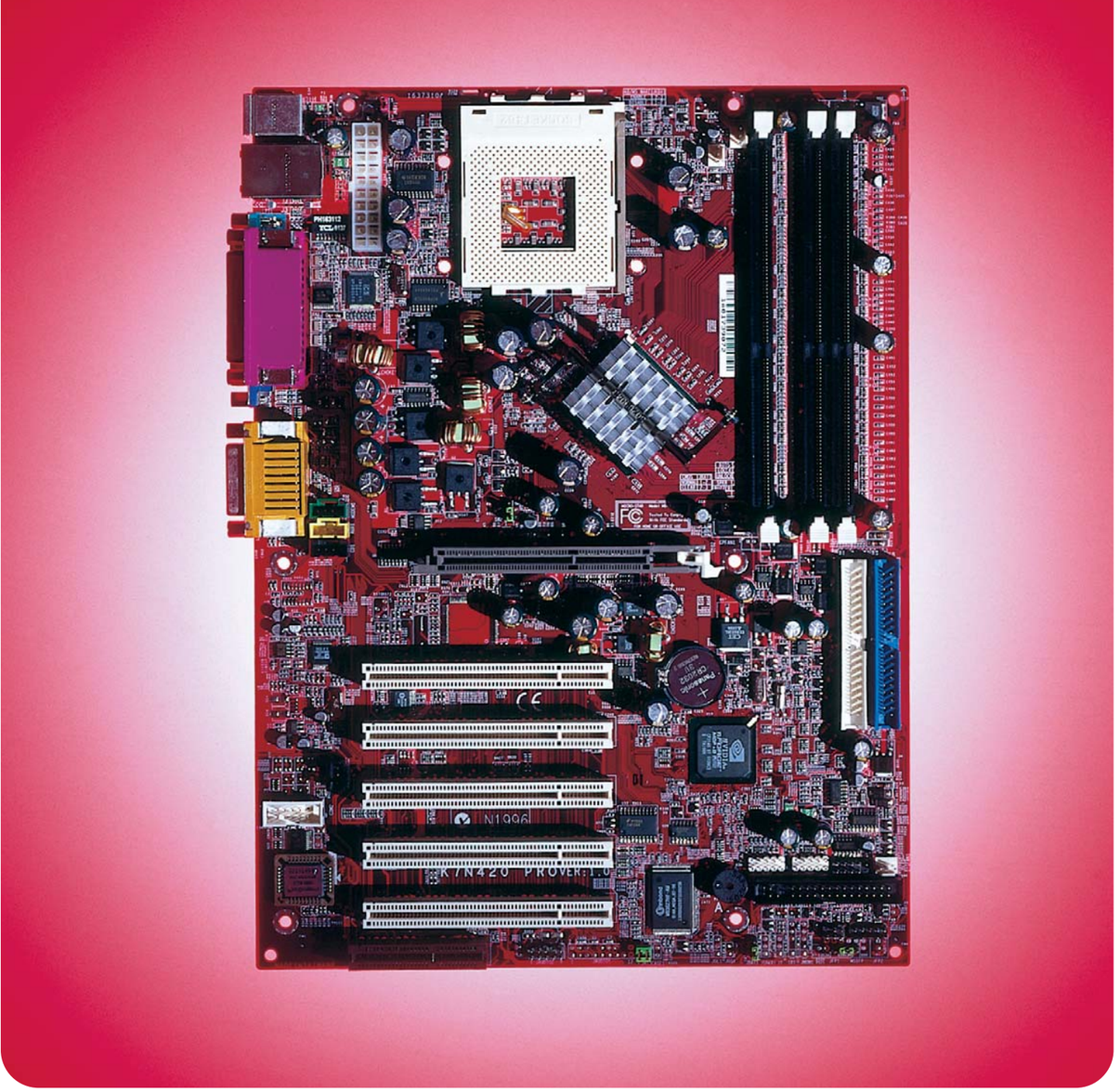


Technofile: motherboards

You may not spend time thinking about your motherboard, but it's the most vital part of a PC. It links all the necessary hardware elements, making sure they correctly work together. Will Head explains the ever-developing technology behind the motherboard, and helps you find the perfect product for your setup

Although often overlooked, the motherboard is one of the most important components inside a PC. It connects everything else together, so its stability and reliability are vital. If you're unsure what a motherboard looks like, a quick peek inside your PC will set you straight. Find the biggest single item in there – the one that everything else plugs into – and that's it. It plays home to your processor and memory, expansion cards, graphics card, hard drive and CD-ROM connectors and any external ports. It also houses the Bios (basic input output system), which controls the simplest configuration of your machine and performs the Post (power on self test) health check when you switch on your machine.

The motherboard world has been through a lot of changes recently following, as it usually does, processor developments. DDR (double data rate) RAM has virtually replaced SDR (single data rate) RAM in the Athlon space; Pentium 4 has pushed out Pentium III and the chipset market has seen a lot of movement. Read on for the low down on the technology, what to look out for and what boards are currently available.

PHOTOGRAPHY: ROBERT HOLMES

Chipsets

A motherboard will only support one type of processor for two main reasons. First, different chips use connectors that are physically different. There is no technical reason for this, but it ensures that you can't plug the wrong chip into the wrong motherboard by accident. The second constraint is the chipset. If you think of the motherboard as the physical hardware, then the chipset is the logic that underlies it. The chipset is the part that dictates how different components talk to one another. Processor development and chipset design go hand in hand, with the chipset being built to support the facilities offered by a certain processor.

There used to be a number of chipset vendors on the market, but the competition has boiled down to three main companies in the consumer space: Intel, AMD and Via. Intel and AMD only produce chipsets for their own processors, while Via manufactures for both sides. This year also sees an unusual new entrant to the chipset market – nVidia.

More commonly known for its graphics processors, nVidia has now turned its expertise to chipsets and come up with the nForce. The nForce offers integrated graphics and sound quality that far surpasses previous onboard offerings, so if you're after an all-round system for a reasonable price, then an nForce-based system may be right for you.

The chipset covers several different functions: it controls the memory and your access to it, co-ordinates the EIDE (enhanced integrated drive electronics), PCI (peripheral component interconnect) and USB (universal serial bus) connector. It also runs the real-time clock and connects your mouse and keyboard to the PC and devices.

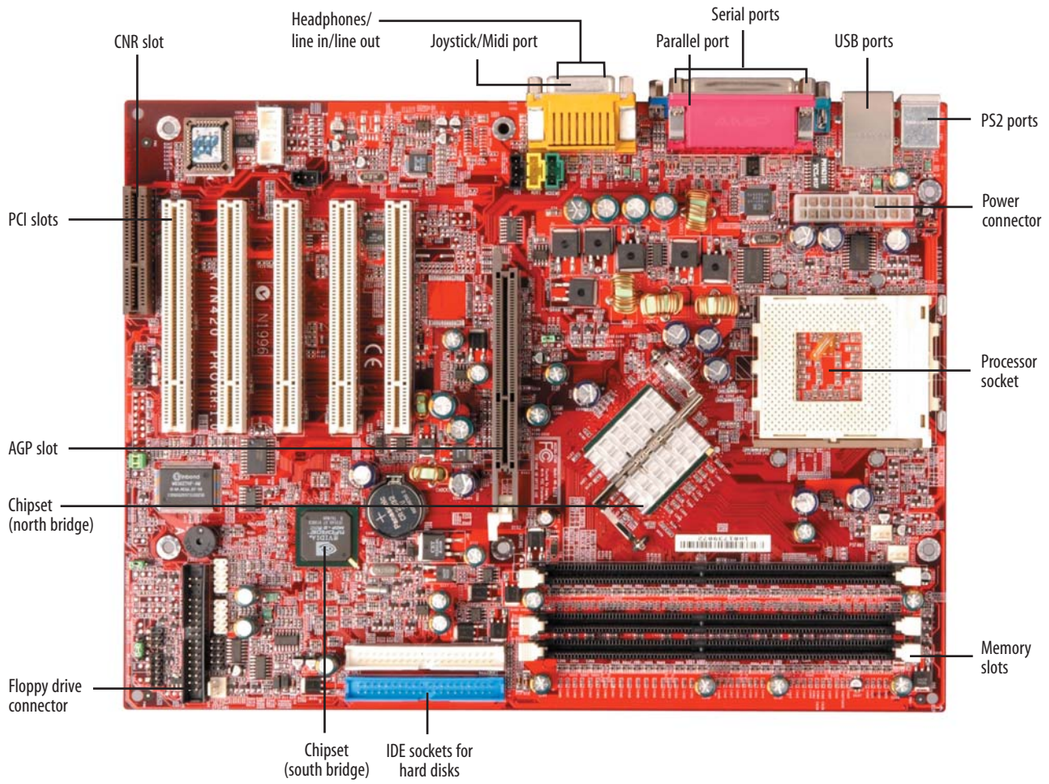
While each of these functions used to require its own dedicated chip, VLSI (very large scale integration) has meant that they can all be controlled by only a couple of chips. Typically, the chipset is split into two major parts: the north bridge and the south bridge. The north bridge controls the major functionality such as the memory, cache, PCI and AGP (accelerated graphics support) connectors, whereas the south bridge contains the less important elements such as the EIDE, serial and USB controllers.

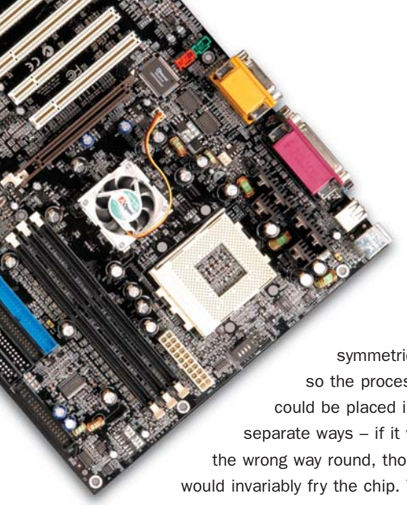
Getting the chips in

Back in the days of the 486 and the original Pentium, all processors were socketed. This design involved a square processor (about 25mm thick), with an array of pins approximately 30mm long on the bottom. The individual pins were connected to parts of the processor and allowed the chipset to control the chip's operation. The pins slotted into a set of holes – the socket – on the motherboard, hence the name.

The first sockets were a bit of pain for a couple of reasons. First, they were

Inside your motherboard





← The motherboard plays home to your processor, memory, expansion cards, graphics card, hard drive, CD-ROM connectors and any external ports

symmetrical, so the processor could be placed in four separate ways – if it went in the wrong way round, though, it would invariably fry the chip. The second problem came from trying to remove the processor. Once it was seated, the casing was flush with the socket and it required a special tool and a fair amount of dexterity to successfully remove it.

Gaining leverage

The next generation of chips improved on the design, solving both these problems. An extra pin was positioned on one of the corners, so the chip would only fit in the socket one way round, and the fit was improved by the invention of the ZIF (zero insertion force) socket. This was basically a lever on the side of the socket, which, when lifted up, allowed the processor to be dropped in or lifted out without the need to exert any pressure (hence the name). When the lever was closed, the top half of the socket made contact with the bottom and the pins lined up with the holes. The most famous ZIF socket is the Socket 7, as used by later Pentiums.

Although the ZIF socket worked well enough, when the Pentium II was released it came in a different format, referred to as SECC (single-edge contact cartridge). Rather than using a socket, this format connected via a slot similar to a PCI card connector, called Slot 1. One reason for this was that Pentium II moved the level 2 cache closer to the processor, so it could run faster.

The SECC housing required two supporting rails to keep it secure and upright. While AMD had been using Socket 7 for its K6 line of chips, when it came to the Athlon it too opted for a Slot design. Although fundamentally similar to Slot 1, its Slot A was incompatible. It was the same size, but the processor went in the opposite way round, thus avoiding the problem of someone inadvertently putting an Athlon processor in a Pentium board and vice versa.

The next level

Around this time, Intel's budget chip, the Celeron, also appeared. This started life in the same SECC packaging as the Pentium, but later moved to a socket when the level 2 cache was integrated on to the processor core, relieving the need for the larger cartridge. The new Celeron format was referred to as PPGA (plastic pin grid array) and utilised 370 pins, so the socket was called Socket 370.

When the level 2 cache on the Pentium III was integrated into the core of the processor it also moved back to a socket format. Although it utilised the same Socket 370 connector as the Celeron, it wasn't possible to use them in existing Celeron boards. The new Pentium IIIs utilised what was referred to as FCPGA (flip chip pin grid array) packaging, the 'flip chip' coming from the fact the processor core was on the top of the chip, not the bottom, placing it in direct contact with the heatsink and increasing heat dissipation.

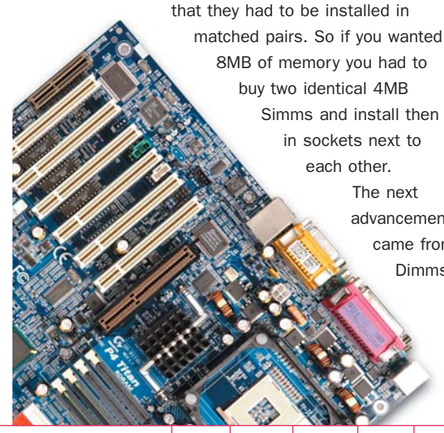
The FCPGA packing also rearranged a couple of pin assignments, which prevented them from working in older sockets. Modern Socket 370 motherboards will now accept either a Celeron or Pentium III without a problem.

The Pentium 4 also uses a socket connector. Early processors used a 423pin connector, but the newer, smaller processors use 478pin sockets. In general, you're best looking for the 478pin solution as the 423pin parts are being rapidly phased out.

AMD has also gone back to sockets with its Thunderbird Athlons, for the same reason as the Pentium III – the extra packaging is no longer necessary. Athlons use Socket A, which employs 462 pins. AMD's budget Duron chip also uses the same Socket A format.

Dimm and distant memories

Memory technology has followed the turbulent change of processor design, evolving through many different forms. The 72pin Simm (single inline memory modules) used to be the norm, seen coupled to Pentium processors. Simms had one major drawback, which was that they had to be installed in matched pairs. So if you wanted 8MB of memory you had to buy two identical 4MB Simms and install then in sockets next to each other.



The next advancement came from Dimms (dual inline memory modules), which only required one module to be used at a time. Dimms come in different flavours, namely PC66, PC100 and PC133. The difference being the speed at which they can operate – PC66 at 66MHZ, PC100 at 100MHz and so on. The reason for the different speed ratings is due to the FSB (front-side bus).

Total recall

There are two factors that dictate the final clock speed of the processor: the chip's internal multiplier and the FSB, the result being the two multiplied together. For example, a 500MHz processor speed can be derived from a 100MHz FSB combined with a five-times processor multiplier.

The current generation of memory has been around for a while and the race for its successor has already begun. Rambus memory can be seen in Pentium 4 PCs, but it is still significantly more expensive than normal Dimms. This is perhaps why Intel has now paired the P4 with cheaper DDR RAM and SDR RAM. In theory, DDR RAM can work twice as fast as SDR.

As far as the AMD Athlon platform is concerned, DDR RAM is pretty much the norm. Prices for this faster memory have fallen so much that there is little difference between a stick of DDR RAM and the slower SDR memory. Given the performance hike offered by DDR, it's best to opt for it over its slower counterpart.

Intel's budget 845 chipset initially supported SDR RAM. However, later versions could use DDR, bringing an affordable solution to Pentium 4 without sacrificing on speed. Via also has its own P4 chipset – the P4X266 – which supports DDR RAM.

Hot discs

With all this information flying back and forth around your PC, you need somewhere to put it. The motherboard provides support for storage, so you can use your hard drives, DVD, CD-RW and other devices. Generally, all motherboards provide at least one drive interface. The interfaces used by your existing drives will make a difference to which motherboard is most suitable for your setup.

Most motherboards support EIDE devices as standard. It provides a good solution for the home and business user, satisfying most needs. The alternative is SCSI (small computer system interface), which is pronounced 'scuzzy'. Although SCSI boasts higher maximum data rates and support for more devices, it is generally a more expensive option.

← To simplify the process of connecting up everything, the sockets on a motherboard are colour coded

Features comparison

	Product	Price	Website	WorldBench 4 score	Processor	Processor socket	Chipset	Form factor	Memory slots	Memory technology	AGP slots	PCI slots	CNR slots	ACR slots	ISA slots	Shared slot	PS/2	USB 1.1	USB 2.0	Serial	Parallel	Onboard VGA	Onboard sound	Onboard network	No of floppy connectors	No of UDMA channels	Raid support
	Abit KG7-Raid	£110	www.abit.com.tw	120	Athlon	Socket A	AMD 761	ATX	4	DDR SDRAM	1	6	0	0	0	N/A	2	4	0	2	1	N	N	N	1	4	Y
	AOpen AK77 Pro	£82	www.aopen.com	117	Athlon	Socket A	VIA KT266	ATX	3	DDR SDRAM	1	5	1	0	0	PCI/CNR	2	2	0	2	1	N	Y	N	1	2	N
	Asus A7N266	£143	www.asus.com	117	Athlon	Socket A	nForce 420	ATX	3	DDR SDRAM	1	5	0	1	0	PCI/ACR	2	2	0	1	1	Y	N	Y	1	2	N
	Asus A7V266E	£133	www.asus.com	121	Athlon	Socket A	VIA KT266A	ATX	3	DDR SDRAM	1	5	0	1	0	PCI/ACR	2	4	0	2	1	N	Y	N	1	4	Y
	DFI AD70-SR	£101	www.dfi.com	122	Athlon	Socket A	VIA KT266	ATX	3	DDR SDRAM	1	5	0	0	0	N/A	2	2	0	2	1	N	N	N	1	4	Y
	MSI K7N420 Pro	£130	www.msi.com.tw	121	Athlon	Socket A	nForce 420	ATX	3	DDR SDRAM	1	5	1	0	0	PCI/CNR	2	6	0	1	1	Y	Y	Y	1	2	N
	Abit TH711-Raid	£147	www.abit.com.tw	119	Pentium 4	Socket 478	Intel 850	ATX	4	Rambus	1	5	1	0	0	PCI/CNR	2	3	0	2	1	N	Y	N	1	4	Y
	AOpen AX4B Pro	£84	www.aopen.com	118	Pentium 4	Socket 478	Intel 845	ATX	3	DDR SDRAM	1	5	1	0	0	PCI/CNR	2	2	0	2	1	N	Y	N	1	2	N
	Gigabyte GA-8IDXH	£110	www.gigabye.com.tw	115	Pentium 4	Socket 478	Intel 845	ATX	3	SDR SDRAM	1	6	1	0	0	PCI/CNR	2	4	0	2	1	N	Y	Y	1	2	N
	Gigabyte GA-8ITXR	£139	www.gigabye.com.tw	119	Pentium 4	Socket 478	Intel 850	ATX	4	Rambus	1	6	1	0	0	PCI/CNR	2	4	0	2	1	N	Y	Y	1	4	Y
	Intel D845WN	£96	www.intel.com	115	Pentium 4	Socket 478	Intel 845	ATX	3	SDR SDRAM	1	6	1	0	0	PCI/CNR	2	4	0	1	1	N	Y	N	1	2	N
	MSI 845 Ultra	£140	www.msi.com.tw	117	Pentium 4	Socket 478	Intel 845	ATX	3	DDR SDRAM	1	5	1	0	0	PCI/CNR	2	2	2	2	1	N	Y	N	1	4	Y
	Tyan S2266 Trinity 510	£76	www.tyan.com	117	Pentium 4	Socket 478	VIA P4X266	ATX	4	DDR SDRAM	1	5	0	0	0	N/A	2	2	0	2	1	N	N	N	1	2	N
	Via P4XB-R	£99	www.via.com.tw	120	Pentium 4	Socket 478	VIA P4X266	ATX	3	DDR SDRAM	1	5	1	0	0	PCI/CNR	2	2	0	2	1	N	Y	N	1	4	Y

PC Advisor would like to thank AMD, Crucial, Evesham and Intel for help with testing

The EIDE interface encapsulates support for CD-ROM and hard drives into one interface. It has evolved further to the UDMA (ultra direct memory access), which provides faster maximum data rates – UDMA33, for instance, offers up to 33.3MBps (megabytes per second). In general, motherboards usually have two UDMA channels, although more are possible. Each channel can support two devices so you could, for example, attach a CD-RW and a DVD-ROM to the same UDMA interface.

Up to UDMA33, the same 40-pin cable was used for all drive connections. The next advance, UDMA66 (providing a maximum data transfer rate of 66.6MBps), requires a new 80-wire cable. It is backwards-compatible with the previous technology – it still uses the same 40-pin connector – however, it will only function to its full potential if the cable, motherboard and devices are all UDMA66-compatible.

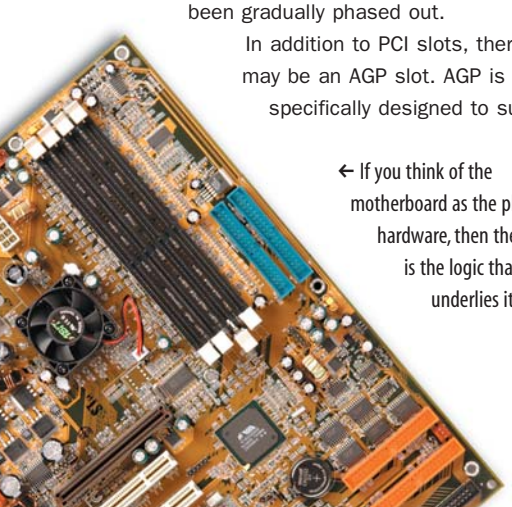
The latest development is UDMA100, providing a peak data transfer rate of 100MBps, although UDMA133 (offering 133MBps) is in the pipeline.

Squeeze another one in there?

Expansion cards allow you to extend the functionality of your system. Whether you want to edit video, watch TV or get your computers talking on a network, there's an expansion card available. When looking for a motherboard, it's important to consider how many cards you've currently got – and any you plan to buy in the future.

There have been a number of different expansion slot formats. Until fairly recently the main options were the ISA (industry standard architecture) bus and the PCI bus. These were easily recognised, as ISA slots were black and PCI slots were white. If you look inside a modern PC, you won't find any black ISA slots, as these have been gradually phased out.

In addition to PCI slots, there may be an AGP slot. AGP is specifically designed to support the high data-transfer rates that complex graphics require. Also bear in mind that, as most new graphics cards are only released in AGP format, you'll need this type of slot to upgrade your graphics card.



← If you think of the motherboard as the physical hardware, then the chipset is the logic that underlies it

→ Two factors dictate the final clock speed of the processor: the chips' internal multiplier and the FSB, the result being the two multiplied together

AMR (audio modem riser) slots appeared briefly, designed with sound card and modem functions in mind. AMR has generally been replaced by CNR (communication and networking riser), which adds ethernet to the standard. However, the CNR format has yet to gain much popularity.

Just to complicate things further, another competing format – ACR (advanced communications riser) – has emerged. Whether these formats will suffer the same fate as AMR, only time (and industry adoption) will tell.

Boxsize

To ensure your motherboard will fit your PC's case, manufacturers must design them for a certain layout. So if you buy a motherboard and case that use the same layout you shouldn't have a problem fitting the two together.

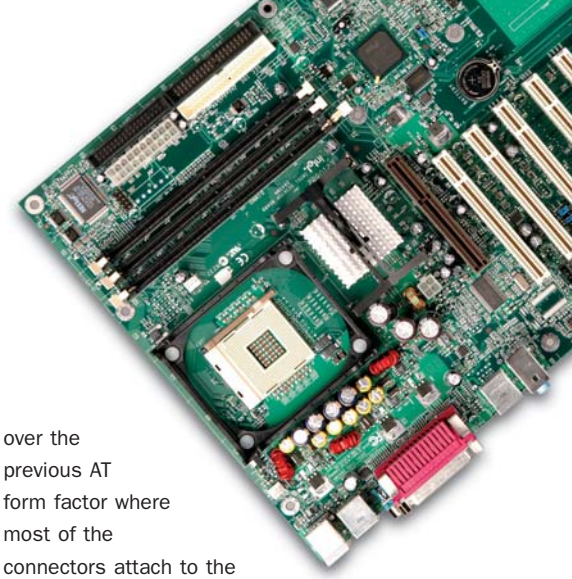
The ATX industry-wide specification not only dictates where the connectors on the back of the motherboards should be to line up with the holes in the case, but also encompasses things such as the power supply connector. There are also variations on form factors. For example, MicroATX takes the basic ATX specification, but shrinks the number of expansion slots to allow for smaller cases.

Other formats exist, such as AT, which was the de facto standard before ATX, and NLX which is used to create slimline PCs.

Crucial links

Although a motherboard may support a number of built-in functions, it's no good if there's no way to access them. For example, if the board offers integrated graphics, then there needs to be a port to connect up the monitor. Not all motherboards offer the same amount of functionality, so it's important to consider what you need when deciding what to buy.

The connectors are attached to an ATX motherboard, simplifying installation over the previous AT form factor where most of the connectors attach to the motherboard via cables. The layout is fairly standard and, at the very least, you should find two PS/2 ports – one keyboard, one mouse – two USB ports, one serial and one parallel.



Some motherboards feature integrated graphics support, which removes the need for a separate, dedicated graphics card. In this case, you'll also find either a video connector or a second serial port. As we've said many times before, the down side of onboard graphics means poor 3D performance delivered for games. However, nVidia's nForce chipset corrects this problem, as it provides enough graphics power for most gamers.

Similar to onboard graphics, some motherboards also come with onboard sound, removing the need for a dedicated sound card. If your motherboard has onboard sound, next to the parallel port there will be a joystick connector plus headphone, line and microphone sockets. As with the integrated graphics, onboard sound will produce satisfactory results, but if you want the best sound available then it's worth opting for a dedicated card. Again, the nForce chipset offers superior audio to traditional integrated sound chips.

To simplify the process of connecting up everything, the sockets on a motherboard are colour coded. This makes it much easier to see what goes where – ideal for novices and experienced PC users alike.

Easy as pie

With so much to deal with, motherboards will always remain a complex issue. However, as long as you are aware of their requirements – and the possibilities they offer – you should be able to choose the best one for your needs (or even just let your supplier do it for you). To make things crystal clear, we've tested the main motherboards on the market, and set out their vital statistics in the table called *Feature comparison* on pages 84-85. ■