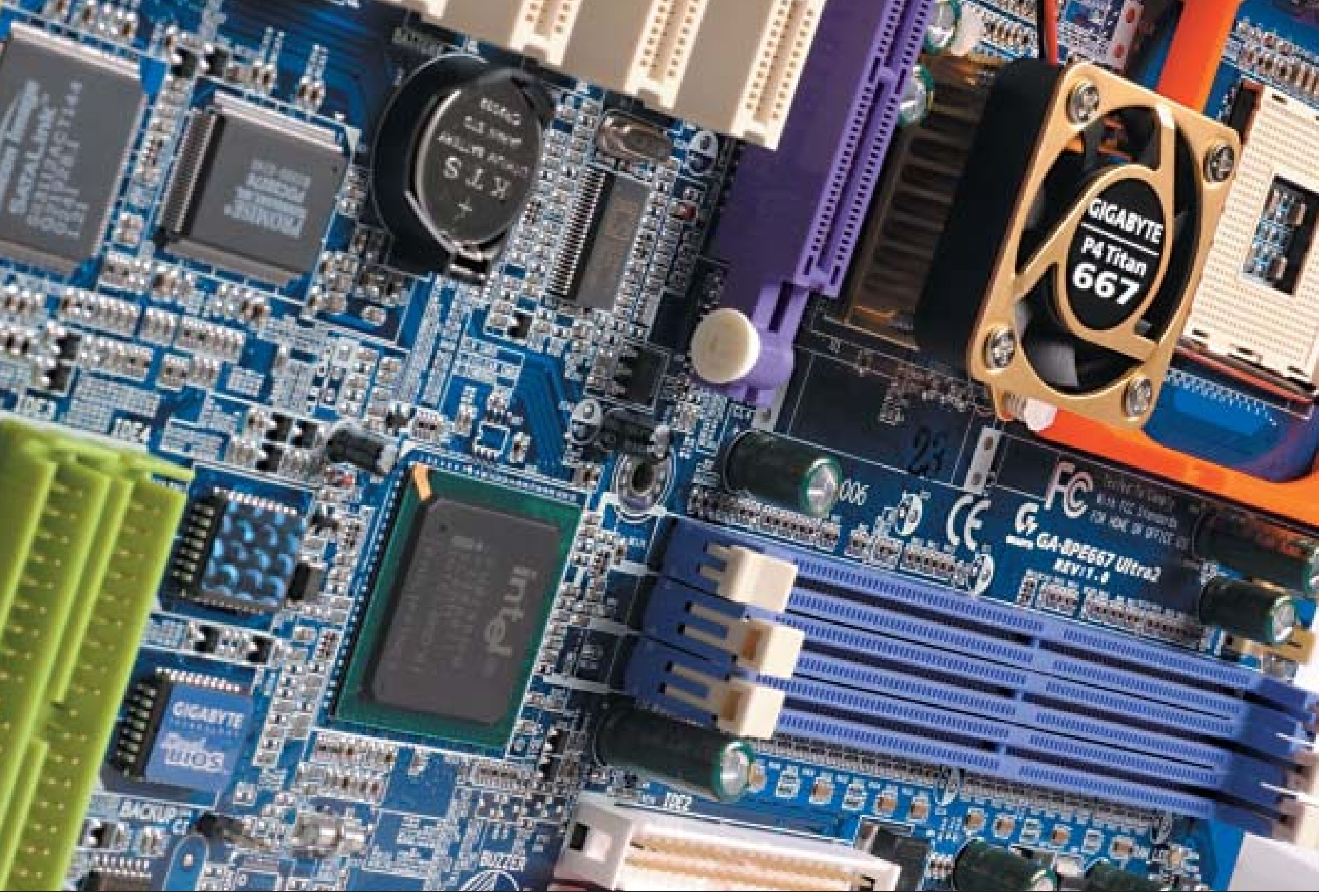


Technofile: motherboards

The motherboard is the unsung hero of your PC and the technical equivalent of a counseller – it gets your PC's processor, memory, expansion cards, hard drive and external ports (among other components) talking. Will Head talks you through this vital system part

The humble motherboard receives little attention compared to the likes of processors, memory or even graphics cards. However, without it none of the components in your PC would be able to communicate with one another.

The motherboard ties the whole PC together, providing communication between all the major parts. And depending on what options your motherboard supports, the next upgrade to the latest, fastest component could simply be a matter of plug in and go. If you're unlucky then you'll need to upgrade your motherboard in order to support it.

If you're looking to upgrade an existing system, thinking of building one from scratch or just interested in what goes on under the hood, we've got the lowdown on motherboard technology, what to look for and a round-up of the boards currently available. If you don't know what a motherboard looks like, have a quick peek inside your PC. The largest single component in your system, the motherboard not only plays home to your processor and memory but all your expansion cards, graphics card, hard drive and CD-ROM connectors plus external ports.

The motherboard also houses the Bios, which contains the simple configuration of your machine and performs the Post (power on self test) healthcheck when you switch on your machine. Before choosing a particular motherboard you need to decide what kind of processor you are intending to use with it.

Since the various chips use physically different connectors, a motherboard will only support one type of processor. Generally this will be a choice between Intel's Pentium 4 and AMD's Athlon – older processors like the Pentium III have pretty much been phased out.

Chip off the old board

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 and dictates how the various 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.

Intel and AMD produce chipsets for their relevant processors, but there are a number of other companies that also make chipsets. VIA and SIS produce chipsets that support both Pentium and Athlon chips, while nVidia has also got into the chipset game with its nForce line that currently only supports Athlon processors.

Theoretically different chipsets offer varying feature sets, but the close integration and advances of the past year have resulted in most of the chipsets offering a similar feature set.

Even memory support has been largely standardised in favour of DDR (double date rate) RAM.

Some of the functions that the chipset covers include:

- memory controller
- EIDE controller
- PCI bridge
- RTC (real-time clock)
- DMA (direct memory access) controller
- IrDA controller
- keyboard controller
- mouse controller
- USB controller

While these functions used to require dedicated chips for each one, VLSI (very large scale integration) has allowed functions to be controlled by only a couple of chips. Typically the chipset is split into two major parts: the Northbridge and the Southbridge. The Northbridge controls the major functions (the memory, PCI and AGP connectors) whereas the Southbridge contains the less important elements like the EIDE, serial and USB controllers.

Common ground

Although some motherboards support different features there are some key components that are present on all current models – for example, the processor connector.

Back in the days of the 486 and original Pentium, all processors were socketed. The chip itself was square and about 2.5mm thick, lined with an array of 3mm pins. The individual pins were connected to parts of the processor and allowed the chipset to control the chip's operation. The original designs required a special tool and a fair amount of dexterity to be removed from the socket. They could also be inserted in four separate ways – although if put in the wrong way round, the chip would invariably be fried.

The next generation improved on the design, solving both these problems. An extra pin was positioned on one inside corner so that the chip could only be fitted into the socket one way round. The second advance was the ZIF (zero insertion force) socket. This worked by placing a lever on the side of the socket.

To insert the processor you simply lifted the lever up and dropped in the chip – no downward force was necessary, hence zero insertion. On closing the lever, the top half of the socket makes contact with the bottom and pins line up with the holes. Removing the chip works the opposite way. Pull the lever up and take the processor out. The most famous ZIF socket is the Socket 7, which is 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 the slot was that on the Pentium II the level 2 cache (a high speed but temporary store of memory) was placed closer to the processor in order to speed up access. As both the cache and the processor were placed side by side in the same packaging, the new processor housing was much larger and required two supporting rails to keep it in place.

While AMD had been happily using Socket 7 for its K6 line of chips, when it came to the Athlon processor 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 into a Pentium motherboard and vice versa. Early Pentium IIIs also used the Slot 1 format.

During this time Intel's budget chip, the Celeron, also appeared. This started life in the same Secc packaging, but later moved to a socket when the level 2 cache was integrated within the processor core itself. The new Celeron format was referred to as PPGA (plastic pin grid array) and utilised 370 pins, hence the socket was called Socket 370.

Put a socket in it

The integration of the level 2 cache also resulted in the later PIII processors moving back to a socket format. But although the connector was identical to the Celeron's Socket 370, the new Pentium IIIs utilised FCPGA (flip chip pin grid array) packaging. The flip chip designation referred to the fact that the processor core was situated at the top

Features comparison

Model	Price (ex VAT)	Supplier website	World-Bench 4	Processor/ socket	Chipset/ hyper-threading	Form factor	Slots & connectors available	Memory slots
Abit NF7-S	£85	www.dabs.com	128	2.17GHz Athlon/462	nVidia nForce2/no	ATX	1 x AGP, 5 x PCI, 2 x PS/2, 4 x USB 2.0, 2 x FireWire, 2 x serial, 1 x parallel	3
Abit IT7-MAX2 V2.0	£117	www.dabs.com	121	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, 4 x PCI, 2 x PS/2, 8 x USB 2.0, 2 x FireWire, 2 x serial	3
Albatron PX845PEV Pro	£70	www.theoverclockingstore.co.uk	120	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, 5 x PCI, 2 x PS/2, 2 x USB 2.0, 2 x serial, 1 x parallel	3
Albatron PX845PE Pro IIs	£98	www.theoverclockingstore.co.uk	120	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, 6 x PCI, 2 x PS/2, 6 x USB 2.0, 1 x serial, 1 x parallel	3
Albatron KX400-8X	£65	www.theoverclockingstore.co.uk	125	2.17GHz Athlon/462	VIA KT400/no	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 x PS/2, 6 x USB 2.0, 2 x serial, 1 x parallel	3
AOpen AX4G3 Max	£92	www.dabs.com	112	2.26GHz Pentium 4/478	Intel 845GE/ yes	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 x PS/2, 2 x FireWire, 2 x serial, 1 x parallel	3
AOpen AX4R Plus	£106	www.dabs.com	115	2.41GHz Pentium4/478	Intel E7205/ yes	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 xPS/2, 6 x USB 2.0, 2 x serial, 1 x parallel	4
Asus A7N8X	£83	www.dabs.com	127	2.17GHz Athlon/462	nVidia nForce2/no	ATX	1 x AGP, 5 x PCI, 2 x PS/2, 6 x USB 2.0, 2 x FireWire, 1 x serial, 1 x parallel	3
Asus P4G8X	£137	www.dabs.com	119	2.8GHz Pentium 4/478	Intel E7205/yes	ATX	1 x AGP, 5 x PCI,2 x PS/2, 6 x USB 2.0, 2 x FireWire, 2 x serial, 1 x parallel	4
Asus P4PE	£100	www.dabs.com	117	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, 6 x PCI, 2 x PS/2, 6 x USB 2.0, 2 x FireWire, 1 x serial, 1 x parallel	3
ECS L4S5MG/651+	£55	www.maplin.co.uk	113	2.4GHz Pentium 4/478	SIS 651/yes	Micro ATX	1 x AGP, shared 3 x PCI & 1 x CNR, 3 x PS/2, 2 x USB 2.0, 1 x serial, 1 x parallel	2
ECS L7S7A2	£55	www. maplin.co.uk	125	2.17GHz Athlon/462	SIS 746/no	ATX	1 x AGP, shared 5 x PCI & 1 x CNR, 2 x PS/2. 4 x USB 2.0, 2 x serial, 1 x parallel	3
Gigabyte 8PE667 Ultra II	£112	www.dabs.com	117	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 x PS/2, 4 x USB 2.0, 2 x serial, 1 x parallel	3
Gigabyte 7VAXP Ultra	£94	www.dabs.com	125	2.17GHz Athlon/462	VIA KT400/no	ATX	1 x AGP, 5 x PCI, 2 x PS/2, 6 x USB 2.0, 3 x FireWire, 2 x serial, 1 x parallel	3
MSI 845PE Max 2-FIR	£109	www.dabs.com	119	2.8GHz Pentium 4/478	Intel 845PE/yes	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 x PS/2, 6 x USB 2.0, 3 x FireWire, 2 x serial, 1 x parallel	3
MSI KYN2-L	£71	www.dabs.com	128	2.17GHz Athlon/462	nVidia nForce2/no	ATX	1 x AGP, shared 5 x PCI & 1 x ACR, 2 x PS/2, 6 x USB 2.0, 1 x serial, 1 x parallel	3
Shuttle SB51G	£185	www.microdirect.co.uk	125	2.8GHz Pentium 4/478	Intel 845GE/yes	Shuttle	1 x AGP, 1 x PCI, 2 x PS/2, 4 x USB 2.0, 3 x FireWire, 2 x serial	2
Via P4PB Ultra	£99	www.rapid-ltd.co.uk	118	2.8GHz Pentium 4/478	VIA P4X400/yes	ATX	1 x AGP, shared 6 x PCI & 1 x CNR, 2 x PS/2, 6 x USB 2.0, 2 x serial, 1 x parallel	3
Via EPIA M9000	£129	www.mini-itx.com	72	933MHz VIA C3/embedded	VIA CLE266/no	Mini ITX	1 x PCI, 2 x PS/2, 4 x USB 2.0, 2 x FireWire, 1 x serial, 1 x parallel	1

(rather than the bottom) of the chip, placing it in direct contact with the heatsink and thus increasing heat dissipation. The FCPGA packing also rearranged a couple of pin assignments, which prevented them from working in older sockets. The original FCPGA Pentium IIIs were incompatible with Socket 370 Celerons, but many modern Socket 370 motherboards can accept both Celeron and Pentium III chips.

Pentium 4 processors also used a socket connector. Early chips used a 423pin connector but the newer, smaller processors use 478pin sockets – 423pin parts have been phased out now. Celeron has also made the leap to 478pin, so is compatible with the same boards as its bigger sibling.

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.

Take a Dimm view

Memory technology has followed the turbulent change of processor design, evolving through many different forms. The 72pin Simms (single inline memory modules) used by the original Pentiums had the drawback that they had to be

Memory technology/ max speed	VGA chipset	Sound chipset	S/PDIF in/out	Network speed	UDMA channels/ serial ATA	RAID support
DDR/333MHz	n/a	Realtek ALC650	no/yes	10/100Mbps	2/2	no
DDR/533MHz	n/a	Realtek ALC650	no/yes	10/100Mbps	4/2	yes
DDR/333MHz	n/a	Realtek ALC650	optional	10/100Mbps	2/0	no
DDR/333MHz	n/a	Realtek ALC650	yes/yes	10/100Mbps	2/2	yes
DDR/400MHz	n/a	Realtek ALC650	optional	n/a	2/0	no
DDR/333MHz	845G	Realtek ALC650	yes/yes	10/100Mbps	3/2	no
DDR/400MHz	n/a	Realtek ALC650	no/no	10/100Mbps	3/2	yes
DDR/400MHz	n/a	Realtek ALC650	yes/yes	10/100Mbps	2/2	yes
DDR/266MHz	n/a	Realtek ALC650	yes/yes	10/100/ 1,000Mbps	2/2	yes
DDR/333MHz	n/a	ADI 1980	yes/yes	10/100/ 1,000Mbps	2/2	yes
DDR/333MHz	Sis 651	Realtek 8100B	no/no	10/100Mbps	1/0	no
DDR/400MHz	n/a	AC-97 2.2	no/no	10/100Mbps	1/0	no
DDR/400MHz	n/a	Realtek ALC650	no/yes	10/100/ 1,000Mbps	4/2	yes
DDR/400MHz	n/a	Realtek ALC650	no/yes	10/100Mbps	4/2	yes
DDR/333MHz	n/a	C-Media 8738MX	no/yes	10/100/ 1,000Mbps	4/0	yes
DDR/400MHz	n/a	Realtek ALC650	no/no	10/100Mbps	2/0	no
DDR/333MHz	845G	Realtek ALC650	yes/yes	10/100Mbps	2/0	no
DDR/400MHz	n/a	C-Media CM18738	no/yes	10/100Mbps	4/0	yes
DDR/266MHz	Castle Rock	VT1616	no/yes	10/100Mbps	2/0	no

installed in matched pairs – if you wanted 8MB of memory you had to buy two identical 4MB Simms.

The next advance, the Dimm (dual inline memory module), did away with this requirement and came in a variety of flavours: PC66, PC100 and PC133. The difference was the speed at which they could operate – PC66 at 66MHz, PC100 at 100MHz and so on. If you use PC100 RAM it will happily run at 66MHz, however PC66 RAM isn't guaranteed to run at 100MHz.

How quickly the memory can run will be determined by the FSB (front side bus). Measured in megahertz, FSB indicates the basic speed of the motherboard. It also determines the final clock speed of the processor. To do this, multiply the chip's internal multiplier by the FSB. For example, a 500MHz processor can be derived from a 100MHz FSB and 5x processor multiplier, as 5 x 100 = 500.

On the other hand, if you use the same 100MHz FSB but increase the processor multiplier to 5.5x, you could power a 550MHz processor instead.

With the current generation of memory – now termed SDR (single data rate) – unable to keep up with advancing processor speeds, the battle for its successor started. The two main options were Rambus, a fundamentally different design, and DDR (double data rate) which, as its name suggests, runs at twice the data rate of SDR.

Rambus is still around but mainly reserved for high-end systems. It's also only supported by Intel processors.

It's all so quiet

The faster you run a processor, the more heat it generates and the more fans you need. This means an increase in noise. Obviously some people are more bothered by noisy machines and location can also exacerbate the problem. So what passes as background noise in a busy office will sound more like Heathrow airport when you're alone at home. One day it all got too much for Glenn Garrett, so he set up QuietPC.com to help others stop the noises.

QuietPC stocks a number of innovative products designed to reduce the noise output of your PC, from quiet power supplies to acoustic padding. Although you can't eliminate all fans, many can be replaced with larger versions (which can run more slowly and therefore less noisily) and more efficient heat sinks.

The design of the Zalman Flower cooler, for example, promotes greater surface area and efficiency through its use of large fins that fan out. Advanced cooling is provided by a large (and quiet) fan, resulting in a discreet but effective substitute for the traditional heatsink and fan combo.

QuietPC has loads of products all with the specific aim of reducing the noise output of your PC. To hear yourself think its well worth visiting the website.

↑ The AcoustiCase's steel sheeting panels reduce unwanted resonances and assist cooling

DDR is now pretty much the de facto standard on both Intel and AMD platforms.

DDR RAM is commonly referred to in two ways – either by its effective speed or bandwidth. For example, DDR-200 has an effective speed of 200MHz but is also referred to as PC1600. Other speeds available are DDR-266 (PC2100), DDR-300 (PC2400), DDR-333 (PC2700) and DDR-400 (PC3200). To ensure futureproofing you should look for DDR-333 or DDR-400 support.

At the drive-in

Most motherboards support EIDE (enhanced integrated drive electronics) devices as standard. The alternative to EIDE is SCSI (small computer system interface). Although SCSI boasts higher maximum data rates and support for more devices, it is generally more expensive. EIDE will satisfy most of the needs of the home and business user.

The original EIDE design has evolved many times. Upgrading to UDMA (ultra direct memory access) technology, in the form of UDMA33, has allowed for transfer rates of up to 33.3MBps (megabytes per second). Two different devices are supported with each UDMA channel and most motherboards will have two such channels.

UDMA66 takes the technology further still, but its maximum data transfer rate of 66.6MBps is only possible if an 80-wire cable is used and if all devices support UDMA66. For example, if you had a UDMA66 hard drive and a non-UDMA66 CD-ROM on the same interface only 33.3MBps would be possible.

Later introductions include UDMA100 and UDMA133, offering peak data transfer rates of 100MBps and 133MBps respectively.

The next advance is Serial ATA. This offers a number of advantages over the existing parallel IDE interfaces. Serial ATA starts at 150MBps, giving a slight speed boost over UDMA133, but it's scalable with 300MBps and 600MBps planned.

Serial ATA does away with the wide ribbon cables in favour of a smaller, thinner cable. This should help increase airflow through the case as there's less cable to get in the way, making PCs more reliable. Serial ATA also supports hot-plugging, allowing you to change drives while the computer is on. Support for Serial ATA drives is currently lacking but this looks set to change. And buying a board with Serial ATA could save you a costly upgrade later on.

Expand your motherboard

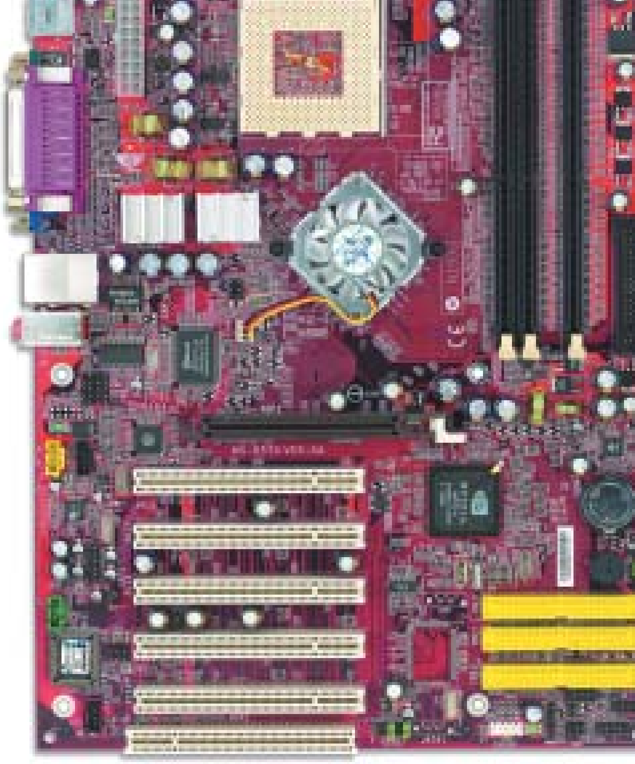
If you want to add functionality to your machine all you have to do is drop in a card that does the job. In modern PCs you'll find two different types. The white PCI (peripheral component interconnect) slots are the rank and file and are superior to the now phased out ISA (industry standard architecture) slots.

Most PCs have a dedicated AGP (accelerated graphics port) slot, capable of delivering the high data transfer rates

Want to know more?

For more information on any of the motherboards listed in this Technofile, please refer to the manufacturer's website listed below.

- Abit **www.abit.com.tw**
- Albatron **www.albatron.com.tw**
- AOpen **www.aopen.nl**
- Asus **www.asus.com**
- ECS **www.ecs.uk.com**
- Gigabyte **www.gbt-tech.co.uk**
- MSI **www.msi.com.tw**
- Shuttle **www.shuttle.com**
- VIA **www.viamainboard.com**



Hyperthreading: the lowdown

If you're shopping for a Pentium 4 motherboard, another new feature to look out for is hyperthreading support. Introduced with the 3GHz chip, this facility allows one processor to behave as two.

Hyperthreading aims to utilise idle CPU time by ensuring that the processor is always doing something productive. At its most basic, applications divide their workload into a series of tasks (called threads) that need to be accomplished. These tasks are then sent to the processor. If you've got two real processors available then you can send one task to one and one to the other.

On a single processor system, if the processor starts work on a task but then has to wait for something else to happen this time would normally be wasted. On a hyperthreaded system, however, two tasks are sent to the processor at one time. While the processor is waiting on task one it can be getting on with task two.

The performance result of hyperthread-enabled systems are mixed. Indeed in some cases, enabling hyperthreading worsened a system's performance – it really depends on the applications involved. Your PC must be running Windows XP and using applications that are designed for multiprocessor systems. Once hyperthreading is established and applications are designed with it in mind the benefits should be more obvious, but it's worth remembering if you plan to go down the Intel route.

required by complex graphics. Should you wish to upgrade your graphics card, you'll almost certainly need one of these.

Form factor

Motherboards come in different shapes and sizes but to ease the process of designing cases, certain formats, called form factors, have been decided on.

The most common form factor in the consumer space is ATX. This specification not only dictates where the connectors on the back of the motherboards should be (allowing them to line up with the holes in the case), but also encompasses such features as the power supply connector.

There are variations among form factors too. MicroATX, for example, takes the basic ATX specification but shrinks the number of expansion slots to allow for smaller cases.

You may also find the older AT form factor – the de facto standard before ATX. Other alternatives include Via's 170x170mm Mini-ITX format and Shuttle's range of small form factor boards. With the latter, a custom motherboard and tiny case are bundled together. You lose out on expansion slots, but if you want something small and sleek then it may be worth the sacrifice.

Get connected

With ATX most of the connectors are built directly on to the motherboard. This results in a simpler installation than the previous AT form factor, where most of the connectors are attached to the motherboard via cables.

The ATX layout is fairly standard – at the very least you should find two PS/2 ports (one keyboard, one mouse), two USB ports, one serial and one parallel. You may also have a second serial and, if the motherboard has integrated graphics support, a video connector.

While integrated graphics removes the need for a separate graphics card, the performance won't compare to that of a dedicated card.

The technology has improved considerably, however, and for standard Windows use onboard graphics may suffice. Integrated audio has seen huge advances and support for 5.1 surround sound and digital features make many integrated sound solutions a viable prospect when the highest quality of audio isn't necessary.

Onboard support has also increased in the form of USB and FireWire connectors. Motherboards used to come with two USB 1.1 ports, but this has increased with some offering six or more. USB 2.0 ups the maximum data rate to 480Mbps, so is well worth looking out for, and Firewire (with a data rate of 400Mbps) can also come in handy.

Ethernet has also migrated from the add-on card to the motherboard, with many boards supporting at least one 10/100Mbps port.

To simplify the process of connecting everything up, all the sockets are colour coded, making it much easier to see what goes where.

Making your mind up

With so many choices and manufacturers available, we've taken a look at what's currently available on the market. Whether you want a Pentium 4 or Athlon processor, integrated features or basic functionality there should be something for you.

All AMD boards were tested with a 2700+ Athlon processor and Intel with a 2.8GHz Pentium 4 unless otherwise stated, so the scores between Intel and AMD boards are not directly comparable. WorldBench 4 was used to test reliability rather than to specifically establish a performance score.

PC Advisor would like to thank Albatron, AMD, Crucial, and Intel for help with testing. ■

Unsure of a technical term? Find out exactly what it means in our searchable Glossary which is on the cover disc