each peripheral needs, including driver software and bus bandwidth, and makes them available. Future versions of Windows 95 will be equipped with drivers that allow a PC to recognise USB peripherals. The plug-and-play feature enables users to attach or remove peripherals with the system running and without requiring the nuisance of rebooting. According to Dataquest, by the summer, 75 percent of the 22 million PCs manufactured worldwide will be equipped with USB ports.

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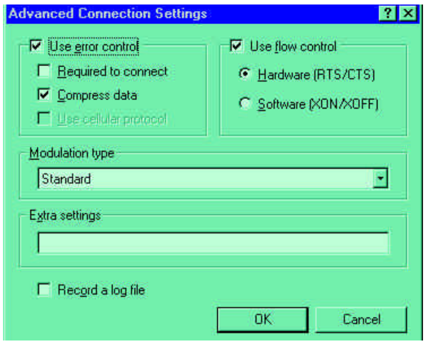

If you want reliable, high-speed modem connections it's important to make sure you're using hardware rather than software handshaking; use this dialog to choose which

Rant corner — baud and bps

It's embarrassing, the number of otherwise knowledgeable people who use the terms baud rate and bits per second interchangeably. For example, the brand new CompuServe front-end, v3.0, continues to refer to "baud rate" when it really means bits per second. Baud actually refers to modulation rate: the number of times the line changes state every second. The difference between baud and bps is a result of the different forms of modulation used to encode digital data into analogue waveforms. At 300bps transmission rates, bps and baud happen to be the same; but above this speed, the 1:1 relationship ends. The maximum baud rate possible over normal phone lines is 2,400; the maximum bits per second rate is, at present, 33,600bps. So please stop using baud when you mean bits per second. Purleeze!

persist, increase the size of the buffer to 4,096 or even 8,192bytes. Note also that the 16550A by default wakes up in 8250 mode and has to be switched in to 16550 mode via software. So if you've got a 16550 buffered serial port, you have to explicitly tell Windows 3.1x to use it. Add this line to the [386Enh] section of your SYSTEM.INI file:

```
COMnFIFO=On
```

where n represents the number of the COM port for which you are activating the buffer.

Another tweakable parameter is the COMBoostTime. This SYSTEM.INI entry specifies the time allowed a "virtual machine" to process a COM interrupt: if it's too short, you can lose characters. Its default value is 2 but you could try increasing it to 4. Once again, it's located in the [386enh] section:

```
COMBoostTime=4
```

Note: If you don't find it here, just add it. You can specify an even higher value but be conservative, since setting it too high can actually slow down communications.

Windows 95

Mercifully, Windows 95 makes optimising your modem's data throughput considerably easier than Windows 3.1x. Provided the modem is installed correctly, then there are only a couple of things to check. You should have received an INF setup file with your modem, which correctly describes all the modem's features for Windows 95. But if it didn't come with one and your modem doesn't feature in Windows 95's list of modems, you can always install it as a generic "standard" modem. This is OK-ish but not optimal, and if at all possible I'd recommend paying a visit to your modem maker's web site to see if proper Windows 95 INF files are available for your modem, for download.

Once installed, open Control Panel and click on the Modem applet. Highlight the modem and click the Properties button. On the General Tab set the maximum speed to four times that of your modem's speed: if you have a 28,800bps modem, set it to 115,200bps. Windows traditionally errs on the side of caution and always underrates the modem speed, typically setting the maximum speed to 57,600bps.

Next, click on the Connection tab and then on the Port Settings button. Make sure the Use FIFO buffers option is ticked and experiment by sliding the Receive buffer all the way up to 16. Click OK and then click on the Advanced button. Make sure the Use Error Control and Use Flow Control options are checked. Click OK several times to quit. And, er, that's it!

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Printer potential

Look at your printer: it’s working, right, and it does just the job you want? Maybe; but it could do better. Why not upgrade it? Roger Gann explains how.

The humble printer is arguably the most important computer peripheral you can buy, perhaps second only to the PC itself. Printers have traditionally tended to be fixed-function devices, capable of performing the actions they were designed to and nothing else, and largely incapable of being upgraded. If you had a daisywheel printer (remember them?) you could change the daisywheel or add a cut-sheet feeder, but that was about it. Things weren’t much better for dot-matrix printers, either.

Expansion potential increased with the advent of laser printers. Many had at least one slot for a font cartridge, a slot for additional memory or perhaps an interface to the printer’s “video” engine. It was now possible to upgrade your printer. Today, most laser printers are built with expansion in mind and feature things like SIMM slots, MIO ports for network interface cards, font card slots and comprehensive paper-handling options. Upgrade options for inkjet printers are less extensive, however. Nevertheless, it’s surprising just how far you can upgrade a printer. But why would you want to?

There are several reasons. First in line is cost — it can be cheaper than buying a new replacement printer if all you’re missing is a feature that an add-on can provide. And add-ons protect your investment in a printer: you only have to pay for the features you wish to add. You might think it doesn’t make economic sense to upgrade an old laser printer, but printers like the LaserJet II and III were built like tanks and even today still have plenty of life left in them.

Printer upgrades neatly fall in to two categories, hardware and software.

Hardware

Memory

Laser printers, or more accurately, page printers, hold a whole page of data in memory before printing it. The amount of installed memory isn’t too important when it comes to printing text but it’s crucial if you want to print graphics: a 300dpi printer needs a full megabyte of memory to print an A4-sized image. The move to higher resolutions, to 600dpi, actually quadruples the memory requirement, but the application of memory compression technology has kept the amount of RAM required to just a couple of megabytes. Even so, putting in extra RAM will always help when it comes to printing complex graphics, especially if PostScript is involved.

In the past, extra printer memory took the form of expensive proprietary custom memory cards, but most current printers take standard SIMMs so adding more RAM needn’t be too painful, especially as memory is still relatively cheap. Don’t forget that if you have a GDI printer you can add more memory to the host PC to improve printing performance, with the benefit that it goes into the PC’s general memory “pool”.

Some printers, such as the EcoSys range from Kyocera and the LaserJet 5, can take flash memory as well. This special kind of memory is used to semi-permanently store downloaded print images, e.g. forms or letter headings. Every time you wanted to print a letter you could send a code to the printer to print the scanned-in header first. This way you’d print on plain paper and so wouldn’t have to keep stocks of specially-printed headed paper: you’d never run short either. More importantly, it would mean that you could dispense with the need for a second paper tray to hold the headed paper.

Paper handling

It’s highly likely that, regardless of what printer you’ve got, additional paper handling add-ons are available for it, so that you can use different sorts or sizes of paper with your printer. Take the dot-matrix printer — printing sticky labels can be a risky proposition with a push tractor feed that many dot-matrix printers have as standard. Many allow the fitting of a pull-tractor feed specifically for this task. Or you might want to do a lot of mail merges so you need a cut-sheet feeder instead, something a little more advanced than that rudimentary cut-sheet tray that came as standard with the printer.

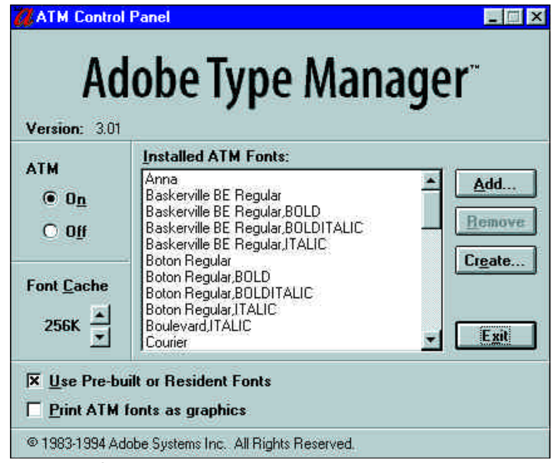
Most laser printers are now designed with add-on paper tray “stacking” in mind and so can take a second paper tray that fits to the underside of the printer. Fitting a second paper tray allows you to put your letter-heading in one tray and your continuation sheets in the other. Or, if the printer is a busy one, being shared on a network, the second tray can be used to expand the printer’s overall paper capacity : such trays typically have a 250-sheet capacity. Some inkjet printers even have a second paper tray option. Most are a doddle to fit — the printer just sits on the second paper tray and once you’ve made a few changes to the configuration via the front panel or through the printer driver, you’re away.

Enhancing your parallel port

This is one of the few printer hardware upgrades that you fit in your PC. I’m not talking about any sort of printer port, I’m talking about the very latest bi-directional (bi-di) parallel port. This is available in several flavours, sometimes called an Enhanced Parallel Port (EPP) or Extended Capabilities Port (ECP). Either way, a “bi-di” parallel port enables a two-way conversation between your PC and the printer, allowing the printer to pass status messages back to the PC, vital things like “Paper Jam” or “Low toner”. These “8-bit” parallel ports are faster than the standard 4-bit parallel port fitted to most PCs, and if you have a GDI printer you’ll appreciate a faster parallel port. So, if your printer has a “bi-di” port, it makes sense for the PC to have one as well. The best one I’ve come across is a VL-Bus multi I/O combo card with an IDE interface plus fast serial ports. Price £29 from Dabs Direct ((0800) 558866) but check the ads in *PCW* for other deals.

Updated printer drivers

The Windows printer drivers that shipped with your printer have most probably been superseded, the ones that came with Windows almost definitely have. Getting the latest driver means you’ll be using a less buggy (hopefully!) version that’s probably a bit faster and possibly with more controls or features. You can check the version number by opening Printers in the Control Panel, clicking on Setup and then clicking on the “About...” button. The best way to get the latest drivers is to download them from bulletin boards such as CIX, CompuServe or over the internet, from the manufacturer’s web site. For example, the latest PostScript driver, v4.1, is available from the Adobe Systems web site at www.adobe.comand this has numerous extra features compared to the plain vanilla Win95 version written by Microsoft. You can also download the latest PPD and INF files for your PostScript printer to ensure it’s correctly installed.



The ATM Control Panel. The create panel allows you to make customised versions of Adobe Multiple Master fonts

Colour

You may not be able to upgrade your laser printer to colour (though the NEC SuperScript 610/660 can do spot colour) but both inkjet and dot-matrix printers can commonly be upgraded from mono. By far the easiest to convert are inkjet printers: providing they are “colour ready”, all you do is remove the black ink cartridge and replace it with a snap-in tri-colour cartridge. You then specify “colour” in the printer driver (or install a colour driver) and, hey presto, you’ve got colour, for about £25 or less. If only all upgrades were this simple.

Font cartridges

One of the original printer upgrades was to increase its stock of internal fonts. This took the form of a cartridge or card that you plugged into a special socket on the printer.

Expanding the number of internal fonts might not seem relevant to Windows users; after all, scaleable TrueType fonts are a dime a dozen these days. But there’s still a compelling reason not to turn your back on resident fonts — speed. When a font resides in the printer, not only is there no time wasted downloading soft fonts, but the print time is also quicker. If you have to do a lot of printing in the same font, then you should consider making that font a permanent, resident printer font.

Pacific Data Products produces one of the best known font cartridges, the 25 in One. This cartridge contains 172 fonts and is available for the II, III and 4 Series printers, plus IBM and Epson laser printers. It’s also available as a SIMM for the LaserJet 5.

PostScript upgrades

The ultimate font upgrade has to be the one that installs PostScript on your laser printer as these typically also install the basic “family” of 35 PostScript fonts. You get the exacting typographical accuracy of PostScript , too.

Installation is simple: you just plug in the PostScript cartridge (or SIMM in the case of the LaserJet 4 and 5) to get instant, high-quality PostScript fonts. This is undeniably simple, but there’s a price to be paid as most genuine PostScript printers have relatively powerful processors, something lacking in older LaserJets, and this can make for slow printing. You may need to top up printer memory, too. Expect to pay about £200 to £250 for a PostScript upgrade, from Hewlett-Packard. Pacific Data has the PacificPage Level 2, a PostScript Level 2 language emulation SIMM module for the LaserJet 4 and 4 Plus printers.

Pacific Data Products also sells a range of plug-in accelerator cards, designed to speed up sluggish print performance in a LaserJet fitted with a PostScript cartridge. There are two versions: the PacificPage IIXL, for the LaserJet II, which consists of the PostScript cartridge plus an accelerator board; and the PacificPage PE/XL, which is for the LaserJet IIP, IIP Plus, III, IIID and IIIP.

PACIFIC DATA PRODUCTS

Software upgrades

The software driver plays a significant part in the printing process, having a major influence on both speed and print quality. The drivers that come with Windows are pretty good but, as ever, there’s always room for improvement, either adding features that don’t exist or doing existing tasks better.

Perhaps the simplest printer enhancement you can buy is to add extra TrueType fonts to your Windows installation — these are available from Microsoft, Monotype, Bitstream.

More sophisticated upgrades fall into two categories — accelerators and print enhancements.

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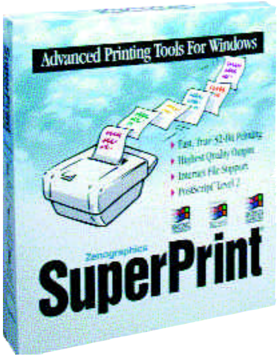
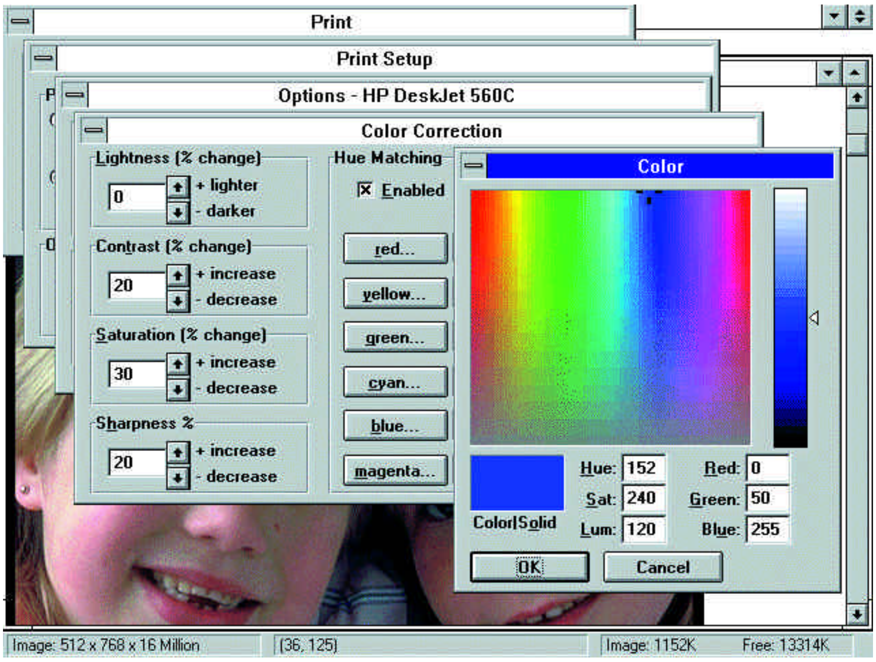
Adobe Type Manager

Adobe Type Manager (ATM) predates TrueType and was the original scalable font manager for Windows. For most Windows users, it



carries out much the same function as TrueType — it allows a printer font to be accurately displayed on-screen at all point sizes, thus removing the need for a raft of separate fixed-point screen and printer fonts. ATM also lets you use superior PostScript soft fonts with a non-PostScript printer, and its Multiple Master fonts feature is useful if you want to fine-tune the appearance of a font. However, much of ATM's thunder was stolen by TrueType which has the redeeming virtue of costing zilch. As a result, only those that really need to use genuine PostScript fonts will fork out £30 for ATM, i.e. those submitting work to a print bureau or typesetter.

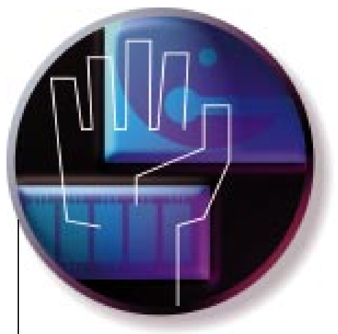
SuperPrint's comprehensive colour correction options



SuperPrint 4.0

SuperPrint's job is simple — it speeds up Windows printing, especially colour printing, which has always been a relatively slow process. It does this by using highly-optimised 32-bit printer drivers and sending the data to the printer in a special compressed "metafile" format. It comes complete with "SuperDrivers" for Windows 3.1x, 95, and NT 3.51, with controls for sharpness, contrast, lightness, saturation, dot gain and hue matching. Like ATM, it allows you to turn your non-PostScript printers into PostScript devices, but this time for graphics as well.

While you can get speed gains when used in conjunction with low-end colour printers, I guess that the true benefits of SuperPrint only become apparent when used in conjunction with high-end output devices where fine control of the output print quality is important. You will need a fairly well specified PC in order to run SuperPrint; basically, the more RAM you have the better, and I'd start at 16Mb. This amount allows its "SuperRIP" to perform full-frame rasterisation of the entire image to be "printed" in RAM; with lesser amounts of RAM it has to break down the image into bands, which is of course slower.



Drive time

Floppy disks have been overtaken and lapped by today's removable storage drives. Roger Gann explains the new technologies and sorts the hatchbacks from the sportsters.

It's all to do with relativity, you know. Ten years ago, when your PC had a 20Mb hard disk, a 1.2Mb floppy was a capacious device capable of backing up the entire drive with a mere 17 disks. Today, the standard hard disk fitted to PCs has become the 1.2Gb drive: a 600-fold increase in capacity. And what of the humble floppy? In the same period, its capacity has increased by less than 20 percent. As a result, it's now at a disadvantage when used in conjunction with any modern large hard disks — for most users, the standard floppy disk just isn't big enough anymore.

In the past, this problem only affected a tiny proportion of users, and for those that did require high-capacity removable disks (typically DTP'ers running Macs), solutions were available: 44Mb 5.25in SyQuest removable hard disks. But these were expensive.

Times have changed, and today, everybody needs high-capacity removable storage. These days, applications don't come on single floppies. They come on CD-ROMs. Thanks to Windows and the impact of multimedia, file sizes have gone through the ceiling. Create a Word document with a few embedded graphics and before you know it, you've got a multi-megabyte data file, quite incapable of being shoehorned into a floppy disk.

Awkward as it is, there's no getting away from the fact that a PC just has to have some sort of removable, writable storage, with a capacity in tune with current storage requirements. We all need removable storage for several reasons: to transport files between PCs, to back up personal data, and to act as an overspill for your hard disk, to give you (in theory) unlimited storage. It's much easier to swap removable disks than fit another hard disk to obtain extra storage capacity.

In 1981, 5.25in floppies kicked off at 160Kb, quickly went to 180Kb and then to 360Kb with the advent of double-sided drives. In 1984, the 5.25in floppy maxed-out at 1.2Mb. That same year, Apricot and HP launched PCs with the revolutionary Sony 3.5in 720Kb disk drive. Three years down the road, this doubled in size to 1.44Mb and for the past decade or so, that's where it's stayed. Oh sure, there have been attempts to increase the capacity of the humble floppy, but none got very far.

First, there was IBM's bid (in 1991) to foist a 2.88Mb floppy standard on the PC world, using expensive barium-ferrite disks, but it never caught on. And both Iomega and 3M had another go in 1993 with the 21Mb "Floptical" disk. But it never took off: it was just too dear and too small.

For a long time, the range of removable storage options wasn't extensive. You could choose between low-capacity floppies, clumsy tape solutions, expensive optical drives, and removable cartridges. But today, the situation is radically different, and finally there is a real choice in removable storage. There is a wide range of capacities on offer, starting around100Mb and rising to 1Gb. The new removable drives have never been more affordable, and having been designed with the end-user in mind, are easy to install.

Installation options

Removable drives are available both in external and internal versions. The former will have either a parallel port or SCSI interface, while the latter will have a SCSI or IDE interface, although IDE is not all that common at the moment.

Unlike fitting a second hard disk, which can be a daunting task, the great news is that most of the new breed of removable storage devices have been designed with ease-of-installation in mind. The easiest to install are the external drives with a parallel port interface. Not only do you not have to take the lid off your PC, but it also lets you share/move the drive between different PCs. You can use it with a notebook, too. And because it uses your printer/parallel port, installation is no more complicated than plugging in a cable.

The only problem with this otherwise perfect arrangement is that the parallel port, which was never designed to handle these devices, isn't very "fast", and older parallel ports can act as a bottleneck, slowing down the drive's data transfer rate. Luckily, however, most recent PCs are equipped with an enhanced parallel port (EPP or ECP) and these are capable of good data transfer rates. I recently used a parallel port tape streamer hooked up to an EPP port and it was capable of backing up at just under 8Mb/min — a pretty respectable rate. In any event, such bottlenecks would only really impinge on fast devices, such as removable hard disks. Slower devices, such as the Zip drive, don't have a stellar data transfer rate to start with and so are unlikely to suffer at the hands of the parallel port interface.

If the ultimate data transfer rate is what you're after, you ought to consider SCSI versions of these devices. Most internal drives (Jaz, SyQuest, MaxIT and Zip) tend to use a SCSI interface, which is fine if you already have a SCSI card fitted as installation is no more complicated than plugging a spare connector on the SCSI ribbon cable into the back of the drive. The same applies to external SCSI drives, too. Very often they can be "daisy-chained" to other external SCSI devices. If you haven't got a SCSI card, they can be expensive to buy and fiddly to configure, although Iomega does a cut-down SCSI host adaptor called the Jet, which sells for around £80. Given the choice, I'd spend another £20 and buy a better host adaptor, from, say, Adaptec, Bus Logic or AvanSys.

Left Iomega's Jaz drive can take cartridges as big as 1Gb — enough space for you to back up your entire hard disk

Below SyQuest's EZflyer is cheaper but holds a maximum of 230Mb

Spoilt for choice

Although all these devices offer the same basic facilities and differ only in terms of capacity and speed, they do employ different technologies. They can be split into categories based on their respective technologies. At the last count there were three removable storage technologies: super-floppy, hard disk, and magneto-optical. Even though CD-R discs are dropping in price and the Panasonic innovative PD hybrid drive offers some interesting advantages, neither technology currently has much market presence.

Super-floppies

The current crop of super-floppies may resemble conventional floppy disks in physical size and operation, but they don't use the same magnetic recording technology employed on the standard 1.44Mb floppy. Without doubt, the most popular super-floppy is the Zip drive, of which Iomega claims to have sold ten million. The secret of the Zip's good performance (apart from its high 3,000 rpm spin rate) is a technology pioneered by Iomega (based on the Bernoulli aerodynamic principle) which actually sucks the flexible disk up towards the read/write head rather than vice-versa. The disks are soft and flexible like floppy disks, which makes them cheap to make and less susceptible to shock. They're fast, and have a capacity of 94Mb — big enough for most users. Sadly, Zip drives are not backward compatible with 3.5in floppies and can't be used as boot devices, although there are BIOSs in the pipeline which will permit that. Imagine, you could install Win95 from a single floppy!

The new kid on the super-floppy block is the rival standard being promoted by 3M and Compaq. An LS-120 disk looks very similar to a common-or-garden 1.44Mb 3.5in disk, but uses a refinement of the old 21Mb floptical technology to deliver much greater capacity and speed. In fact, this technology had originally been developed by Iomega, but

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was abandoned and sold on to 3M. Named after the "laser servo" technology it employs, an LS-120 disk has optical reference tracks on its surface that are both written and read by a laser system. These "servo" tracks are much narrower and can be laid closer together on the disk: an LS-120 disk has a track density of 2,490tpi (tracks per inch) compared with 135tpi on a standard 1.44Mb floppy. As a result, the LS-120 can hold 120Mb of data.

As well as being a bit bigger, its other advantage over the Zip drive is that it can also read/write ordinary 3.5in floppies and so can be used as a boot device. While its data transfer rate is faster than that of a standard 3.5in floppy drive, it's not as fast as a Zip drive due to its considerably slower spin speed. And at present, the LS-120 isn't available to buy as an add-on — it's currently only available ready-installed on Compaq's new range of Deskpro PCs.

Hard disks

Above about 100Mb, the most commonly used removable drive technology is derived from that found in conventional hard disks, which not only gives you high capacities but also provides fast performance, pretty close to that of conventional fixed hard disks. These drives behave just like small, fast hard disks.

This approach isn't particularly new: SyQuest cartridges have been using the technology for many years. However, SyQuest drives have tended to be small

The PowerMO 230 is one of the latest generation of magneto-optical drives from Olympus

(44Mb and 88Mb). Recently, SyQuest embraced the 3.5in form factor and launched a 135Mb drive (the EZ-135) but this has been rapidly superseded by the 230Mb EZflyer. It's fast, like a hard disk, and reasonably priced (about £200).

Xyratex, the IBM spin-off, has got in on the act with its 540Mb MaxIT drive. This is a little pricier (about £300) but has twice the capacity and can read older SyQuest cartridges. It's nippy, too.

The drive with the largest capacity is Iomega's Jaz which can take cartridges as large as 1Gb. This, too, is affordably priced (about £375) and offers excellent capacity with great performance. Its huge capacity makes it possible to back up your original hard disk in one go, in just a matter of minutes. It's a good choice for audio-visual work, capable of holding an entire MPEG movie in one swallow. You could even make it your primary drive!

Magneto-optical

As you might expect from the name, these drives use a hybrid of magnetic and optical technologies. The disks have a special alloy layer that can be modified under the influence of a magnetic field. Changes can then be read by reflecting a laser beam off the alloy layer. The magnetic field in the magneto-optical (MO) disk actually twists the laser's beam of light, and this twist can be detected and used to read the data.

However, this is a "two-pass" process, and as a result, MO operations are relatively slow. This drawback is compounded by the fact that MO heads tend to be heavy, which also makes for slow average access times. Nevertheless, MO disks are cheap at around a tenner and they have top archival properties, often being rated with an average life of 30 years — far longer than any magnetic media.

MO came close to being killed off by the Zip, but a new generation of faster, cheaper drives, spearheaded by Fujitsu, have breathed new life into the format. MO disks are much the same size as 3.5in floppies but about twice as thick. Olympus has been the first to market the latest generation of MO kit with the slick-looking PowerMO 230. And Fujitsu has recently announced a 640Mb MO drive, the £299 DynaMO, which is backwards-compatible with older 128Mb and 230Mb MO disks.

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Two's company

You don't need an entire bank of PCs to create a network. Roger Gann's no-nonsense guide shows that linking two PCs can be not only a simple task but cheap, too.

As we race headlong towards the Millennium (no Matrox puns intended), the PC buzzword is "connectivity". To get the maximum from your investment, your PC just has to be connected to others, either via a local area network or to the internet. The *Hands On Hardware* column is nothing if not topical, so this month I'll be showing you how cheap and easy it is to network a pair of PCs, courtesy of Windows 95.

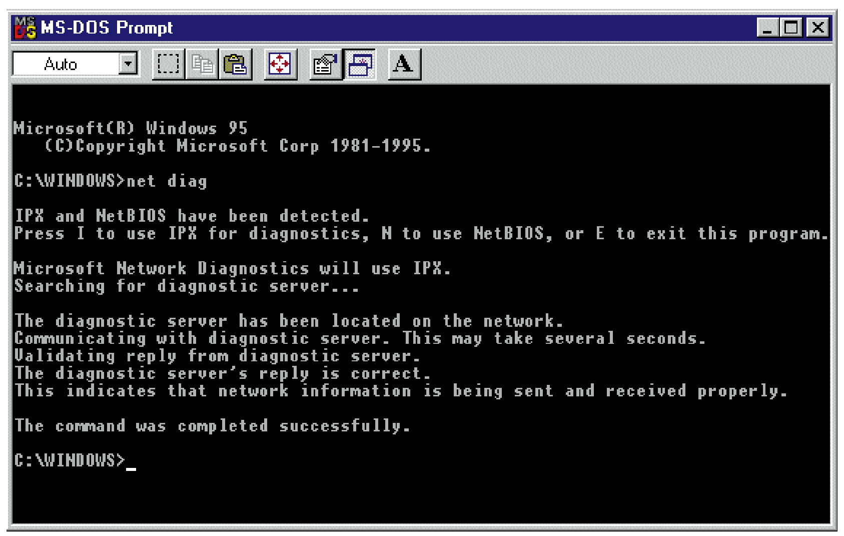
Why network? The age-old reasons are just as valid for two PCs as they are for 2,000: you can share data and expensive peripherals, you can centralise backup and improve security. Here is an example: maybe you've already got a PC at home in addition to the one you've bought your child, ready for Christmas. There's no sense in having two printers, or two tape streamers or two CD-ROMs in the house. You might as well share them on a simple network. Or, maybe you just fancy playing Quake in deathmatch mode?

This sounds like using a sledgehammer to crack a nut but it's so cheap to network a pair of PCs that it's almost a no-brainer. With less than £50 you'll be able to fully network both PCs to let them share resources. And yes, that does include VAT!

We're talking about real bargains here. And Windows 95 is the best network client you can have. It comes ready for just about any kind of connectivity you care to throw at it, together with all the networking software you may need. All you have to do is to add the hardware.

Troubleshooting

What if you can't browse your new network at all and can't see any of the shared resources on the other PC? Often it's much better to try and sort out a problem like this from the comfort of a DOS prompt, unencumbered by Windows 95 baggage. Windows 95 comes with elementary network diagnostics which come in handy at times like these. Open a DOS window and type NET DIAG <CR> on one machine. Select I for IPX (assuming you're using this network protocol). Type N to make this PC act as a diagnostic server, then do the same at the other machine, typing I for IPX and Y. The first machine will be broadcasting test messages which the other PC will be listening out for. If it can't hear anything, there must be a hardware problem of some sort, either with the cable or with the configuration of the card.



Cable capers

Mercifully, your network hardware shopping list won't be very long. All you need is a pair of network interface cards and some cable.

By far the most popular networking cable (or "media" in networking parlance) is thin Ethernet, also known as 10Base-2. This resembles a co-axial cable, the sort used in TC aerials. A five-metre long cable, terminated in BNC connectors will cost you around £10.

You will also need a pair of T-pieces and a pair of terminators, the total cost of which is about £6. Thin Ethernet uses what is termed a daisy-chain or "bus" topology, with all the devices linked by what becomes a single cable running between each PC.

If you were far-sighted you might think that twisted-pair cabling (also known as 10Base-T) was the true path to follow, rather than thin Ethernet and you'd be right.

However, because it uses a star "topology" with all the cables returning to a central hub, the cost of the hub generally makes it a non-viable proposition when linking only a pair of personal computers. But it is possible to buy what I term a "null-modem" twisted pair cable that you can use to directly connect two PCs, thereby obviating the need for a hub.

Many network interface combo cards will have both 10Base-2 and 10Base-T connectors and they will automatically sense which one you're using. But they tend to be relatively expensive and for our modest project I'm wanting to keep the costs down, so I'll go for the simplest 16-bit Ethernet card with just a 10Base-2 BNC connector, which should set you back less than £20 a kick.

A really good gauge of compatibility is whether or not it is "NE2000" compatible, so look out for this — the NE2000 was an old make of network card, which was originally sold by Novell, the mother of all PC networking.

Connecting the card

Installing a network card isn't a difficult job: no worse than, say, fitting a SCSI host adaptor. These days most network interface cards, even the cheap ones, are software-configurable, which makes life much simpler when first commissioning your network.

All network cards require hardware resources, specifically an IRQ and an I/O port address. Typically, an NE2000-compatible card will, by default, be set to use IRQ 3 and I/O port 300h. There's normally no problem with this I/O address but the default IRQ is another matter. We all know (don't we?) that IRQ 3 is already spoken for, being the preserve of COM 2. It is now possible to share IRQs on a PC but it's not a particularly good idea, so in the interests of having a quiet life I'd recommend using another, unused, IRQ instead — perhaps IRQ5 which is ear-marked for LPT 2. Or maybe IRQ 10. It really does not matter which one you choose just so long as it is free.

The fact of whether you've got an old-fashioned card festooned with jumpers, or a modern jumper-less software-configurable card determines the install sequence. If it's the former, you should use Windows 95's "Add new hardware" wizard to install the card drivers. These may come with the card, or if it really is NE2000-compatible it might rely on the standard NE2000 drivers that come with Windows 95.

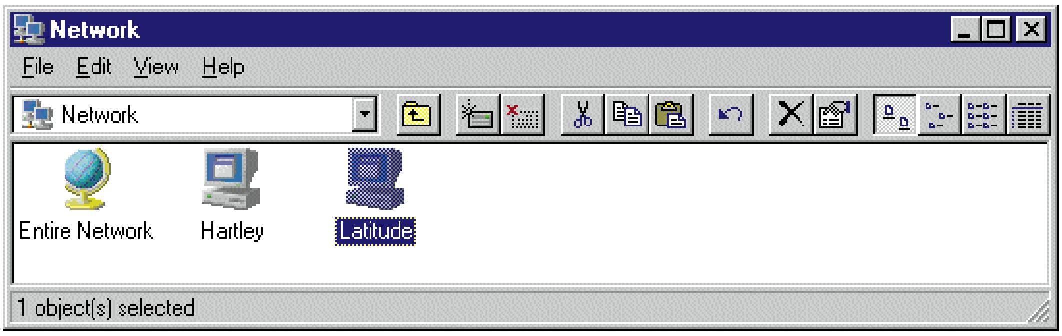
At this point, using the card's default settings, the Windows 95 Device Manager will tell you whether there are going to be any hardware resource conflicts. If there are, it's a simple matter to adjust the hardware resource setting that is conflicting, to one that isn't. Note down the new settings and adjust the card's jumpers to make it match. You can then open the PC and install the card in the usual way.

If, on the other hand, you have a modern network card, the correct sequence is to install the card in the PC first and then reboot Windows 95. If your PC is blessed with a plug-and-play BIOS, the new card should be recognised and you'll be prompted for drivers and then settings. If the BIOS doesn't support plug and play, use the Add new hardware wizard to auto-detect the new card. Install the appropriate drivers when prompted and if there's a hardware resource clash, simply adjusting the values on-screen will reconfigure the card. The final step is to cable up the two PCs. Fit the T-piece onto the BNC socket on the network interface card using the "vertical" side. Plug the Ethernet cable into one side and the terminator plug into the other. Then, just repeat the operation at the other end and that's it.

Putting in the protocol

We've now got to install the network protocol we're going to use, so hunt down the Windows 95 CD-ROM and plonk it in the CD-ROM drive because we'll be needing it. Windows 95 comes with several heavy-duty network protocols but for our little peer network (so-called because the workstations are of equal status), all we really need is NetBEUI. If you use dial-up networking to access your internet access provider, you might already have TCP/IP installed. Don't worry, because you can have more than one protocol "stack" in use at a time.

Fire up Control Panel and click on the Network icon. The Configuration tab should list the network card you've just installed. Click the Add button at the bottom and add a Client (the Client for



The Network Neighbourhood facility displays all machines connected to your peer-to-peer network: from here, you can configure the shared drive

Microsoft Networks). Click OK. Select Protocol and click Add. Select Microsoft from the list on the left and NetBEUI from the list on the right. Click OK. Finally click Service, select Microsoft on the left and File and Printer Sharing for Microsoft Networks on the right, then click OK.

Back at the main Network dialogue, select the Identification tab, give your computer and your workgroup (i.e. network) a name. Make sure both PCs have different individual names but the same workgroup names. Entering a description is optional.

When you accept all these settings, you'll be asked to restart the PC. When the PC reboots, you'll see a new dialogue box halfway through the Windows 95 boot sequence, prompting you for your name and password. These are "blank" at present so if you enter a name and password it'll ask you to re-enter and confirm it. Remember the password as it could come in handy later! We're now logged on to our little network. But how do we access drives and printers on the other PC?

A caring, sharing kind of network

Before we can see resources like drives and printers on other PCs, they have to be "shared". Once shared, they become available on the network. At its most simple, you right-click the drive, folder or printer icon and, from the pop-up context menu, select Sharing. Click on the Shared As button and give the resource a Share name (e.g. CD-ROM or just a letter if it's a hard disk). Select the type of access you want. For instance: full, read-only or "depends on password".

If you want, you can give a password specific to this resource. In this way you can make entire drives available either for sharing (you share the root) or just individual folders. On a network like this, I'd share entire drives and probably give full-access and read-only for CD-ROM drives.

A printer connected to the host can be shared, too. Once shared, don't forget to go over to the other PC and add the printer in Control Panel, specifying it as a network printer rather than a local printer. When Windows 95 browses the network to find shared printers, it will discover the shared printer on your other PC. It will then install an appropriate driver, then you'll be able to use that printer as though it were directly connected to your PC.

Once you've shared your resources, you should be able to see them from the other PC. Go over to it and click on Network Neighbourhood. You should see the other PC listed next to the Entire Network icon, plus an icon for this PC. Double-click it and the shared resources will be listed (typically, a drive letter like C:). Right-click the shared object and select Map Network Drive from the pop-up context menu. Give the new drive a letter like D and check the Reconnect at logon box. When you start Windows 95, you'll be able to access the other PC's hard disk as if it were Drive D:.

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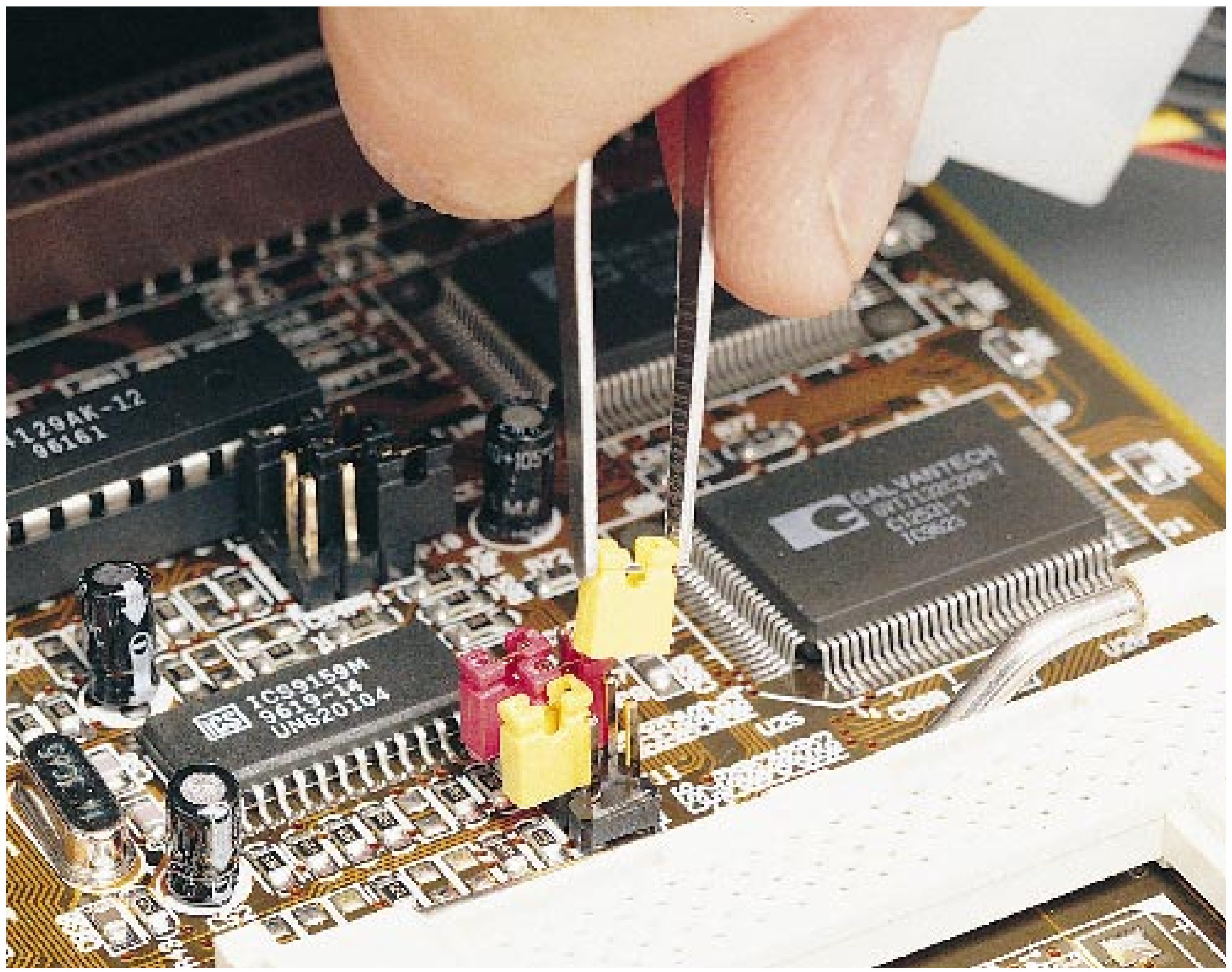
Out with the **old**

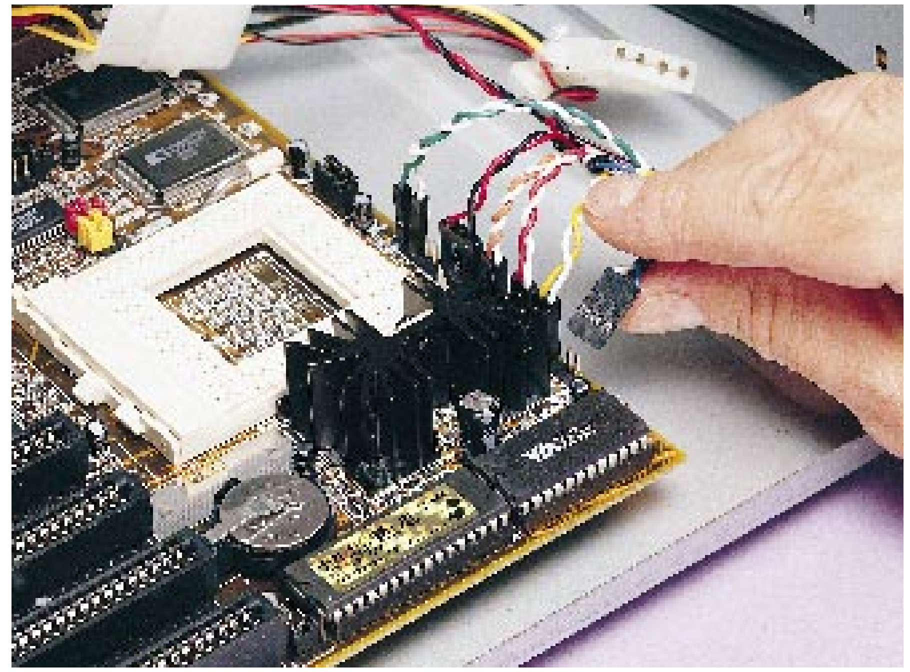
Fed up with watching paint dry while your PC chugs away? Why not upgrade the motherboard — Roger Gann shows you how.

Over the past few months I've looked at upgrading your PC in various ways: adding more memory, fitting an overdrive processor, adding an EIDE hard disk, and so on. While all these upgrades will improve your PC's performance, the overall gains garnered from these upgrades aren't particularly breathtaking. This is because all you're doing is moving a performance bottleneck elsewhere in the PC to some other, relatively old, component.

A more fundamental upgrade is required if you are looking for tangible performance gains: I'm talking about replacing the motherboard in your PC with a more powerful one. Not only would such a move allow you to use a more powerful processor, but you'd benefit from other advances, too, such as pipeline burst mode cache or the latest RAM technologies, such as EDO or Synchronous DRAM. You would also benefit from the latest PCI bus technology and lifesavers such as plug and play, especially if you're a Windows 95 user.



Coloured jumpers: we're in luck as this motherboard uses coloured jumper sleeves to differentiate the various types of jumper, e.g. clock speed and processor type. Make sure the new motherboard is correctly jumpered for the type and speed of processor you're using



Multicoloured leads: pay close attention to the multicoloured leads and plugs before you unplug them from the old motherboard — it'll help you to identify each cable. If you're lucky, the plugs will be labelled

Sometimes you have no choice but to swap motherboards. The fastest Pentium overdrive for the 486 architecture stops at 83MHz, yet Pentiums are now running at 200MHz, and if you want more performance you'll have to upgrade your motherboard. But this is not as expensive as you might think. A DX4/100 overdrive will cost £120, while a 100MHz Pentium motherboard will cost only £70 more. Don't lose sight of the potential extra costs imposed by the new motherboard, such as new memory if you've got old 30-pin SIMMs, or a new PCI graphics card if all you've got is VL-Bus.

A motherboard upgrade sounds complex, but don't worry. It is relatively hassle-free and your old PC gets a power boost without the need to duplicate or replace files, connections or peripherals. Complex reconfiguring is not necessary and, outwardly, your PC remains as its old familiar self.

The downside

Although it is physically possible to upgrade just about any PC's motherboard, you should pause before taking the plunge. Swapping motherboards is rather more involved than fitting an expansion card and not something for the technically timid. Choosing a motherboard can be a big problem because, apart from Intel with its Endeavour and Atlantis main boards, most are brand-less designs from companies of which you may never have heard.

Another problem is that, thanks to the pace of change, a particular model of motherboard might only be in production for a few weeks before being replaced. Remember, only four months separated the launch of the 166MHz and 200MHz Pentium processors, so the odds are that when you see a motherboard listed in an advertisement, its make and model won't be listed. Motherboards are effectively

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generic products, rather like potatoes. As for technical support, well — you are almost always on your own. Then there is the problem of overdoing it. There is no point in performing such an upgrade on a 386 because the rest of its hardware, like its graphics card and its hard disk, will be so slow as to be inadequate. The “weakest link in the chain” analogy applies here.

Another significant problem is the form factor of the motherboard: that is, its shape and size. While most clone manufacturers use the so-called “Baby AT”-sized mother-boards which are readily interchangeable, most big name manufacturers tend to use their own proprietary motherboard designs, which aren’t. Not only are they an odd, non-standard shape, but they may also be highly-integrated designs incorporating all I/O functions directly on the motherboard and not on expansion cards. You expect this from the likes of IBM and Compaq but you’ll find that Amstrad, Viglen and Elonex also fall into this category.

The only way to upgrade the motherboard in these makes of machine is via the manufacturer, which makes them difficult to get hold of and pricey. So before jumping in at the deep end, make sure your new board will fit okay.

Step by step

Step 1 — Preliminaries

■ Before doing anything, it’s a good idea to print out your existing CMOS settings. You can do this by taking a screendump of each screenful of settings. Ensure your printer is on and connected to the PC, and press the PrtScr key.

The reason for doing this is to prevent potential problems later on when you install your new motherboard and you can’t remember the previous settings. Don’t forget, we’re only changing the motherboard — all the other components are staying put.

Probably the most important settings are those that set the hard disk’s geometry, because if you get these wrong, the PC won’t reboot at the completion of the upgrade.

You could argue that this is unnecessary as most modern BIOSes are capable of auto-configuring the hard disk’s geometry, so what’s the point? Problems can arise if you previously used drive translation, say to reduce the number of cylinders to less than 1,024. When auto-configuration kicks in, it will only use the drive’s default geometry, not the translated one. The drive will not then boot or be recognised. But if you have the original values, it’s easy to key them in.

■ Take a moment to examine your new motherboard and read through its undoubtedly sparse manual. Check if there’s anything important of which you should be aware. Most motherboard manuals are invariably techie, but you should try to identify the positions of important jumpers.

■ If you’re fitting a new processor as well, install it and move all the jumpers now, while you’ve got perfect access to every corner of the board. The same applies if you’re fitting new RAM.

■ Finally, assemble your toolkit. You’ll need a crosshead screwdriver, an electrician’s screwdriver and maybe a pair of fine needle-nose pliers.

Step 2 — Dismantle the case

■ Switch off the PC and unplug everything attached to the system unit: typically the keyboard and screen. All micro-electronics are very sensitive to static, and the kind of static discharge that gives you a very mild electric shock can be fatal to micro-electronics, so take the precaution of earthing yourself by touching some metal plumbing before handling the new motherboard. Better still, invest in an earthing wrist-strap.

■ Remove the casing lid by undoing the screws at the back.

Step 3 — Remove the expansion cards

■ Our next task is to remove all the expansion cards, so undo the screw holding each card’s blanking plate and carefully extract each card, putting it somewhere safe.

I guess that most people will need to remove just three cards: a graphics accelerator, a sound card and a multi I/O card which will have the serial ports, parallel ports and the hard disk/floppy disk controller. This will have a couple of grey ribbon cables plugged into it, so unplug

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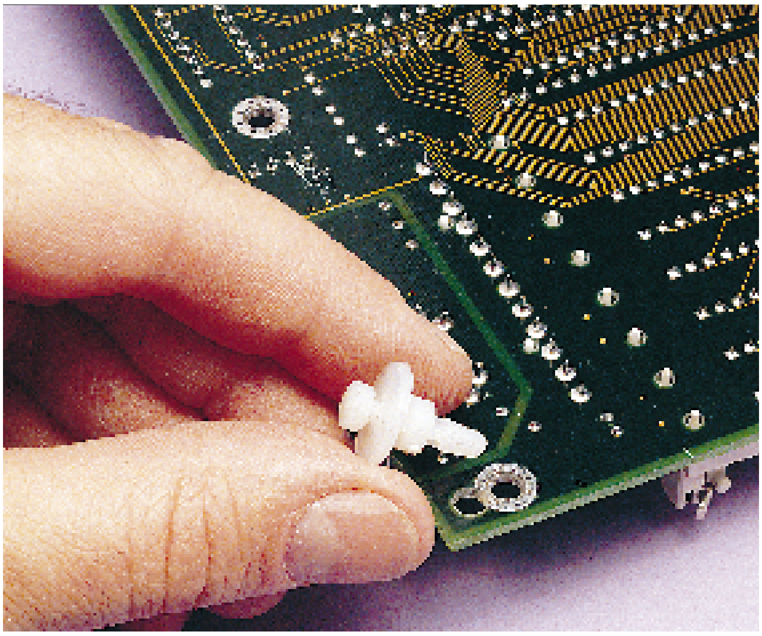
them, taking careful note of which side of the ribbon has the coloured edge.

■ Tuck the now loose cables away behind the disk drives and don't forget to unplug the hard disk's activity LED cable. More modern motherboards have done away with separate I/O cards and instead integrate the I/O ports on the motherboard, so in this case unplug all the cables.

If you have a sound card, unplug the thin CD audio cable before removing the card. With all the cards out, there's no need to remove anything else. The hard and floppy disk drives can stay put. Some compact casing designs use drive cages that hang out over the motherboard and make installing/removing a motherboard awkward, so remove these as well.



Plastic standoffs: be sure to make a careful note of which holes the standoffs occupied in the old motherboard before transferring them to the new one. You'll need a pair of pliers to remove them

Step 4 — Remove the cables

■ The next step is to remove the rest of the cables from the motherboard. Located somewhere near the keyboard socket at the rear you should see a pair of large, white or cream, power leads perhaps labelled P8 and P9. These can be quite reluctant to unplug, so you may have to use measured force to get them to shift.

■ There will also be a group of thin multi-coloured cables plugged in at the front of the motherboard. These are for the power and turbo LEDs, the keylock and reset button. Occasionally, the little black plugs will be labelled. If they're not, it makes sense to identify them now while they're still connected. There's often a name printed on the motherboard to identify that connector.

Step 5 — Remove the old motherboard

■ The motherboard will probably be held by a couple of bolts. Locate them, undo them and put them in a safe place.

■ The motherboard will now be resting on several white plastic stand-offs, or spacers. These fit into tapered slots at the base of the chassis. You should now be able to slide the old motherboard out to the left but you may have to wiggle it about a bit first.

■ Once the old motherboard is out, use the pliers to extract the stand-offs and re-fit them in the corresponding holes in the new motherboard. There are normally several spare holes in the motherboard so don't fit spacers to all, as there won't necessarily be corresponding slots in the system case.

■ If you're able to reuse any SIMM modules, now is the time to remove them and transfer them to the new board.

Step 6 — Install the new motherboard

■ Give the new motherboard a once-over to make sure you've correctly set its jumpers.

■ Slide the new motherboard into position at the base of the chassis, so that the stand-offs engage in the right slots in the casing. The position of the keyboard socket and the hole in the casing for it will help you to locate the motherboard correctly.

■ Refit the bolts to secure the motherboard in place.

Step 7 — Reconnect the cables

■ Refit the P8 and P9 power cables to the motherboard: the norm is that the black cables on each plug should go together. The most fiddly bit is refitting the little multicoloured cables. Typically, these will be positioned along the front edge of the motherboard and I can guarantee that they won't be in precisely the same position or order as they were on the old motherboard.

■ There will probably be connectors for these cables: keylock, reset, power, turbo LED, switch and speaker. Sometimes they can be grouped together to form two or three plugs. If this is a problem because the motherboard connectors are not arranged like this, it's okay to split the plastic plug into two separate plugs using a sharp knife.

Step 8 — Refit the expansion cards

■ Replace the previously-removed expansion cards, the graphics card, the I/O and hard disk controller.

■ Reattach the hard disk data ribbon and LED cables.

■ Replace the cover, plug in the screen and keyboard, and power up your PC. If something is not right, you'll know it because the BIOS will signal an error.

As the BIOS can't depend on the video working, it will simply emit a series of coded beeps through the speaker. If you haven't fitted the memory properly, or if the video card isn't working, you'll hear a pattern of repeated beeps. Check the motherboard handbook to decode the pattern. In my experience, the most common problem has involved a badly-fitted or defective video card. A badly-fitted SIMM which is not quite seated is another candidate.

Step 9 — Edit the CMOS settings

■ The new motherboard's CMOS settings will effectively be blank, so the first time you boot up you'll typically be invited to enter CMOS setup to key things like the date and time, hard disk details and so on.

■ Try out the hard disk auto-configuration option and, using the notes you made earlier, compare the old settings with the suggested new ones: if they're the same, accept them; if not, edit the values manually. Don't forget to specify your floppy disk settings. Delay tweaking the advanced CMOS settings for another day, save the settings, and reboot. All things being equal, your PC should now boot up as normal.

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