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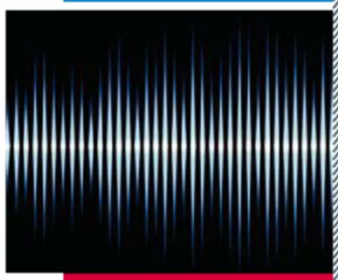


Hotwired...

Game reviews...

FIXING IT ALL

The industry needs to wake up and work as one

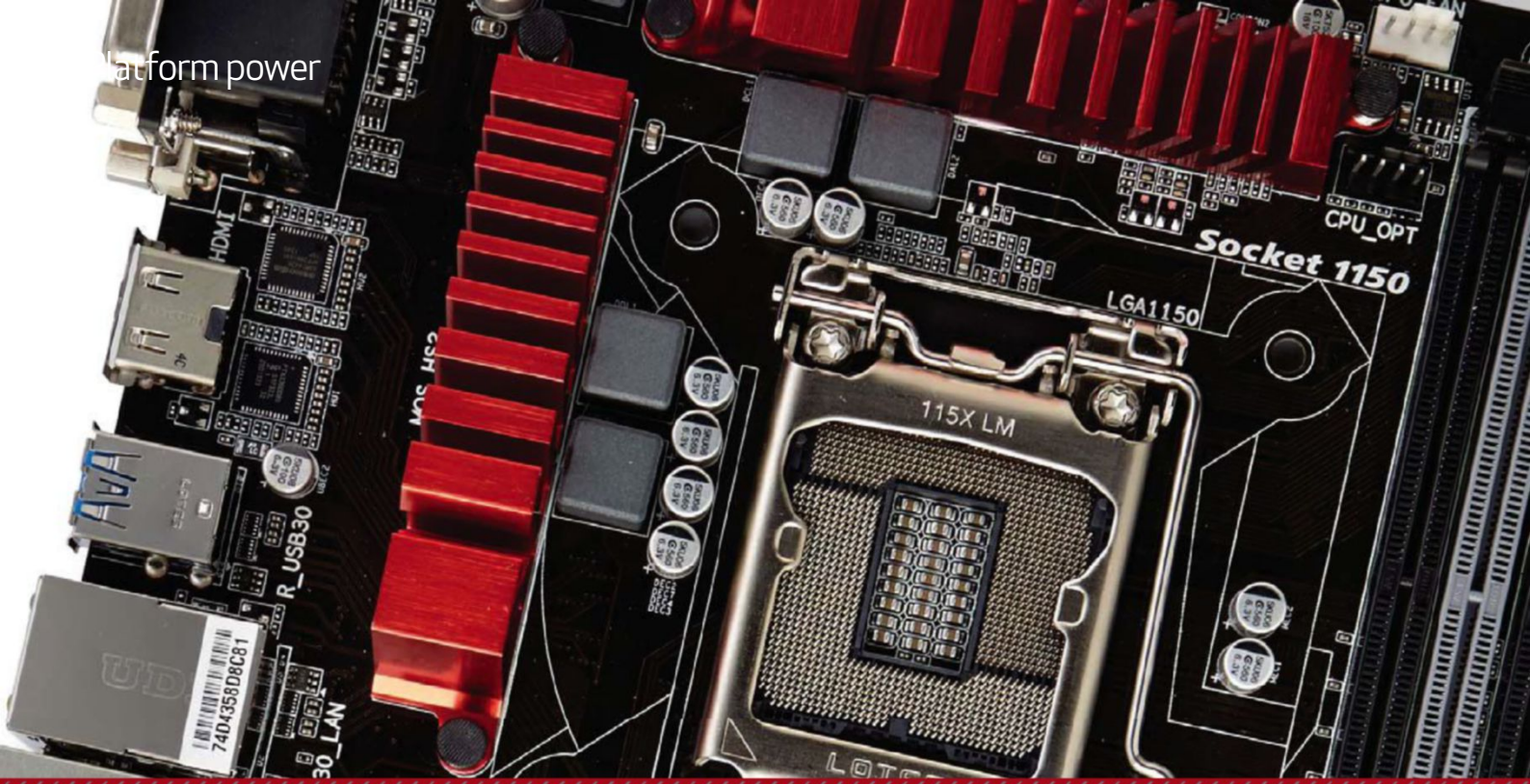
Watch Dogs, one of the most eagerly anticipated games of the year, rolled in as one of Ubisoft's most successful and fastest selling titles to date. It hasn't been without its problems though, with the PC version essentially broken for anyone running an AMD graphics cards. Which may be one or two people or, you know, a few million. Why? It's all down to the way a certain GPU maker has 'worked with' the developer and got it to use certain hardware tricks that break the game engine for everyone else.

And if there's one problem with PCs as a gaming platform, it's that there are compatibility issues between all the different components. The power is there, there's little doubt about that – PCs are going to find the transition to 4K displays much easier than either the Xbox One or the PS4 – but if you can't always get your games to work without fiddling around for months on end, then what's the incentive to developer for that platform in the first place? Add a little dash of console politics, and it's amazing to think that the industry is still making the same old mistakes in 2014.

If the PC industry did a better job of working with each other, as opposed to screwing everyone over at every opportunity to score a buck, the PC as a whole could be a much healthier proposition. It would get more development, become the standard gaming platform for everyone, and thus PC sales would rocket. Everyone wins, as opposed to one company scrambling for short term gains.

Despite this, gaming is still the healthiest sector of the PC market – something that was highlighted by Intel in a recent conference call for the release of it's latest processor, codenamed Devil's Canyon. You can find the full review of this new chip starting on page 24. And if you're looking for a new motherboard to plug this chip into, then this month's group test (page 6) is here to help, as we look at 9-Series motherboards.

Alan Dexter
Editor
alan.dexter@futurenet.com



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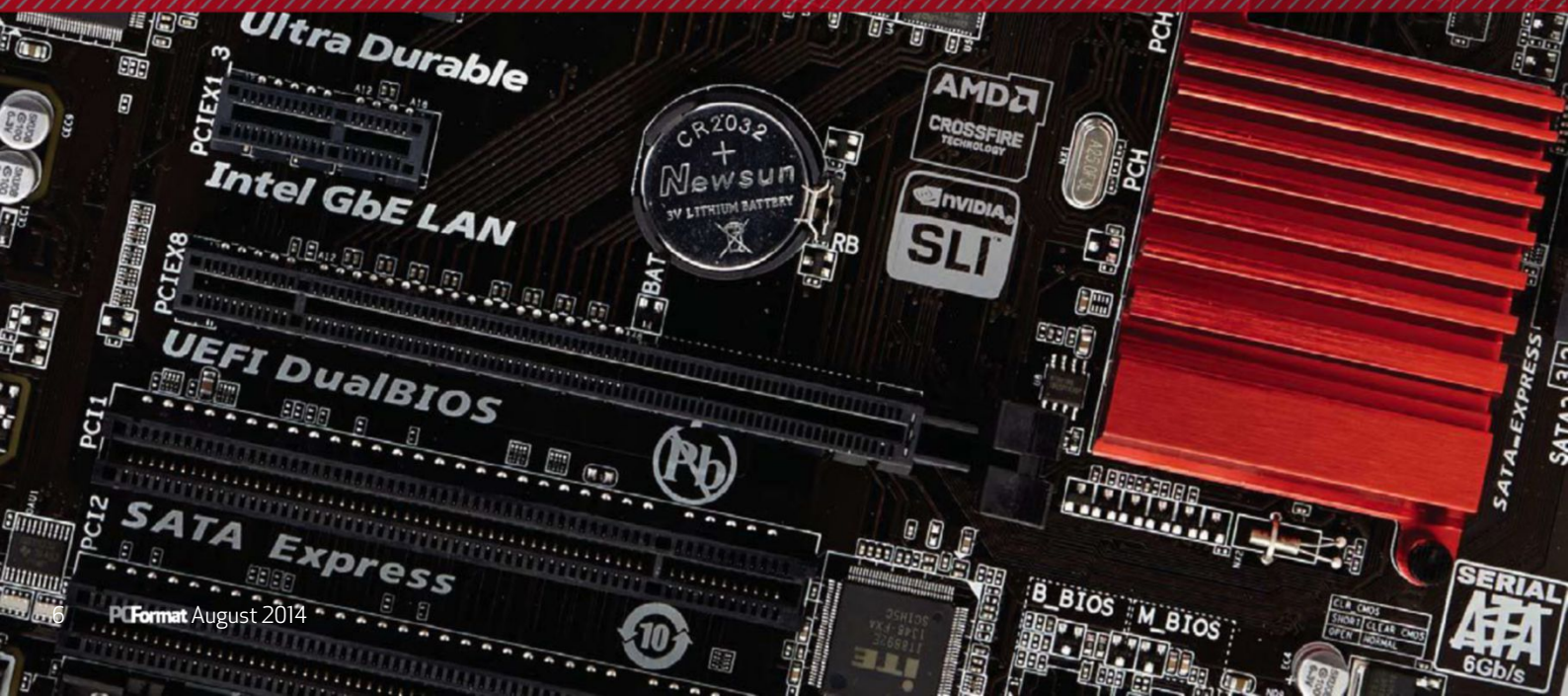
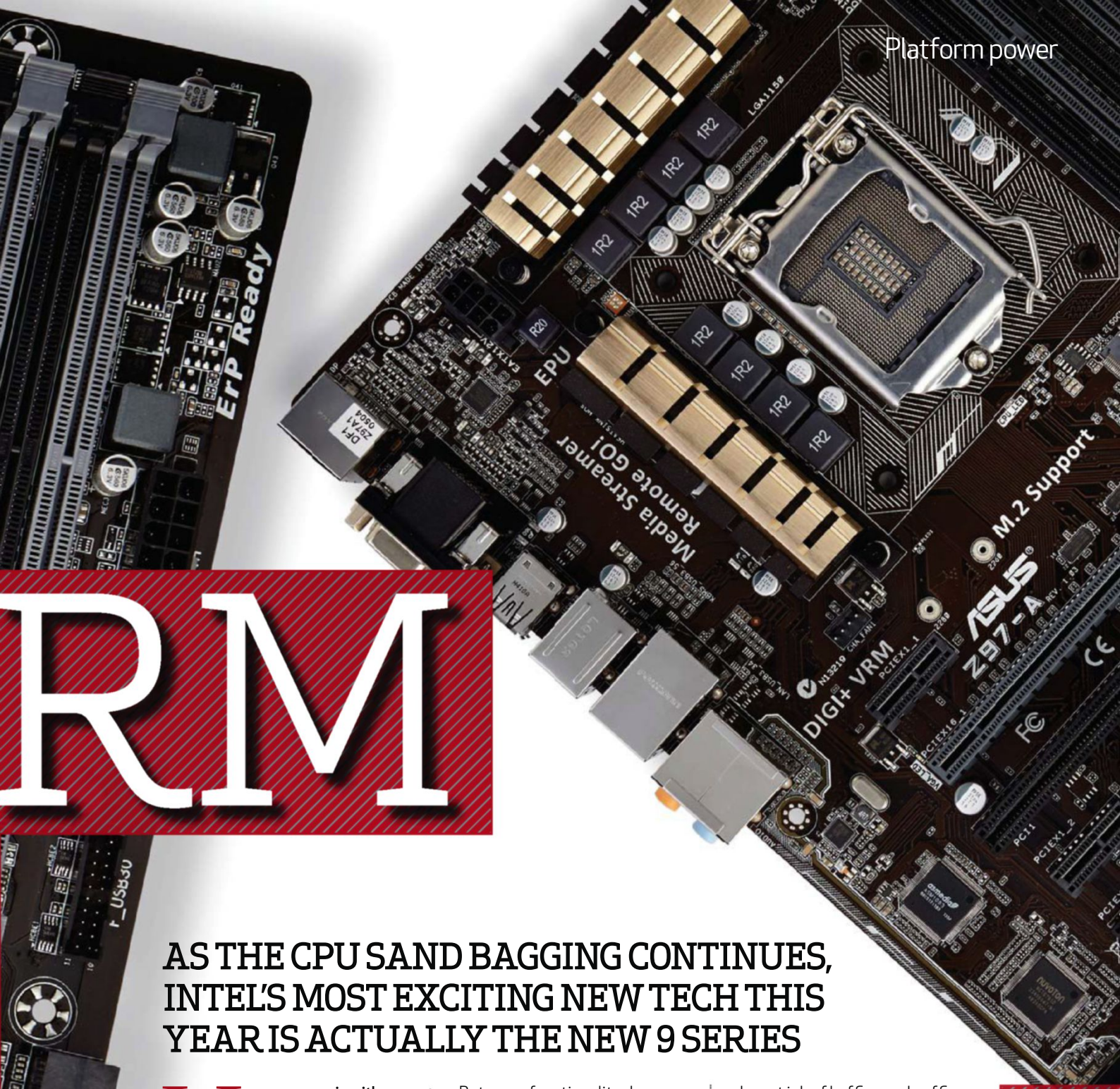




RM

AS THE CPU SAND BAGGING CONTINUES, INTEL'S MOST EXCITING NEW TECH THIS YEAR IS ACTUALLY THE NEW 9 SERIES

Here we go again with another new desktop platform from Intel. Give it up for the exciting, the innovative, the downright dashing Intel 9 Series motherboard chipsets.

Okay, 'dashing' is taking it a bit too far. It's fair to say motherboard chipsets ain't what they used to be. So much functionality now resides on the CPU itself that system performance barely varies from one chipset or board to another.

And aren't new Intel chipsets usually just an excuse to break backwards compatibility and prevent you from simply dropping a new CPU into your existing PC? Intel obviously makes more money if you have to buy a new board to go with one of its latest chips.

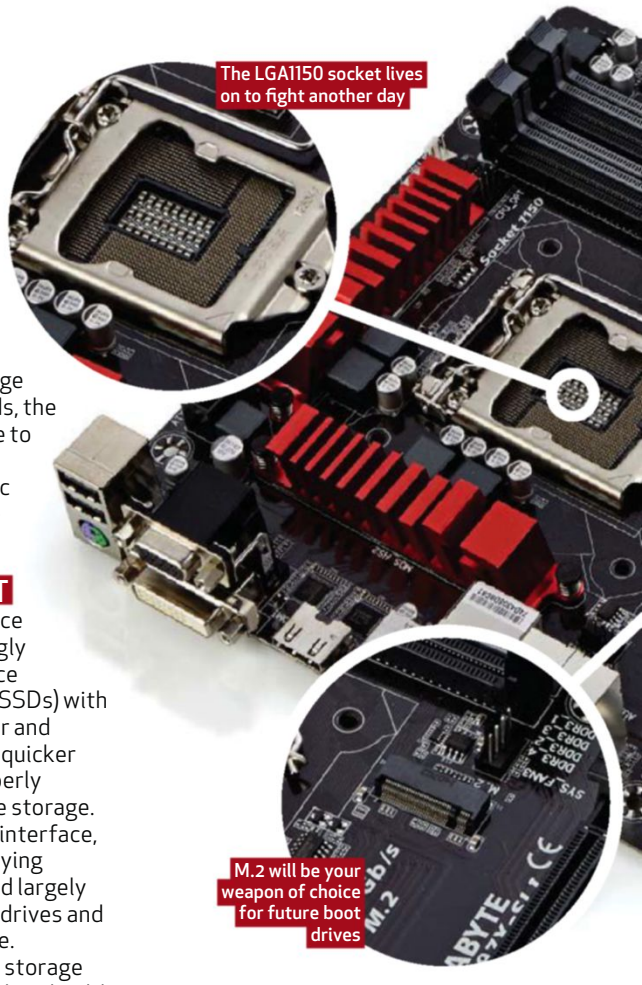
But some functionality does remain 'boardside. And the 9 Series isn't just one of those infinitesimally incremental platform upgrades. It brings with it a number of new technologies that we've been waiting on for an age. It's a big step forward in terms of storage, that's for sure. Both SATA Express and the closely-related M.2 SSD interface are part of the package.

Admittedly, it does disappoint in one or two areas. There's no support for DDR4 memory, for instance. We'll come to all that momentarily. But before we do, it's worth noting the absent elephant in the room. We've got a new family of chipsets, but where are the new CPUs to go with them?

In Intel's labs until at least the end of the year, that's where. Intel does a decent job of huffing and puffing about everything going according to plan, but the fact is, we were originally expecting the new 14nm Broadwell CPU architecture to appear at the end of last year. So it's going to be a year late.

Not that it matters all that much; our understanding is that Broadwell, yet again, won't be a huge step forward in terms of desktop CPU performance. It'll top out at four cores and we're not expecting a huge frequency bump.

In a weird kind of way, then, it's actually the 9 Series chipsets that look to be the most interesting technical development for the desktop PC from Intel for the foreseeable future. So, maybe those missing CPUs don't matter so much after all.



The desktop ain't dead. If there's anything to take away from this latest Intel platform refresh, it's that. Intel has new chipsets out. CPUs will follow at the end of the year. And AMD has recently committed to creating a brand new x86 CPU architecture. That's not to mention countless innovations in graphics and screen technology. There's loads going on.

But this time around it's motherboards and specifically Intel's newest family of chipsets, the 9 Series. First up, let's deal with the basic structure of the 9 Series. As before, it's a family of chipsets, and as before there are two key chipsets that matter most to us. Put simply, the old Z87 gives way to Z97 as Intel's high-spec mainstream chipset and H87 gives way to the new mid-range H97.

The Z97 exclusively offers full overclocking support for Intel's unlocked CPU models. The other big differentiator is support for multi-GPU graphics, again with the Z97 chipset only.

Of course, with the previous Z87 and H87 chipsets, motherboard makers flouted Intel's rules regarding overclocking and released BIOS updates for H87 that allowed overclocking. It's key to note here that with both the 8 Series and 9 Series, the PCH chip is shared. There are no hardware differences – it's all about unlocking features in the firmware. Anyway, if that's what separates the two, arguably more interesting is what they share. The big news is support for the latest PCI Express storage interfaces. In other words, the connections that you use to hook up hard drives, be they traditional magnetic items or the latest solid-state gubbins.

CONNECT CORRECT

The basic idea is to replace SATA (which is increasingly presenting a performance bottleneck to the latest SSDs) with something that is quicker and slicker. Actually, not just quicker and slicker, but also properly optimised for solid-state storage. SATA has been a worthy interface, but both it and its underlying protocols were conceived largely for traditional magnetic drives and it's high time for a change.

That change is to base storage connectivity on the high-bandwidth PCI Express interface and then underpin it with control protocols optimised for SSDs. If that's a straightforward ambition, the implementation is proving to be a bit of a headache to follow.

That's because it's been split into two parallel standards: one that offers backwards compatibility with existing SATA drives, and one that's all-new. The hybrid solution is known as SATA Express. Physically, it uses a slightly bizarre mash-up of existing SATA ports and a new proprietary socket. The SATA ports can be used as normal, but to get the benefit of SATA Express, you also use the new proprietary port.

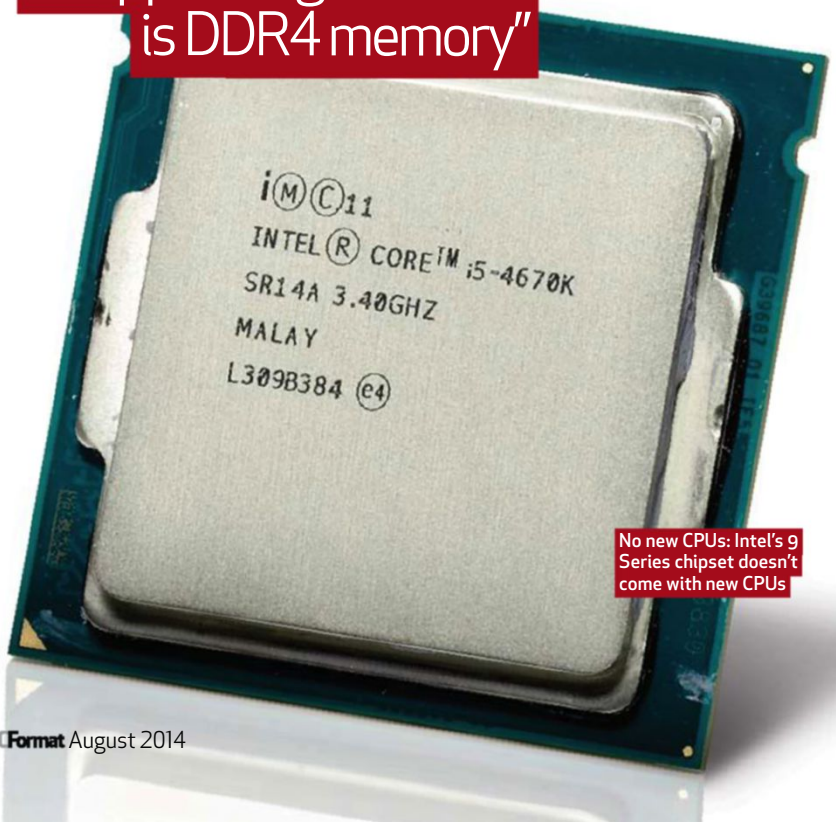
The net result is a very bulky connector that spans multiple sockets for one drive and feels like a bit of a kludge. Frankly, it is. But that's acceptable in return for retaining backwards compatibility.

The other parallel standard is known as M.2. Instead of a port for cables to plug into, it's a socket for small PCBs, much like mini PCI Express from which it is derived. M.2 accepts small SSD cards with exposed chips that plug directly into the motherboard, unlike SATA SSDs with their full enclosures and cable-based connectivity.

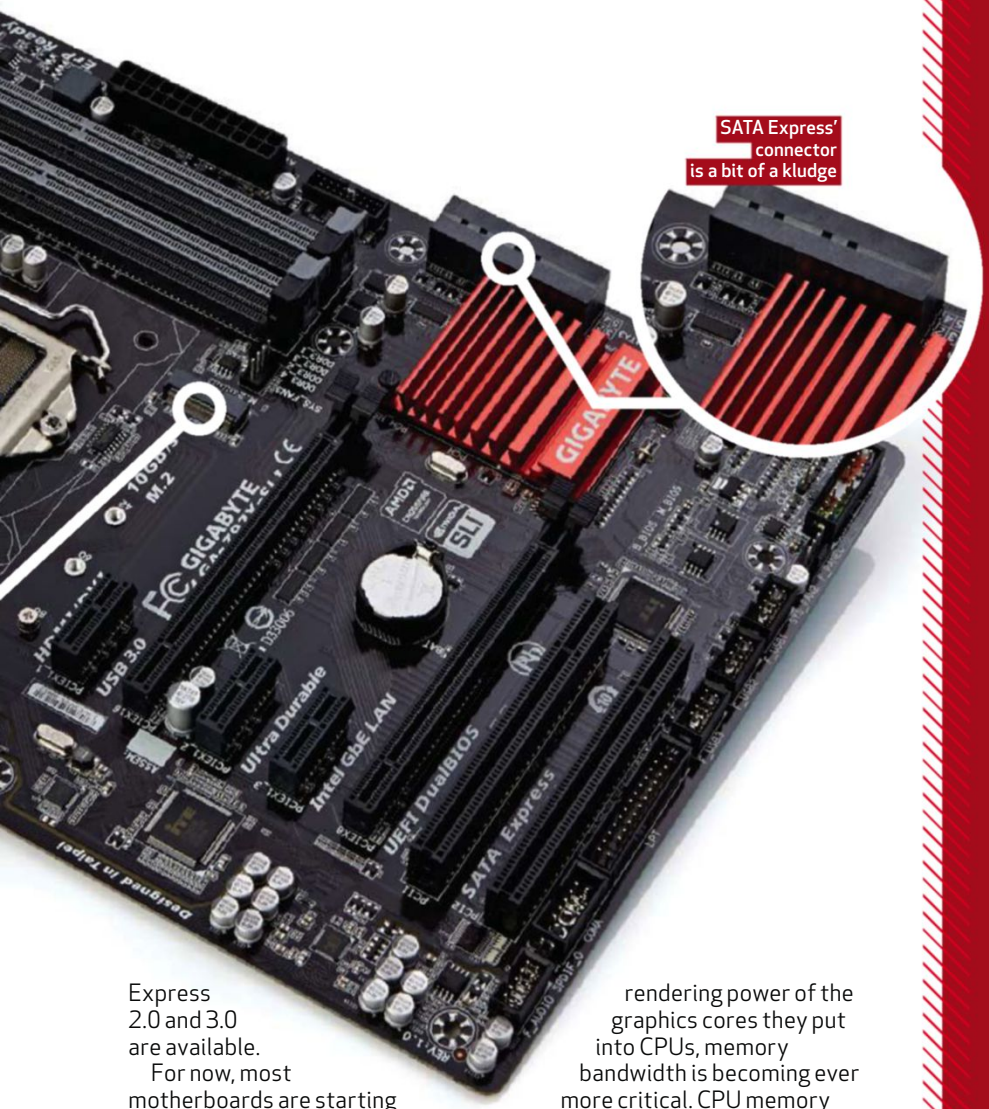
In our view, M.2 is the superior, less compromised solution. For now, most boards will typically offer one of each connector type. We reckon the optimal setup is to view the M.2 socket as the connection of choice for your boot drive. And then you can use the SATA sockets for mass storage. Meanwhile, the SATA Express port is a good option for a secondary OS in a dual-boot system.

As for the performance of both SATA Express and M.2, that's also a tricky question to answer. Because these new standards use PCI Express lanes, all kinds of performance options are available. You can use multiple lanes, and PCI

"One slightly disappointing omission is DDR4 memory"



No new CPUs: Intel's 9 Series chipset doesn't come with new CPUs



Express 2.0 and 3.0 are available.

For now, most motherboards are starting with single-lane configuration, which caps real-world maximum throughput to about 800MB/s. That's a decent upgrade over the 550MB/s that SATA 6Gbps can achieve, but of course there's much more to storage performance than mere bandwidth.

With these fancy PCI Express-based interfaces comes a new control protocol which is known as NVMe. It replaces AHCI and introduces optimisations specifically for SSDs, and is claimed to reduce latencies by as much as 50 per cent. Exactly how that translates into real-world performance is yet to be seen, but we're certainly looking forward to finding out.

If that's the storage story covered, what else do these chipsets have to offer? Well, you get up to 14 USB ports, six of which support USB 3.0. You can also run three independent displays off integrated graphics.

MEMORY LAPSE

One slightly disappointing omission is DDR4 memory. Of course, since this chipset takes existing CPUs and those CPUs run DDR3, it's not a surprise as such. However, as both Intel and AMD crank up the rendering power of the graphics cores they put into CPUs, memory bandwidth is becoming ever more critical. CPU memory bandwidth, if not latency, is miles behind that of even a low-end graphics card. DDR4 isn't suddenly going to solve that problem, but it will be a step in the right direction.

Oh, and for the record, the CPU socket is the same: good old LGA1150. Since the new Broadwell CPU architecture isn't out yet, the Z97 and H97 obviously support existing Haswell-generation processors such as the Core i5-4670K and Core i7-4770K.

There are, of course, other members of the 9 Series family. At the very high end, the X99 will appear to support the upcoming Haswell-E chips, including the chronically belated arrival of an eight-core desktop processor from Intel. In truth, the X99 and the CPUs that will drop into it are re-badged enterprise technology and little related to Z97 and H97.

There are also more budget-oriented chipsets, such as H91, that lop off a few features and definitely won't support overclocking. Broadly speaking, if you decide to veer away from Z97 and H97, you just need to take extra care to review the specifications of the board you're buying and make sure there's nothing missing that you absolutely need. ■

Wherefore art thou, AMD?

Isn't it about time AMD's desktop CPUs got a major platform update?

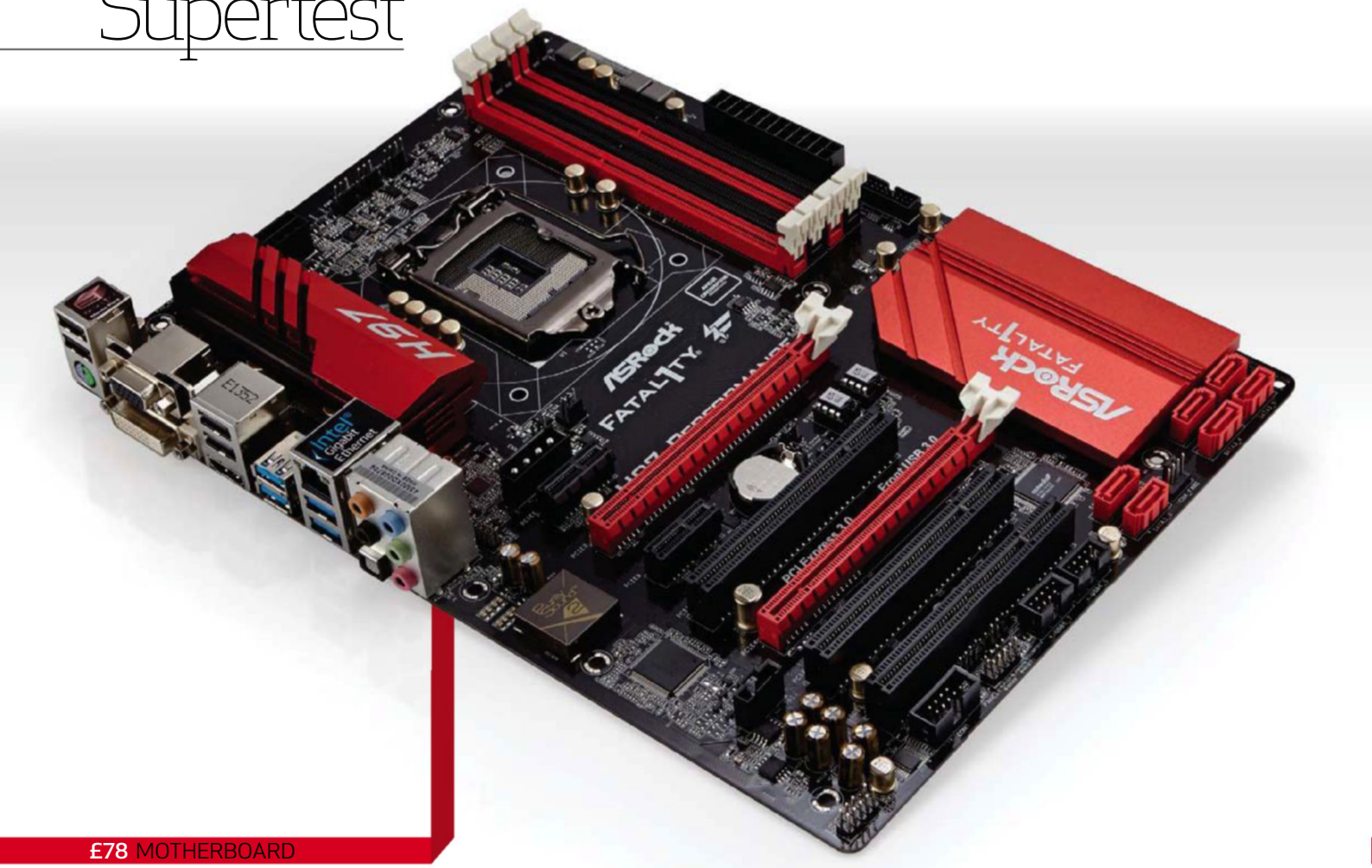
So Intel has a fancy new chipset out and CPUs coming later this year. But what can we expect from AMD?

The world and its dog know that AMDs CPUs haven't exactly been putting the bat up Intel's nightdress of late, but if anything, its chipsets are even more dreary. AMD has been rebadging the same old kit for years.

Part of the explanation is that AMD has limited focus and attention, and much of that has been spent on mobile platforms of late. But with Intel now introducing some pretty killer features like SATA Express and M.2, doesn't AMD need to keep up?

The latest rumour is that AMD is planning to outsource development of future desktop chipsets to ASMedia, a subsidiary of the same company that owns Asus. As recently as April this year, AMD was still posting losses, albeit much reduced from previous quarters. So despite recent successes (including winning the main chips inside both of the new big games consoles) and reports that some big names are returning to AMD, money is very likely still tight.

A partnership that brings features like SATA Express to AMD platforms sooner rather than later would be very welcome indeed. However, ASMedia's USB and SATA controllers have tended to perform a little worse than USB and SATA interfaces integrated into main motherboard chipsets. Whether that reflects poor work from ASMedia or is merely because of the advantage of having items integrated into the platform is hard to say.



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Chipset Intel H97
Form factor ATX (non-standard)
Sockets LGA1150
Storage 6x SATA
Multi-GPU AMD CrossfireX
Video-out DVI, HDMI, VGA

Profits are a problem. Not so much for motherboard makers. But for you and, yes indeed, we. That's because there is more money to be made from higher-end boards than mere everyday mainstream tackle.

And that's why all the usual suspects are pushing their new Intel Z97 boards hard, and why getting a sniff of anything with an H97 sticker is tricky. But thank goodness for Asrock. It's always done things a bit differently and it's the only board maker to come up with an H97 for us to prod and poke.

Actually, the Fatal1ty H97 Performance conforms to quite a few Asrock norms. Not all of them are good. The PCB is thin (read: cheap) and the form factor is pretty oddball. It's full ATX in width but slightly shallower.

So what, you say? Well, the slight shortening means the board doesn't reach the third set of ATX mounting points but overhangs the middle mounts by some margin. On the wrong side of this divide are the memory DIMM slots.

Factor in the thin PCB and that makes for quite a lot of flex when you push in the memory sticks. Not exactly the end of the world, but it does have us slightly worried about long-term reliability. Ditto the prospect of the board bending and distorting due to heat cycling over time.

Of course, at this kind of price point something has to give. You simply can't expect a luxuriously thick multi-layer PCB. That said, it's a pretty snazzy looking item superficially speaking, what with the red-and-black Fatal1ty livery. And you could hardly accuse Asrock of skimping on the chipset cooling as you get a couple a hefty lumps of alloy to keep things chilly. But we would prefer to see the board mounted more securely.

Whatever, the main attraction here is the question of whether manufacturer Asrock has indeed given Intel the metaphorical finger and enabled CPU overclocking access for this H97 chipset. Straight into the BIOS then and, hurrah, all of the options – including the all-important CPU ratios – are there.

Dial in 45 on the CPU ratio, reboot and hey presto we're in Windows at 4.5GHz. Except something's not quite right. CPUZ reports the ratio is set to 45, but the clockspeed hasn't budged from our 4770K test chip's standard frequencies. Hmm.

We take a few more trips into the BIOS and have a quick check of the CPU cooler mounting and thermal paste, but there's no getting round it – something's not right. No doubt it's just an early glitch that will be ironed out with a BIOS update, but as it stands, overclocking doesn't work.

That's a real pity because the stock-clocked numbers we ran prior to overclocking looked exceptionally good. It's fastest in Cinebench, both single and multi-threaded. Ditto *Rome: Total War*. The storage performance numbers look decent, too, though the lack of SATA Express and M.2 is off putting.

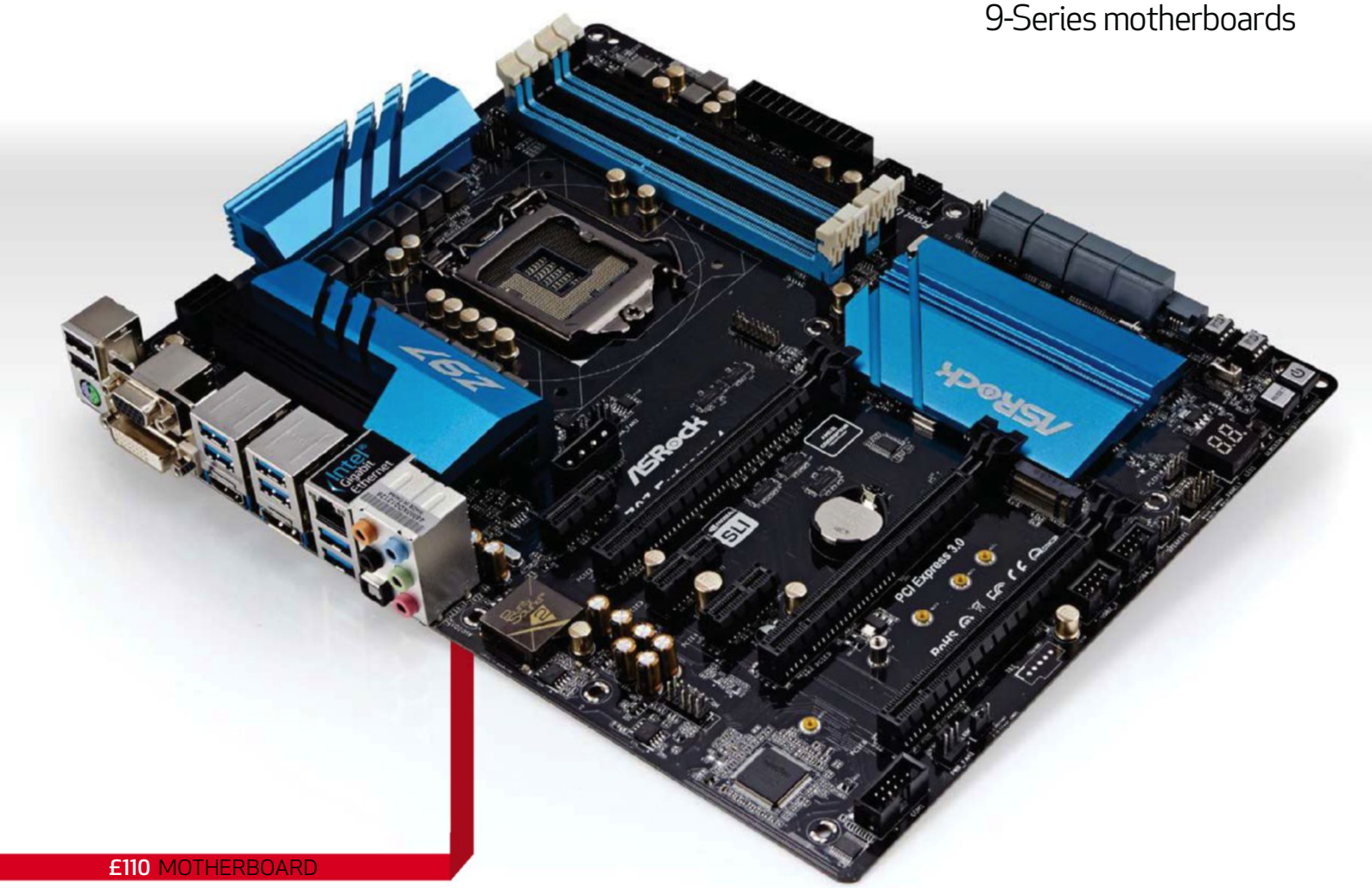
As it happens, Asrock says the Fatal1ty H97 Performance also supports AMD's CrossfireX multi-GPU tech, which is another feature that's not part of the standard H97 package. So, there's plenty to like. But with the broken overclocking it just feels like it's a little bit unfinished. ■

PCFormat Verdict

Features ★★★½☆
Performance ★★★½☆
Value ★★★★☆

A valiant and welcome attempt to undercut the Z97 horde, but this motherboard is currently lacking a little bit of polish.

★★★½☆



£110 MOTHERBOARD

ASROCK Z97 EXTREME4

VITAL STATISTICS

Price £110
Manufacturer Asrock
Web www.asrock.com
Chipset Intel Z97
Form factor ATX
Sockets LGA1150
Storage 8x SATA, SATA Express, M.2
Multi-GPU SLI, CrossfireX
Video-out DVI, HDMI, VGA, DisplayPort

Very cheap for a premium-spec Z79 board? Or a thinly disguised budget board with a bit of tinsel to distract from the truth of its lowly underpinnings? Just what should we make of the Asrock Z97 Extreme4?

Let's start by counting the ways in which it looks like a premium product. Both of the new high-bandwidth PCI Express-based storage interfaces appear. So there's a SATA Express connector mixed in among the eight (yes, eight) SATA ports. Actually, the M.2 slot nearly escaped us, located as it is in true Asrock oddball fashion out on the edge of the motherboard between the furthest two PCI Express slots. But there it is.

Next up is three-way CrossfireX and quad SLI support. The latter refers to a pair of dual-GPU boards, since there are only three PCI Express 16-lane lots on board. Then there are the LED debug display and physical power and reset switches. Oh and a clear CMOS button, which for us is far, far preferable to fiddling with jumpers should you overcook your overclocking.

Rounding out the 'yup, it sure seems like a premium feature set' column are a 12-phase power supply, optical S/PDIF, DisplayPort connectivity for integrated graphics and six USB 3.0 sockets on the back panel. Just for the record, the latter indicates the presence of an ASMedia USB 3.0 chip to complement the native USB 3.0 connectivity of the Intel Z97 chipset.

With that roll call of tasty features in mind, is there anywhere the Z97 Extreme4 falls short? It's a familiar refrain, but there really is no getting away from the thinness of the PCB itself. It's svelte because using fewer layers makes it cheaper to manufacture. Conversely, more layers make for a better shield and that can improve the board's stability and long-term robustness.

Similarly, the audio circuitry hasn't been fully isolated from the rest of the board. And UEFI BIOS – while decent enough in isolation – lacks the clarity, ease of use and visual pizazz of Asus'. On balance, then, things seem to be looking pretty decent for Asrock. What about performance?

Pretty darn good actually, thanks for asking. At stock clocks it's not a world beater, admittedly. But the margins are oh-so very tight. We've said it before, but you are simply not going to feel the difference in performance terms between this motherboard and the very best ones out there.

Even better, it scores a draw at 4.7GHz with the Asus Z97-A for the highest CPU overclock frequency. Props to Asrock. If there is a wee blemish to all this, it's the startlingly high power consumption when overclocked. As with the other boards here, we used auto settings for the CPU voltage when overclocking. And it's possible that you could happily achieve competitive overclocking results by hand tuning the voltages.

What we can say is that we'd be uncomfortable running our CPU so stressed in the long term. So the Extreme4 loses out to the best of the rest in terms of being an easy-to-overclock board. You will need to get your hands dirty to achieve sustainable and safe overclocking frequencies. ■

PCFormat Verdict

Features ★★★★½
Performance ★★★★☆
Value ★★★★½

Runs super close to the Asus Z97-A thanks to its fabulous features, but it just loses out on overall quality.

★★★★½

£110 MOTHERBOARD

ASROCK Z97E-ITX/AC

VITAL STATISTICS

Price £110
Manufacturer Asrock
Web www.asrock.com
Chipset Intel Z97
Form factor Mini ITX
Sockets LGA1150
Storage 5x SATA, SATA Express, M.2
Multi-GPU No
Video-out DVI, HDMI, DisplayPort

There's something impossibly seductive about small form factor PCs. Maybe it's the allure of condensing all that number crunching and rendering power into compact confines. Whatever, there is something satisfying about a machine that's around the same size as a games console, but that blows those Sony and Microsoft boxes away.

What's more, depending on exactly what you're after from a PC, you might be surprised at just how few compromises need to be made. Which is where the Asrock Z97E-ITX/ac comes in. The first thing we looked for in the ceremonious de-boxing routine was next-gen storage support.

It's the key feature that comes with the new 9 Series chipsets from Intel, and we were worried that space constraints would put the kybosh on at least one of the two with a mini ITX board like this Asrock. But no. Asrock have somehow managed to squeeze both SATA Express and M.2 on board, though there is a caveat or two.

On the SATA Express side, the conventional SATA port count is limited to five to allow the lone SATA Express connector enough space. As for M.2, the snag here is that the slot is taken up by the ac wireless network adapter as standard. So, if you want to have an M.2 SSD, you have to bin the Wi-Fi adapter you've just paid for. Whoops.

We did wonder whether Asrock offers an alternative version of this motherboard, just without all of the wireless networking gubbins. But sadly, they don't. Bummer.

Another area of compromise concerns cooling. You get just two fan ports. That could be limiting, especially if you want to use a water cooler, some of which need three ports to operate at full efficiency. Needless to say, you're not going to be hooking up a pair of graphics cards in SLI or CrossfireX multi-GPU mode, either. There's just one PCI Express 16-lane socket.

Performance-wise, the Z97E-ITX/ac isn't quite out of the top drawer, perhaps unsurprisingly. At stock clocks, it's typically about 5 per cent off the pace of the fastest full-ATX boards when it comes to CPU and graphics intensive tasks like, ya know, gaming

At 4.5GHz, it is the slowest of our boards that successfully overclocks. If all that is beginning to sound like we're down on this pint-sized Asrock board, nothing could be further from the truth. You have to remember what exactly you're getting.

This is Intel's top new chipset for the LGA1150 socket. In the real world, CPU and graphics performance – assuming you favour single-GPU rendering like we do – will be indistinguishable from a full ATX rig. Even if you're overclocking, it will reach speeds that are quick enough to make the subjective gaming performance essentially indistinguishable from a full-on ATX system. And you don't even have to compromise on storage performance. The latest technology is on board.

Ideally, we would like to have the option of paying a bit less and dumping the ac wireless adapter. Given the competitive pricing even with the wireless clobber, it would presumably be properly cheap without it. But as an overall package, this motherboard is still an awfully attractive option. ■

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★½

Squeezes the important Z97 bits into a teeny-tiny mini ITX package. Option to drop Wi-Fi would be pretty handy.

★★★★½

£114 MOTHERBOARDS

ASUS Z97-A

VITAL STATISTICS

Price £114
Manufacturer Asus
Web www.asus.com
Chipset Intel Z97
Form factor ATX
Sockets LGA1150
Storage 6x SATA, SATA Express, M.2
Multi-GPU SLI, CrossfireX
Video-out DVI, HDMI, VGA, DisplayPort

Why pay more? That's what you have to wonder when you line up the Asus Z97-A against the other Z97 options, including Asus' own Maximus VII Hero.

After all, with the Z97-A surely you're getting all the important stuff, right? There's the Z97 chipset, so that means it has full overclocking support and is officially sanctioned by Intel at that. Then there's both SATA Express and M.2, so all your silly-fast next-gen storage bases are covered.

At a glance the motherboard doesn't look too shabby, either, with its snazzy gold and black styling and cooling for both the VRMs and chipset. Hell, there's even support for both Nvidia SLI and AMD Crossfire multi-GPU graphics.

Of course, it's an Asus board and that means an Asus BIOS. Quite frankly, Asus does the best BIOS menus in the business. It's as simple as that. All of which might have you ambling along towards the inevitable question of what more, frankly, do you need? What, of serious importance, are you really missing out on?

Indeed, more than not missing out, the Z97-A actually gives you more. Both the aforementioned SATA Express connector and the DisplayPort socket on the back panel are features that Asus' Hero notably lacks. Not to put too fine a point on it, but the Z97-A's back panel is absolutely loaded.

And yet a few things do flutter out of the window in the quest for cost cutting. The first is true material quality. Asus has skimped on the layering and the result is a thinner, less robust board than its Hero sibling. Several enthusiast-class features like a status LED, physical power and reset switches and voltage monitoring points get the chop, too, although none of that is a huge surprise.

Performance-wise, the Z97-A doesn't exactly set your pants on fire when it comes to stock-clocked numbers. Whether its single and multi-threaded CPU performance in Cinebench, storage performance or in-game frame rates, the general trend is pretty much middling to good.

That's until you come to overclocking and find that it tops the table alongside the Asrock Z97 Extreme4. That the Asus BIOS makes overclocking easy and more fun to implement – the BIOS screens are just so intuitive and look simply superb – just adds to the attraction.

In truth, the fact that this cheaper Asus Z97 is so compelling isn't a huge shock. Asus' more modestly priced offerings embarrass costlier alternatives often enough. But if anything, the Z97-A stands out more than ever.

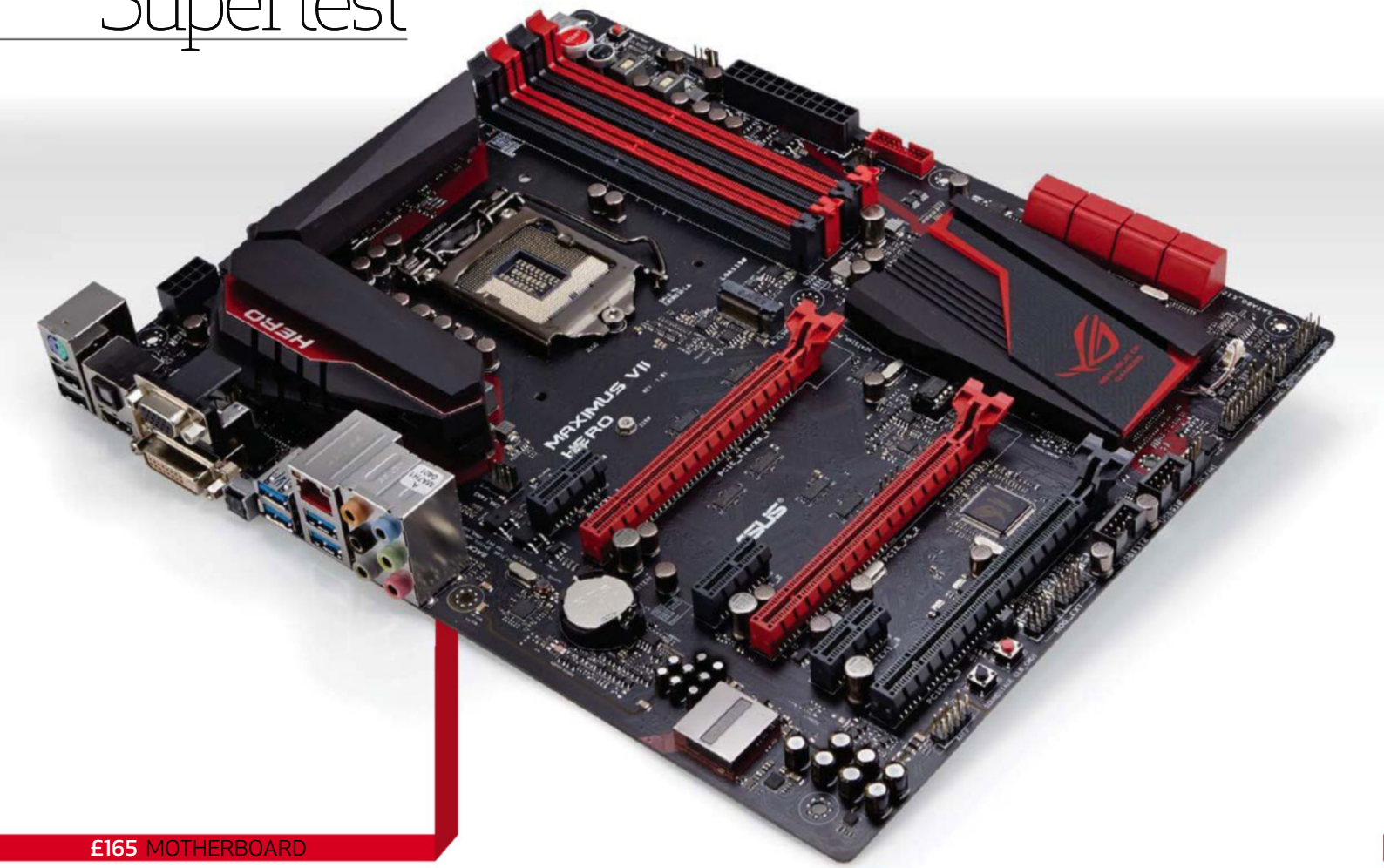
At stock clocks, its performance might not be world-beating. But it's easily good enough. Overclocked, however, it put out the best Cinebench score of all. And in the trade-off for features, you lose things you don't actually need (like a debug LED and voltage monitoring) and get things you might one day be really grateful for (SATA Express and DisplayPort). Then chuck in that lovely BIOS and you're left with a super-strong all-round proposition. The skimpy PCB thickness and the doubt that raises over really long-term reliability is the only thing that gives us the slightest pause for thought. ■

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★★

Flimsy PCB aside, this Z97-A has nearly all the things we care about and lacks little of consequence.

★★★★½



£165 MOTHERBOARD

ASUS MAXIMUS VII HERO

VITAL STATISTICS

Price £165
Manufacturer Asus
Web www.asus.com
Chipset Intel Z97
Form factor ATX
Sockets LGA1150
Storage 8x SATA, M.2
Multi-GPU SLI, CrossfireX
Video-out DVI, HDMI, VGA

From one extreme to the other. If the Asus Z97-A is very nearly the cheapest Z97 motherboard from the company, the Maximus VII Hero is similarly close to – but not quite – the priciest option among the sparkly new offerings from Asus.

Whatever, it's a hell of a lot more expensive than the Z97-A, while Asrock's Fatal1ty H97 Performance is under half the price. This board had better be amazingly good.

Physically, it's a quality bit of kit, but that's what you'd expect from a high-end Asus offering. The PCB is a reassuringly thick, multi-layer affair with a seriously tasty matte finish. Meanwhile, there's plenty of cooling for the main chipset and peripheral components. The colour scheme is the familiar red and black affair, now much copied elsewhere, not that it's Asus' fault.

Unsurprisingly, there is no skimping on this board's features. So stuff like physical power and reset switches are a given, as is the LED status display. There's decent space around the CPU socket, despite the hefty lumps of alloy cooling the VRMs.

Then there's the fully isolated and shielded SupremeFX audio chip, which sports an eight-channel codec, and hooks up to both six 3.5mm jacks an optical S/PDIF on the rear panel.

As for storage capacity, you get no fewer than eight SATA ports. There's also an M.2 socket for super-fast PCIe Express-based SSDs. However, Sir Not Appearing on this motherboard is SATA Express. Is that a big issue, though? In all probability, you're going to want to use M.2 for your boot drive with a board like this. What's more, SATA Express is a messy solution that takes up a lot of precious ports when used.

However, having SATA Express adds another layer of flexibility, and on balance we'd rather have it than not. A definite demerit for the Hero, then. Another notable omission is DisplayPort. Odds are you'll be using discrete graphics with a board like this, so it's not exactly a deal-breaker. But if you're going to have video connectivity, you may as well have the best. At this high price point, that's the very least you can expect.

Of course, what this board ought to be about is brilliant computing performance. And it duly cranks out solid numbers throughout our benchmarks. Yet it is a little startling to note that it actually loses out to Asrock's cheapo Fatal1ty H97 Performance in several of the stock-clocked tests. But in truth, any victories and losses are pretty academic. The gaps aren't nearly big enough to feel in real world performance.

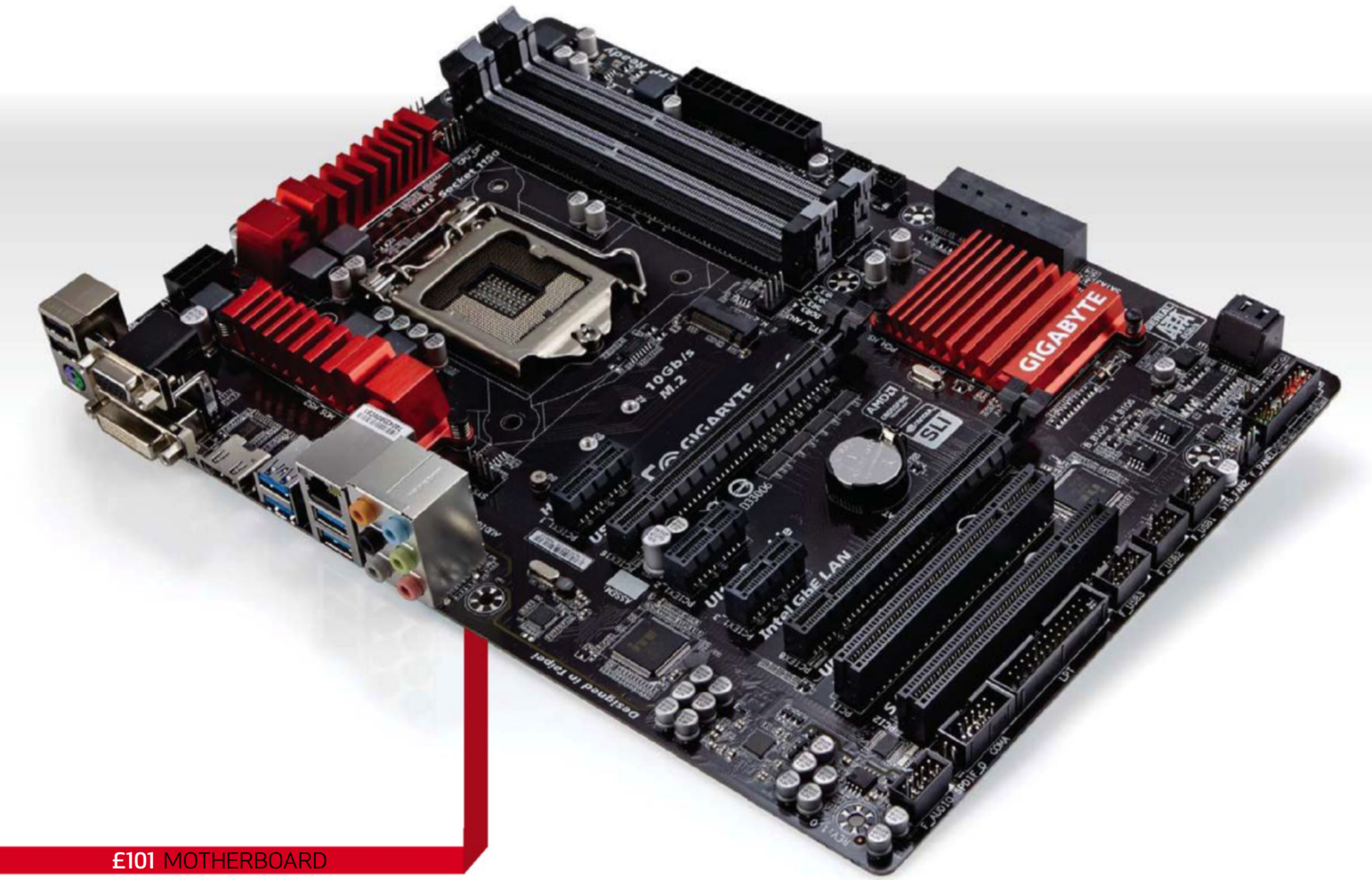
That said, it's a little disappointing to find the Hero isn't positioned at the top of the overclocking table. At 4.6GHz, it's just 100MHz off the best board, but it really ought to be a match. Another factor that makes us a teensy bit hesitant to give this motherboard the full thumbs up is the existence of the Asus Sabertooth Z97 board, which costs about the same amount of cash. As yet, we haven't had a play with the Sabertoothed, armour-clad Z97, but previous Sabertooth boards from Asus have been firm favourites for us at *PC Format* Towers. So that's something we'd ideally like to try before we buy . ■

PCFormat Verdict

Features ★★★★½
Performance ★★★★☆
Value ★★★☆☆

A typically polished affair from Asus. But not quite the spectacular performer we'd expected, especially at this price point.

★★★★☆



£101 MOTHERBOARD

GIGABYTE Z97X-SLI

VITAL STATISTICS

Price £101
Manufacturer Gigabyte
Web http://uk.gigabyte.com
Chipset Intel Z97
Form factor ATX (non standard)
Sockets LGA1150
Storage 6x SATA, SATA Express, M.2
Multi-GPU SLI, CrossfireX
Video-out DVI, HDMI, VGA

There's one in every group. The entry that slips in under the radar with little by way of expectations. This time around, that role is filled by the Gigabyte Z97X-SLI.

In proposition terms, the two Asus offerings were well known quantities. Ditto the three Asrock boards. One promises high-end thrills for a bargain price, the second offers plain cheapness and the third is all about form factor. Meanwhile, the MSI adds an unambiguous gaming angle to the motherboard mix.

Then the Gigabyte Z97X-SLI pops up and suddenly we're flying blind. Where does it fit in? How much does it cost? What should we be expecting?

The price bit is easy. As we go to press you can snag it from www.scan.co.uk for a mere £101. That's pretty aggressive positioning for a Z97 board from a big brand. And it undercuts every other board here save for the Asrock H97 effort. Immediately, we're wondering if anything important has been sacrificed to hit the price point.

The good news is that neither SATA Express nor M.2 have been culled. Both of the new high-bandwidth storage interfaces are present and correct. Hurrah. Likewise, despite the in-your-face Nvidia branding tie-in, both SLI and AMD's competing CrossfireX multi-GPU graphics technologies are supported. Tick another box.

Gigabyte's latest UEFI BIOS menu is quite purty in graphical mode, though not as intuitive as Asus' standard-setting solution. That said, Gigabyte includes a text-based parallel menu for those who like to do it old school.

Given the price point, perhaps the most impressive feature of this motherboard is, funnily enough, the fully isolated audio circuitry to ensure crisp sound quality.

Where you begin to see some corner cutting is with the lack of little extras like an LED status display. There are also no power or reset buttons and you'll have to jumble along with jumpers to reset your BIOS settings. There is also a lack of a clear CMOS button.

However, as usual it's the PCB itself that really gives the game away. It's thin and flimsy for starters and it doesn't extend to full ATX depth. That means it doesn't reach the third row of ATX mounting points. Unlike the Asrock H97 board, however, the overhang isn't excessive enough to cause us real concern.

Overall, the feature set on this motherboard looks surprisingly strong. The missing items are irritants rather than deal-breakers. It would be quite nice to have LED displays and a clear CMOS button, for instance. But we absolutely couldn't live without an M.2 port. In that context, the cheapness of the Gigabyte Z97X-SLI's physical bearing is perhaps inevitable. And where it really counts, Gigabyte hasn't cheaped out.

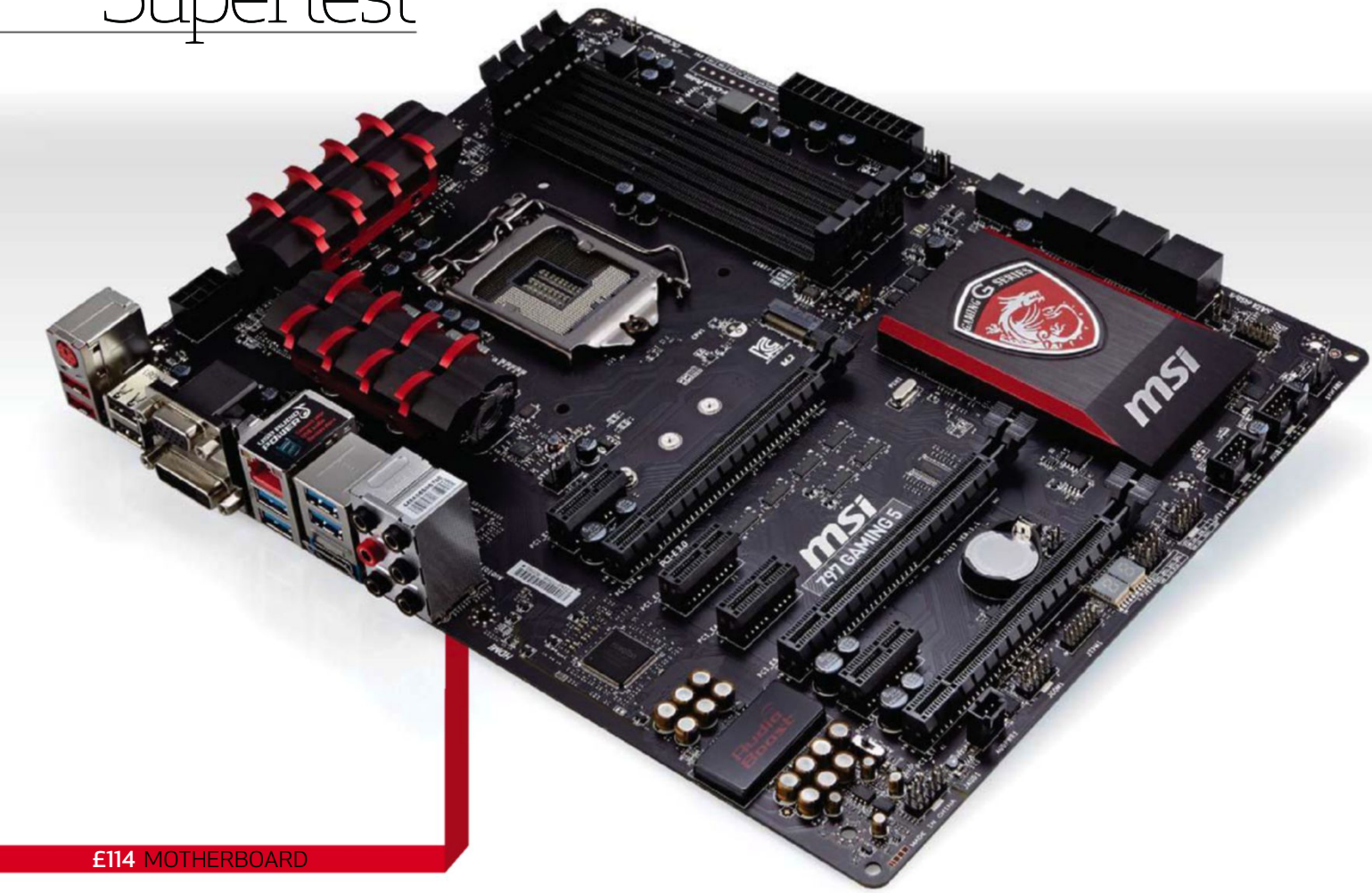
What, then, of this motherboard's performance? At stock clocks, the answer is middling to poor. Storage performance, notably, brings up the rear. An overclocking result of 4.6GHz is much more competitive and the 175W power consumption when overclocked is pretty impressive, too. This option is certainly a strong all-rounder and worthy of your shortlist, thanks to its features, but it is very slightly compromised by patchy performance. ■

PCFormat Verdict

Features ★★★★½
Performance ★★★½☆
Value ★★★★★

Looked to be cruising to victory based on price and features, but its slightly patchy performance let it down a bit.

★★★★☆



£114 MOTHERBOARD

MSI Z97 GAMING 5

VITAL STATISTICS

Price £114
Manufacturer MSI
Web http://uk.msi.com
Chipset Intel Z97
Form factor ATX
Sockets LGA1150
Storage 6x SATA, M.2
Multi-GPU SLI and CrossfireX
Video-out DVI, HDMI, VGA

MSI vs Asus. Motherboard on motherboard action. A £114 deathmatch. On paper, this MSI Z97 Gaming 5 and the Asus Z97-A couldn't be much more closely matched. So is it a battle of pure attrition? Or are there enough differences to make a compelling argument for each of them?

Dig a little deeper and the MSI certainly carves out a bit of a niche for itself. With the unambiguous 'Gaming' branding comes a bit more effort on the aesthetics. Beyond the de rigueur red-and-black colour scheme (somebody, somewhere has clearly decided that these colours trip some kind of Pavlovian response in gamers), there is also an alluring matte finish to the PCB.

It's a superficial feature. The PCB itself is not as thick as a true high-end board, nor does it sport as many electrical layers. But the matte finish still manages to make Asus' Z97-A feel a little bit skanky. A small victory for MSI, then.

Arguably of more importance are the actual gamer-centric features of this board. These start with a clear CMOS switch, which is helpful should you dial in some ill-advised BIOS settings that prevent the machine from booting. Next up are voltage monitoring ports (admittedly, a fringe attraction), five four-pin fan power ports and an LED debug display.

True to its gaming remit, this motherboard also gives you support for both SLI and CrossfireX multi-GPU graphics solutions. Overall, then, the feel is less generic and more enthusiast-focused than the Asus Z97-A. However, that's not quite to say the Gaming 5 has things all its own way.

Our review sample had had a bit of a hard life and was consequently behaving a little oddly. It was slow to boot up and recalcitrant to recognise devices, that sort of thing. That may explain its relatively poor showing in the stock-clocked benchmarks, where it pretty much trailed in last across the board.

Slightly against expectations, given its sickly demeanour, it clocked up a perfectly healthy 4.6GHz in our overclocking test and the second fastest overclocked Cinebench score, even edging the Asrock Z97 Extreme4 running at 4.7GHz. As our American cousins would say, go figure.

You'll be missing out on one or two core features compared to the Asus board, too. For starters, SATA Express doesn't make an appearance. The PCI Express storage support is limited to M.2. As we've discussed elsewhere, M.2 is our pick of the two interfaces and the one that we'd expect to use for our main boot drive. SATA Express is more of a bridging technology to smooth the transition from SATA to PCI Express. But we'd still prefer to have both.

The other obvious omission is DisplayPort output for integrated graphics. Again, hardly a deal-breaker on a gaming board that's surely going to be hooked up with a proper graphics card. Overall, MSI's Gaming 5 makes a very good case for itself. If our sample hadn't been a bit borked, it would have taken the fight right down to the wire with the Asus Z97-A. It might even have won. As it is, the benefit of the doubt must go to the Asus motherboard instead. ■

PCFormat Verdict

Features ★★★★½
Performance ★★★½☆
Value ★★★★½

This board looked promising and is a good price. However, as our review sample wasn't working properly, we can't hand out a prize.

★★★★☆

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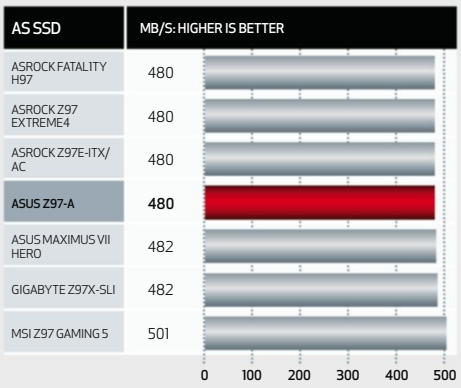
How we tested

In much the same fashion as before. That's because although the big noise with the Intel 9 Series chipsets is the inclusion of PCI Express-based storage interfaces (SATA Express and M.2), you need the motherboards and the drives to test the interfaces. And we've only got the mobos.

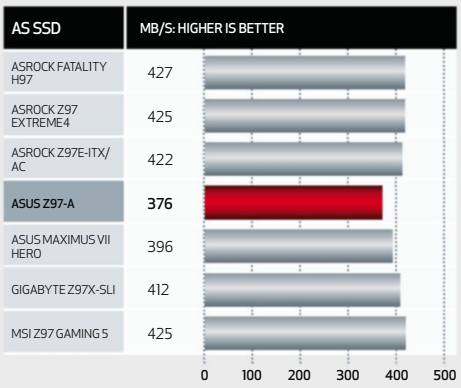
For that reason, our testing is limited to conventional SATA storage performance. Elsewhere, Cinebench single and multi-threaded covers core CPU performance while *Rome: Total War 2* is our weapon of choice for assessing game performance.

We want to find the realistic overclock a non-expert will achieve, so we allow each board to auto-adjust peripheral settings like the CPU voltage while we tweak the CPU ratio. Once a top overclock is achieved, we snag a Cinebench score and overall platform power. Compare the latter to platform power when not overclocked, and you get a nice idea of whether you've got a sustainable long-term setting. ■

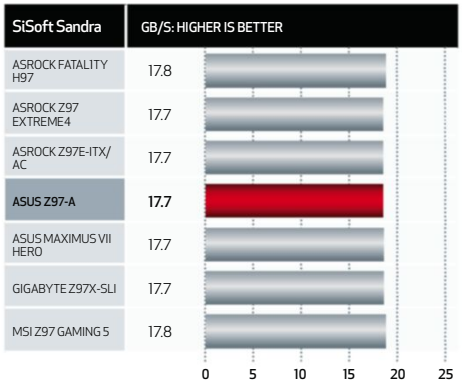
Sequential read performance



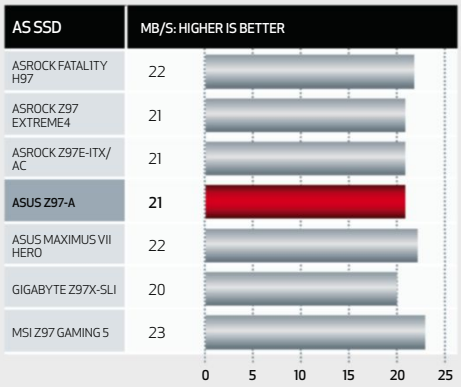
Sequential write performance



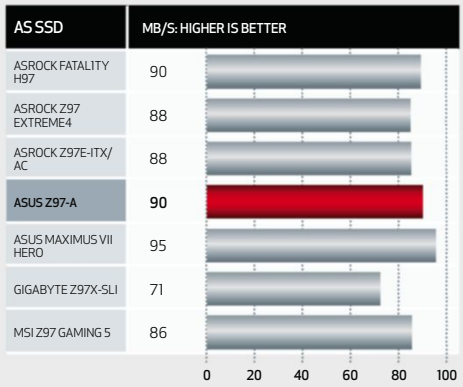
Memory bandwith



4K random read performance



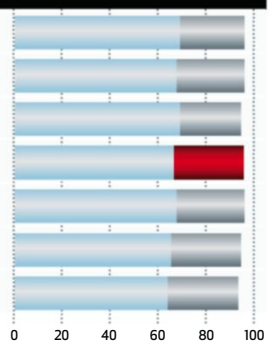
4K random write performance



	Price	Web	Manufacturer	Chipset	Form factor	Sockets	
Asrock Fatal1ty H97 Performance Ser1es	£78	www.asrock.com	Asrock	Intel H97	ATX (non-standard)	LGA1150	
Asrock Z97 Extreme4	£110	www.asrock.com	Asrock	Intel Z97	ATX	LGA1150	
Asrock Z97E-ITX/ac	£110	www.asrock.com	Asrock	Intel Z97	Mini ITX	LGA1150	
Asus Z97-A	**£114**	**www.asus.com**	**Asus**	**Intel Z97**	**ATX**	**LGA1150**	
Asus Maximus VII Hero	£165	www.asus.com	Asus	Intel Z97	ATX	LGA1150	
Gigabyte Z97X-SLI	£101	http://uk.gigabyte.com	Gigabyte	Intel Z97	ATX (non-standard)	LGA1150	
MSI Z97 Gaming 5	£114	http://uk.msi.com	MSI	Intel Z97	ATX	LGA1150	

Gaming performance

Rome: Total War II	(MIN) FRAMES PER SECOND: HIGHER IS BETTER
ASROCK FATALITY H97	(69)96
ASROCK Z97 EXTREME4	(68)97
ASROCK Z97E-ITX/AC	(69)93
ASUS Z97-A	**(67)95**
ASUS MAXIMUS VII HERO	(68)96
GIGABYTE Z97X-SLI	(66)94
MSI Z97 GAMING 5	(64)93

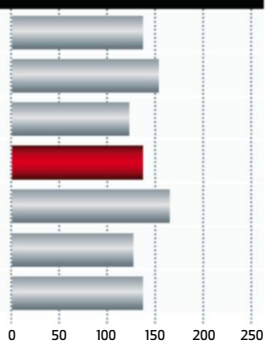


Core CPU performance

Cinebench R15	INDEX SCORE: HIGHER IS BETTER
ASROCK FATALITY H97	785
ASROCK Z97 EXTREME4	778
ASROCK Z97E-ITX/AC	743
ASUS Z97-A	**752**
ASUS MAXIMUS VII HERO	783
GIGABYTE Z97X-SLI	746
MSI Z97 GAMING 5	735

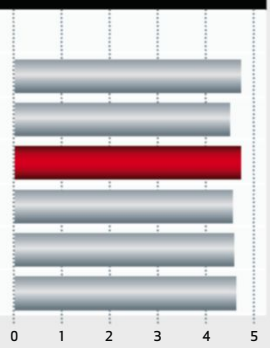
Power

GPU 100%	WATTS: LOWER IS BETTER
ASROCK FATALITY H97	140
ASROCK Z97 EXTREME4	158
ASROCK Z97E-ITX/AC	125
ASUS Z97-A	**135**
ASUS MAXIMUS VII HERO	161
GIGABYTE Z97X-SLI	129
MSI Z97 GAMING 5	135



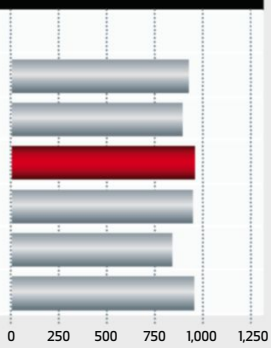
Overclocked core CPU performance

Cinebench	INDEX SCORE: HIGHER IS BETTER
ASROCK FATALITY H97	Fail
ASROCK Z97 EXTREME4	4.7
ASROCK Z97E-ITX/AC	4.5
ASUS Z97-A	**4.7**
ASUS MAXIMUS VII HERO	4.6
GIGABYTE Z97X-SLI	4.6
MSI Z97 GAMING 5	4.6



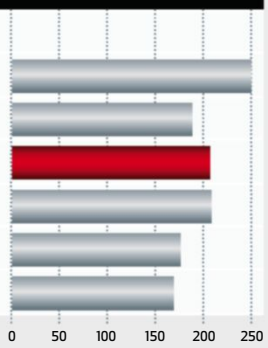
Overclocked core CPU performance

Cinebench R15	INDEX SCORE: HIGHER IS BETTER
ASROCK FATALITY H97	Fail
ASROCK Z97 EXTREME4	910
ASROCK Z97E-ITX/AC	887
ASUS Z97-A	**917**
ASUS MAXIMUS VII HERO	913
GIGABYTE Z97X-SLI	865
MSI Z97 GAMING 5	916

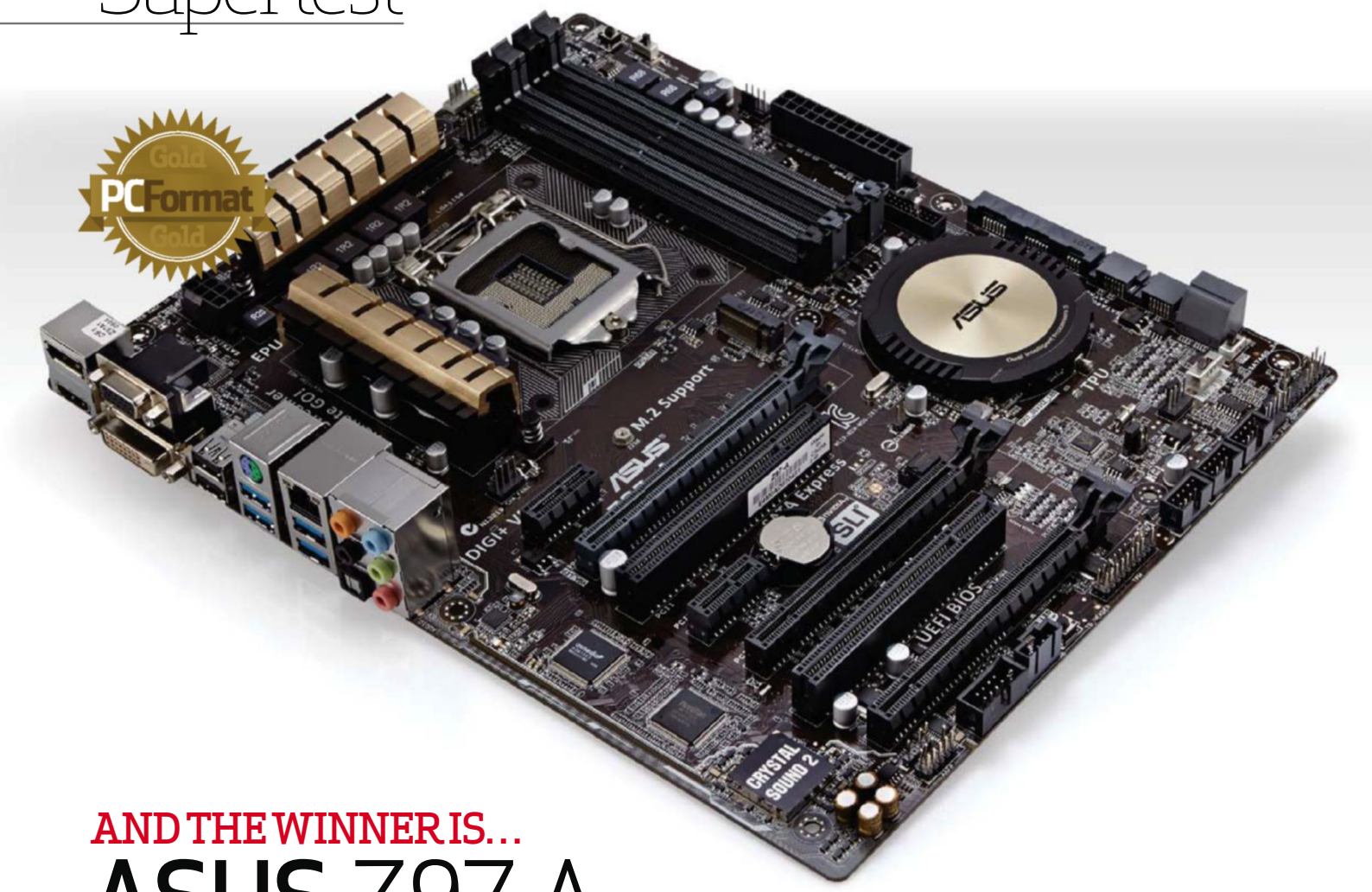


Overclocked overall platform power

GPU 100%	WATTS: LOWER IS BETTER
ASROCK FATALITY H97	Fail
ASROCK Z97 EXTREME4	250
ASROCK Z97E-ITX/AC	190
ASUS Z97-A	**205**
ASUS MAXIMUS VII HERO	209
GIGABYTE Z97X-SLI	175
MSI Z97 GAMING 5	168



	Storage	Multi-GPU	Video-out	Ports	Score
	6x SATA	AMD CrossfireX	DVI, HDMI, VGA	4x USB 3.0, 4x USB 2.0, 4.1 aud, LAN, VGA, DVI, HDMI, PS2, opt SPDIF, 2x PCIE 16, 2x PCIE 1, 3x PCI, 6x SATA	
	8x SATA, SATA Express, M.2	SLI, CrossfireX	DVI, HDMI, VGA, DisplayPort	6x USB 3.0, 2x USB 2.0, VGA, DVI, HDMI, DisplayPort, PS2, LAN, opt SPDIF, 4.1 aud, 3x PCIE 16, 3x PCIE 1, 2x PCI, 1x SATA Expresss, 8x SATA	
	5x SATA, SATA Express, M.2	No	DVI, HDMI, DisplayPort	4x USB 3.0, 2x USB 2.0, DVI, HDMI, DisplayPort, LAN, PS2, opt SPDIF, 4.1 aud, 6x SATA, 1x SATA Express, M.2, 1 PCIE 16	
	6x SATA, SATA Express, M.2	**SLI, CrossfireX**	**DVI, HDMI, VGA, DisplayPort**	**4x USB 3.0, 2x USB 2.0, DVI, HDMI, vga, DisplayPort, PS2, LAN, 4.1 aud, opt SPDIF, 6x SATA, M.2, 1x SATA Express, 3x PCIE 16, 2x PCIE, 1x PCI**	
	8x SATA, M.2	SLI, CrossfireX	DVI, HDMI, VGAs	4x USB 3.0, 2x USB 2.0, LAN, 5.1 aud, DVI, HDMI, VGA, opt SPDIF, LAN, BIOS reset, 8x SATA, no SATA Exp, M.2 socket, 3x PCI 16, 3x PCI 1	
	6x SATA, SATA Express, M.2	SLI, CrossfireX	DVI, HDMI, VGA	4x USB 3.0, 2x USB 2.0, PS2, DVI, HDMI, G, LAN, 5.1 aud, 2x PCIE 16, 3x PCIE 1, 2x PCI, 6x SATA, 1x SATA Express, 1x M.2	
	6x SATA, M.2	SLI and CrossfireX	DVI, HDMI, VGA	4x USB 3.0, 4x USB 2.0, LAN, DVI, VGA, HDMI, 5.1 aud, PS2, 3x PCIE 16, 4x PCIE 1	



AND THE WINNER IS...

ASUS Z97-A

One thing we haven't addressed, and which at this stage might be niggling you, involves those two new high-speed storage interfaces, SATA Express and M.2.

We've been banging on and on about them, positively screaming their praises, and yet all our testing has been done using conventional SATA drives. What gives? It's simply a matter of timing. PCI Express-based storage interfaces are so super new, we haven't got our hands on the drives to go with them.

In that sense, the most exciting bit about the 9 Series platform remains unknown. We've a rough idea of the kind of performance numbers SATA Express and M.2 will deliver initially, but we don't know what impact that will have on how PCs feel to use. Watch this space.

We also wish we had a few more H97 boards to play with, but as ever when a new platform is launched, most board-makers want to pimp their premium wares. That said, although Asrock's H97 essentially failed to overclock properly, the fact that the clear intention is to enable overclocking on H97 boards is promising. We're not a fan of Intel's policy to artificially restrict overclocking to the Z97 chipset. It's bad enough that there's no getting round the way it restricts overclocking to K Series CPUs. It only get worse with more limits involving motherboards.

Those caveats aside, the news is largely good. Most impressive is the array of features available across almost all the boards. Nearly all our test subject sport the important features we most want to see, and that even includes Asrock's mini ITX offering. The more expensive boards do offer some interesting extras, but not really anything you couldn't live without.

On a final note, we were a little disappointed to discover the near-universal use of thin, cheap PCBs. It may be the case that improved manufacturing and engineering has reduced the need for more robust PCBs in terms of electrical properties, but what with the recent spate of board failures we've experienced in recent months (nothing to do with this test), we're not convinced that such flimsy boards are a good idea.

On, then, to the final placings. Ironically, the most promising board pre-test comes in last. Asrock's Fatal1ty H97 Performance is a very interesting option, but can't be recommended until the BIOS issues preventing overclocking are sorted. The jury is also out on the glitchy MSI Z97 Gaming, though that is probably due to a worn out review sample, not any fault of MSI's.

As for the rest, you could make an argument for each. Gigabyte's aggressively priced Z97X-SLI is seriously exciting on paper, but slightly patchy in performance terms. The Asus Maximus VII Hero is a nice bit of kit, but too expensive to win this test. Meanwhile, Asrock's Z97E-ITX/ac is a great small form factor board, but not everyone wants small form factor.

"MOST IMPRESSIVE IS THE RANGE OF FEATURES AVAILABLE"

All of which leaves us with a very close contest between the Asrock Z97 Extreme4 and the Asus Z97-A. Truly, both are winners, but in the end it's the Asus's slightly superior overall quality that wins the day. Same old, then. ■

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Hardware

#294/August

Performance gear, uncompromising verdicts

WHAT ARE YOU DOING, DAVE?

"History is littered with gasping, outdated, overpriced, unsupported dual-GPU cards"

Dave James is getting all excited about both ends of the PC market, chucking 4K resolutions around with the quadfire Vesuvius machine from Overclockers, and prodding at the new mobile Kaveri APUs in the lower end of laptop-land. Speaking of 4K, he's also head over heels for Asus' affordable TN 4K screen. He never thought he could love a twisted nematic again…

With AMD launching its twin-GPU R9 295X2 with a £1,100 price tag and Nvidia hitting back with its own dual-GPU behemoth for around £2,400, you might be forgiven for thinking that the only exciting things happening in the PC market right now are at the top end of the market. But that's not true; there are incredibly exciting things going on down in the lower echelons too.

Sure, those headline-grabbing graphics cards represent some pretty impressive technical achievements, but that's pretty much all they are. You and I could never afford one. If we *did* somehow find ourselves with that much ready cash, we could never justify dropping it all on a graphics card. To be honest, I don't think I'd actually want one either – history is littered with gasping, outdated, overpriced, unsupported dual-GPU cards.

More interesting is what's happening in the more inclusive budget end of the market. That's where actual innovation can happen, and by incestuously marrying the offspring of the two GPU protagonists above, I've found something wonderful. Amid the excitement of wallet-rending graphics cards, the little desktop Kabini release was all but forgotten. I only got a chance to play around with it for the first time last month, and pairing the £66 CPU/mobo combo with a Maxwell-based GTX 750 I put together a 1080p gaming PC for less than £300. That's a full system – SSD, PSU, RAM and chassis included.

Tack on the cost of some 1080p screens and a network switch, and you could build a six-way LAN party for the same price as a GTX Titan Z. To my mind that's a far more exciting possibility than a constant driver battle getting a dual-GPU card to play the latest games at decent frame rates.

There's bargain PC power out there if you know where to look

P48
SILICON PHOTONICS

That's not the whole story either; Intel doesn't want to be pushed out of the budget end of the market, and with the recent Devil's Canyon releases it has also dropped the Pentium Anniversary edition CPU. Essentially that's an unlocked Core i3 Haswell K-series chip – though without HyperThreading – running at a nominal 3.2GHz for under £80.

I might be stretching the idea of 'budget' here, but it's also great to see 4K monitors coming down in price. They may be rocking TN panels for £500, but they're the finest TN screens we've ever seen. Considering the first 4K screen we saw cost £3,000 at Christmas time last year, that price drop is incredible.

Water-cooling hats for your PC

Now that water-cooling has become de rigueur for CPU chilling, everyone is turning their attention towards the other super-heated component of your gaming machine: the GPU. In addition to some funky new chassis, Corsair has unveiled a GPU adapter for its CPU liquid-chillers. Gigabyte has taken things a couple of steps further – it has created a water-cooling block that sits atop your chassis, sucking the heat out of your multi-GPU array like some kind of techie Nosferatu.

The WaterForce setup is designed for up to three discrete graphics cards, with 120mm radiators for each cooler, all controlled via a centralised interface. The LED readout on the front of the water-cooling hat allows you to keep temperature and fan speed under control, or you can use the simple GPU equalisation mode, which keeps each GPU running at the same temperature. Gigabyte claims that WaterForce will help keep temperatures as much as 40 per cent lower than a traditional air-cooled setup, and keep its existing graphics cards some 13dB quieter.

Gold Award

This is the ultimate badge of hardware excellence. Only truly outstanding gear gets this coveted award. Oh, and there are no prizes for runners-up here.

Our Hardware Manifesto

Would we buy it and should you buy it? That's all you want to know and it's all we care about. Performance and value for money are the two key pillars supporting the mighty *PC Format* Gold Award on its lofty pinnacle.

NVIDIA UNLEASHES THE GT 740. MOVING ON...

I'm seriously trying to care. As much as I've been extolling the performance of the budget end of Nvidia's graphics card range, the GT 740 seems like a step too far down cheap street. And the biggest kicker? This is yet another outing for the geriatric GK107 Kepler GPU. It's just a GT 640 with a new sticker.

So, like the GT 640, this GT 740 is running its GK107 GPU with 384 CUDA cores and 16 ROPs, but is a tiny bit faster out of the box. The GT 640 was only clocked at 950MHz for the top GDDR5 version, while the 'new' GT 740 is running at 993MHz. To be fair though, we doubt that the 43MHz clockspeed boost or the possibility of 4GB GDDR5 memory can make this old school GPU worthwhile purchase over a Maxwell-powered GTX 750.

EDITOR'S ONE TO WATCH

CryEngine for all!

Steam really is starting to rule the roost for new indie developers. As part of an exclusive deal with Valve, you can now buy a subscription to use Crytek's excellent CryEngine via Steam. This gives you the ability to develop and publish your games, all from within Valve's platform. It's an impressive deal, with subscriptions for as little as £5.83 per month if you sign up for six months. That gives you access to the CryEngine software, with no royalties to pay.

"By ruling out royalties, we are aiming to make CryEngine the best choice for everyone, and hope its arrival on Steam will empower developers of all sizes to achieve their creative visions," said Carl Jones, director of global business development at Crytek.

Unfortunately there were always going to be caveats when a deal was looking this good. In addition to the CryEngine subscription you also have to pick up the license for the audio engine and integration tool Wwise. If you're using fewer than 200 sound files in your CryEngine game then you can get away with the limited commercial license, but if you want to flog your opus with more than that you'll have to pick up a proper commercial one. If your budget is less than $150K then you'll just need to pay $750, but for anything over that you're looking at a cost in the thousands.

That's the only slight drawback of this setup though, and considering you get a continually updated version of the supremely powerful CryEngine it's really not a bad deal at all. And it's not just a question of being given the software and having to simply get on with it; by subscribing, you get access to a wide selection of demo levels and game assets, as well as a host of reference material and tutorials. There are lots of folk out there already using CryEngine, and they seem happy to talk about it.

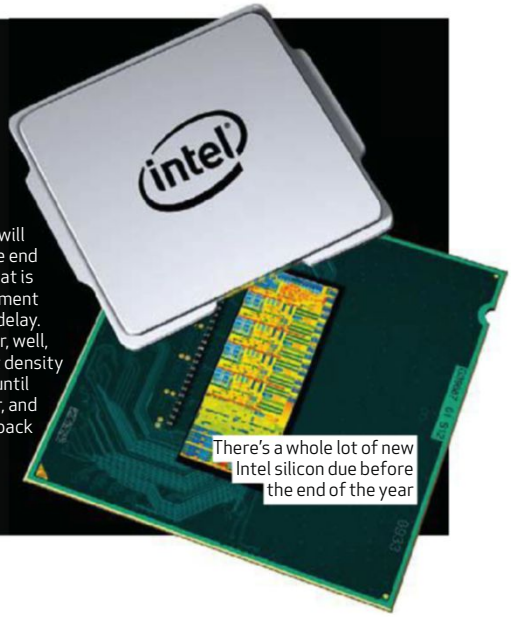
Perhaps the most exciting thing here (speaking as someone without any creative game-making talents whatsoever) is that this should mean that we'll get increasingly polished indie titles using an engine that's capable of some seriously beautiful gaming moments.

Maybe you could make the next *Star Citizen*

Intel's busy Christmas...

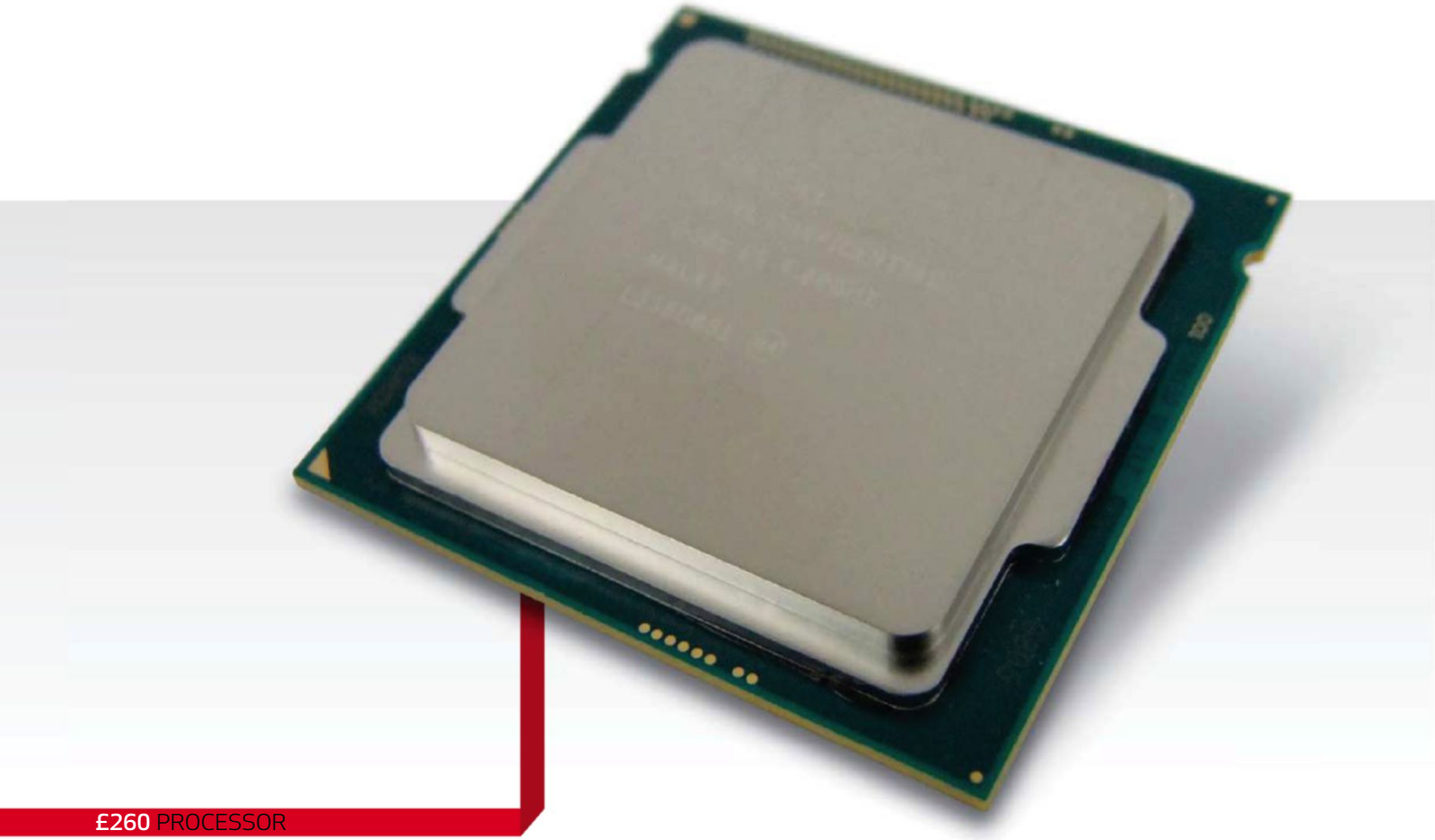
So, the Devil's Canyon chips are here and we're all excitedly clocking the twangers off them to see just how good TIM can be when he's jammed into a CPU package. But that's not it for Intel's chip releases this year; we've also got the Haswell E super-chips winging their way to our machines in the autumn – probably in time for release just before IDF in September. Those will be the server-equivalent desktop chips, complete with DDR4 support and up to eight discrete cores for some serious threading fun.

Intel CEO Brian Krzanich has also announced that Broadwell, the 14nm successor to Haswell, will be available before the end of the year. Yay. But that is actually the announcement of another Broadwell delay. Originally it was set for, well, now, but due to defect density issues it was delayed until the end of the summer, and has now been pushed back to Christmas. It's like Intel is taking timing cues from Valve...



There's a whole lot of new Intel silicon due before the end of the year

HIGHLIGHTS THIS MONTH



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Turbo clock 4.4GHz
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The king is dead. Long live the king. That always seems to be the way of things when Intel releases a new, high-end K-series processor.

You get a new ruling chip that's slightly younger and a bit more dynamic, but almost identical to the original in most other ways. It is, however, the new king, so you can't help but genuflect at its unparalleled processing performance (though in real terms, new Intel CPUs have rarely offered anything fresh apart from an incremental speed boost). The new Core i7 4790K could be a slightly different beast though – instead of the now-traditional 100MHz clock speed bump, we've actually got a relatively hefty 500MHz boost, making this the first 4GHz CPU from Intel since the cancelled single-core Pentium 4 a decade ago.

The i7 4790K is the top chip in the new Devil's Canyon range, and completes this year's refresh of the existing Haswell processors. This Hyperthreaded quad-core, with its eight threads of processing grunt, is the most advanced CPU silicon around right now, and delivers out-of-the-box performance to rival a heftily overclocked i7 4770K from the previous lineup. While the base clock of 4GHz is impressive, Intel is still sticking to its Turbo mode guns, so it's actually capable of regularly hitting 4.4GHz on all cores when fully loaded.

When you consider that most of the enthusiast-class, overclocked machines we've tested from PC builders up and down the land have their i7 Haswell chips set at 4.4GHz – or 4.6GHz at a liquid-chilled push – that's an extremely impressive starting point for an out-of-the-box processor.

New goo

So, how has Intel managed to achieve such a feat? Well, much of the success is owed to the fact that most 4770K chips were actually capable of hitting 4.4GHz anyway, and with little effort on the part of the user. All you had to do was knock the multiplier up to x44 in the BIOS and, generally speaking, you were good to go without worrying that you were going to melt through your motherboard. But to guarantee that every one of the new 4790K chips would be 100 per cent happy running at such a high clock speed, Intel has also re-engineered the CPU package.

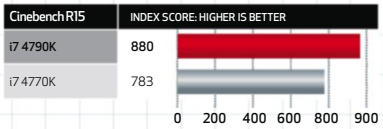
The most integral thing it has done is to replace the thermal interface material (TIM, our favourite acronym). Intel is calling the new goo a next-generation polymer TIM, replacing the original material, which seemed to essentially just be a little dab of Bostik holding the heatspreader onto the silicon package. Moving from Sandy Bridge through Ivy Bridge and onto Haswell Intel shifted away from using its effective solder-based goop, and subsequently CPU temperatures rose and maximum overclocks dropped generation-on-generation. Going back and using an improved TIM for Devil's Canyon ensures the high out-of-the-box clocks are consistent and that these new chips remain cooler too.

As well as the new TIM, Intel has also added some extra capacitors to the die package.

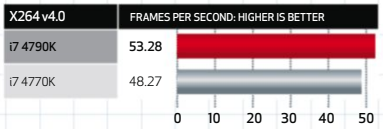
Technical analysis

The 4790K is demonstrably faster than the 4770K on all fronts and, thanks to the improved thermal interface material, it manages to do it all at lower temperatures too. Sadly, that additional speed doesn't translate to significantly improved overclocking performance on our sample, but with stock performance like this, the need to squeeze out even more is somewhat negated. The only real fly in the ointment for us, in these power-conscious times, is that the 4790K demands so much extra power to do what it does – and that's why we need Broadwell.

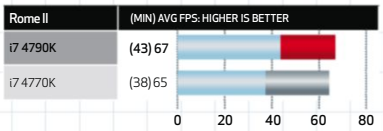
CPU rendering performance



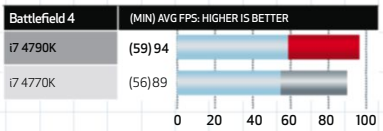
CPU encoding performance



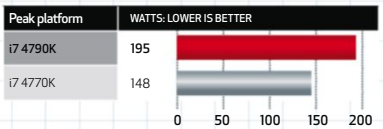
DirectX 11 1080p gaming performance



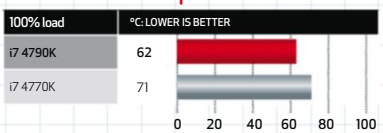
DirectX 11 1080p gaming performance



Power draw



Normalised thermal performance



On the pin-side of the 4790K you can see the extra power components where before there was just green PCB space. These new capacitors are there to smooth out power delivery to the silicon. Combined with the improved thermal material, that should offer an extra level of overclocking to the Devil's Canyon chips that the previous Haswell CPUs couldn't manage. The operative word there though is 'should'… but more on that in a second.

Devil's dumplings

The Devil's Canyon range also takes in the i5 4690K processors, upping the stakes on the original K-series i5 Haswell chips, but by nowhere near as much as this top-end 4790K. Though the new i5 has the same improved TIM and extra power capacitors Intel is only pushing the clocks up to 3.5GHz – that's the same miserly 100MHz speed bump we've become used to from an Intel refresh. We haven't been able to get our mitts on the new i5 as yet, but hopefully when the retail versions do tip up we'll see some serious overclocking headroom.

Though if the engineering samples of the 4790K are anything to go by we wouldn't hold our breath.

But, aside from the extra power components, higher TDP and improved thermal goo, there is little difference between the original and the refreshed Haswell chips. The production process is more mature, the clocks are more stable, and so it's easier for Intel to confidently produce higher-clocked stable parts for retail. This lack of change isn't much of a surprise though, as these processors weren't, strictly speaking, meant to exist in the first place.

> "THESE PROCESSORS WEREN'T MEANT TO EXIST IN THE FIRST PLACE"

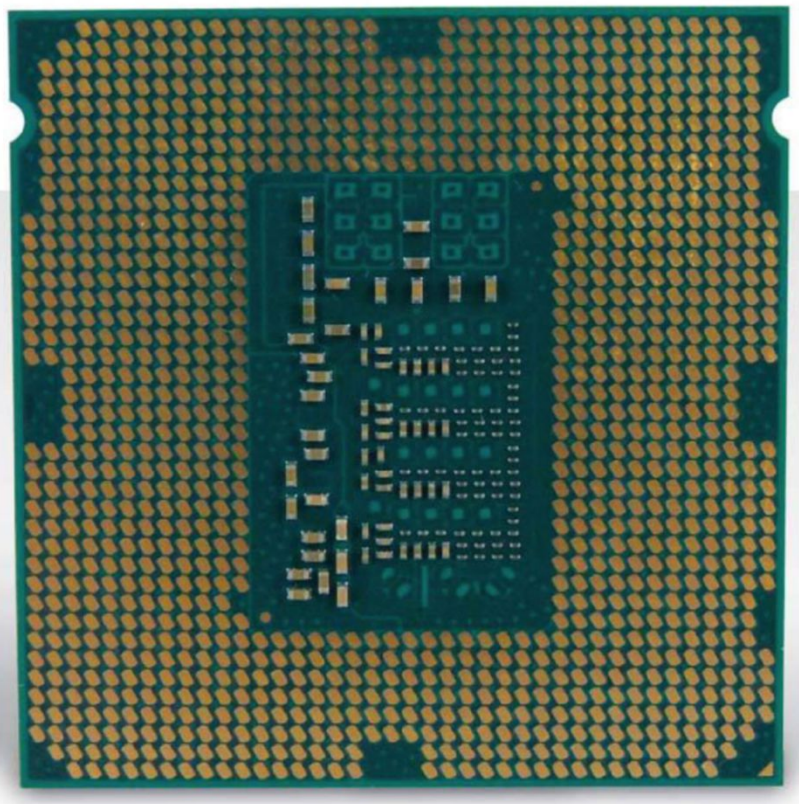
By now the Haswell architecture was scheduled to have been superseded by the Broadwell tick in Intel's traditional tick-tock production principle. The 14nm die-shrink of the Haswell microarchitecture has been delayed multiple times, most recently being pushed back from a delayed September launch to a release in late November or early December. Despite holding up working Broadwell silicon at IDF last year, Intel CEO then had to admit a month later a 'defect density issue' had shifted production back and it seems to have been slipping ever since. So, with Broadwell dropping down the release schedule like a greased-up fat guy down a slip 'n' slide, Intel needed to plug the gap – and thus came Devil's Canyon to ease the pain of having to wait for proper new CPUs.

And they manage it too, especially this 4790K. With its high box-fresh clockspeed, it's a good bit quicker than the 4770K it's replacing. In terms of straight CPU performance the 4790K is around 10 per cent quicker in both the Cinebench rendering test and the X264 HD video encoding benchmark. That extra performance only comes with a slight premium too, with the new i7 coming out at the same price as the original 4770K did at its launch. The older i7 has dropped in price in the intervening time, but typically not by more than £20.

Sadly that extra performance doesn't really translate over to the gaming side of things, with only the *Battlefield 4* benchmark showing a real improvement with the speedy new CPU and only then to the tune of another 5 per cent boost to the average frame rate. Our other gaming tests do show some improvements, but generally only by one or two frames per second on average.

Cooler clocks

As we mentioned though, most 4770K chips are capable of hitting this sort of speed without much tweaking, so you could easily get this level of performance from an existing Core i7. What the new 4790K can offer though is the ability to do it with a lower thermal envelope. The improved TIM



inside the package has made the new chip almost 10°C cooler under load. We tested both chips in the same board, with the same voltage and clockspeed dialled in, and the Devil's Canyon chip sat at a relatively chilly 62°C while the 4770K was a toastier 71°C. At stock speeds then, the 4790K is hitting overclocked Haswell performance without the added heat.

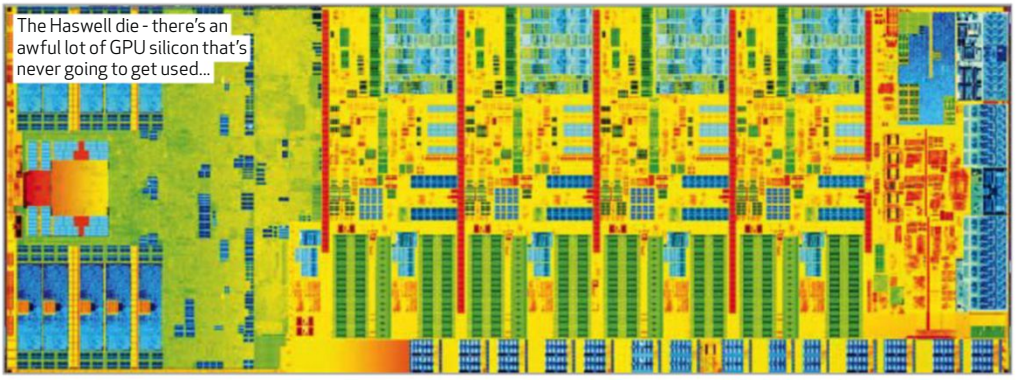
Though it is adding on a fair amount of extra power to ensure it gets to its top speed. Testing both chips at stock speeds the 4790K was drawing some 30 per cent more juice than the 4770K. That's a lot of extra power for a relatively small return in terms of performance.

We are also slightly disappointed by the overclocking performance of our engineering sample of the 4790K. We were hoping the extra TIM and power components might offer a hefty amount of headroom, especially with rumours of 5GHz on air floating around. Intel remains confident that retail chips will be able to hit such heights, but our 4790K could manage 4.7GHz at best. That's only some 100MHz quicker than the 4770K at its peak and I've heard that overclocking results are the same for a wide selection of engineering sample Devil's Canyon CPUs too.

And so a potentially very exciting new top-end K-series processor ends up the same way as most of those that have preceded it: mostly impressive, but with a foam of disappointment resting gently on top. The i7 4790K is the most advanced and most powerful Intel silicon on the market right now – the extreme hex-core end of its stack is still based on an older microarchitecture – but it promised even more.

But because of the fact it's come out at the same price as the 4770K you can't really be *that* disappointed. And because of its high stock and Turbo clock speeds you don't actually need to overclock it; you're already getting overclocked performance without worrying about heat or the CPU falling over because it's being pushed past its best. So yes, the new Devil's Canyon i7 is the go-to processor for high-end PCs, but it's just a replacement part and definitely not an upgrade for Haswell. If you've already got a 4770K we wouldn't be too concerned about making the switch. ■ **Dave James**

Our engineering sample may rock 4GHz, but it lacks serious OC prowess



The Haswell die - there's an awful lot of GPU silicon that's never going to get used...

PCFormat Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★☆

Another top K-series i7 from Intel, with high clocks and low temps, but no extra overclocking skills to show for it.

★★★★½

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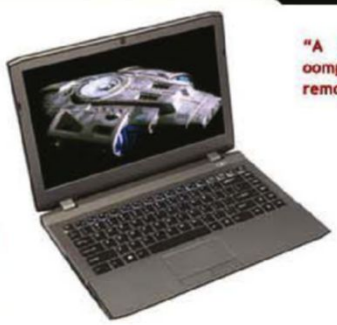

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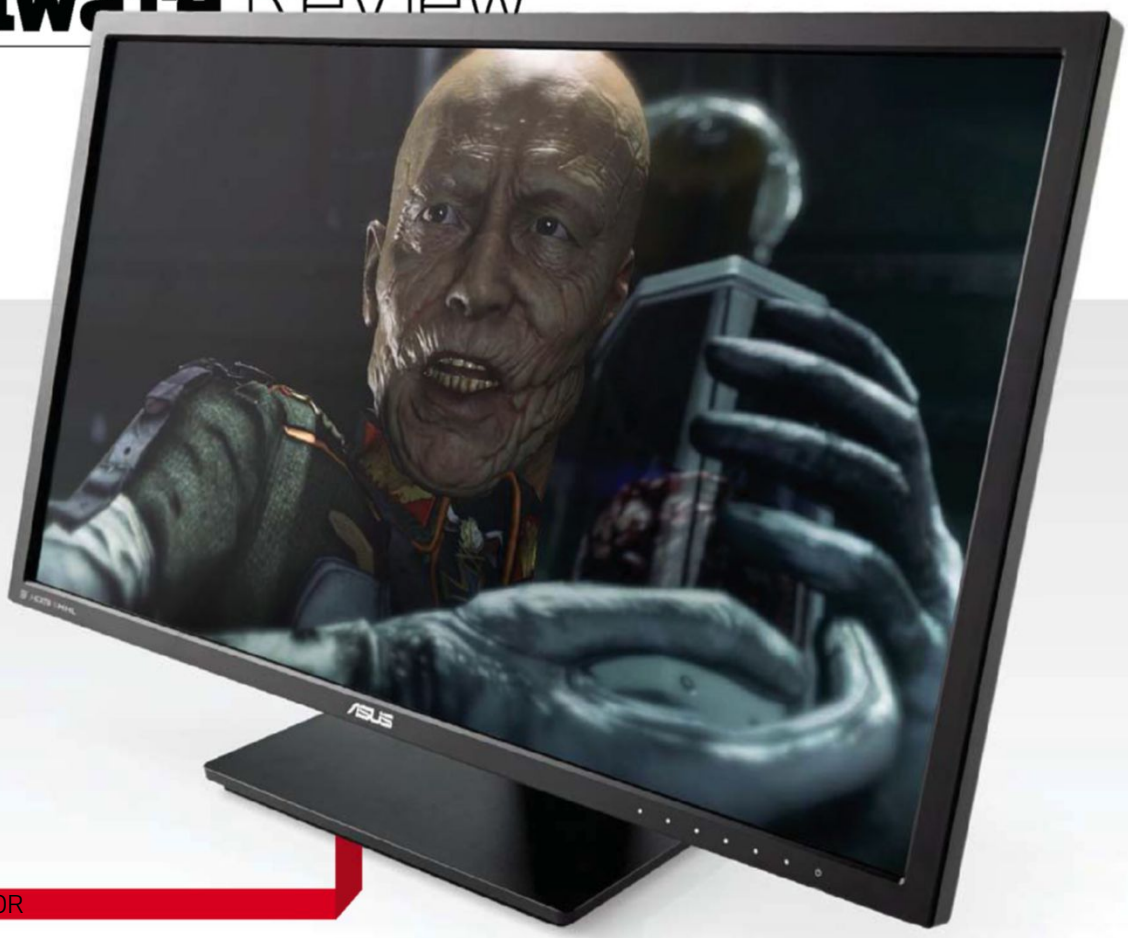

£600 MONITOR

ASUS PB287Q

The affordable 4K cometh…

VITAL STATISTICS

Price £600
Manufacturer Asus
Web www.asus.com
Panel size 28-inch
Native resolution 3,840 x 2,160
Refresh rate 60Hz
Panel tech TN 10-bit
Response time 1ms GTG
Inputs HDMI, HDMI (MHL), DisplayPort

This is not a situation we expected to find ourselves in so quickly. To see 4K monitors drop to this price level so quickly is, frankly, astounding.

When we checked out our first 4K monitor in late 2013, it was Asus' 32-inch PQ321QE – and a lovely thing it was too – but it was £3,000. That's more expensive than a Titan Z, which has become the green standard for something that's too pricey to justify. Then came the Dell UP2414Q, which was the first IPS 4K screen to look vaguely affordable, but at £1,300, it was still beyond the reach of most of us.

Now we've got a host of full 4K panels turning up around the £500-£600 price point, from a variety of vendors. How did this happen? It's all about the panel tech. The first 4K screens we saw were of the IPS variety, with beautiful colour reproduction and impeccable viewing angles. These cheaper monitors are rocking the ol' TN panel tech. Cue groans of disappointment from anyone who's made the switch from an old TN panel to IPS in the last few years…

TN or not TN?

Indeed, we also groaned when the first affordable TN 4Ks informed us of their inability to run 4K resolutions at 60Hz. That just doesn't cut it for gaming, or anything really, so we thought our dreams of affordable 4K screens had died. And then these bona fide 4K beauties arrived, running at 60Hz, and with TN panels that were anything but the tech we'd come to know and loathe.

Sat bezel-by-bezel with an IPS 4K screen, you can tell the difference instantly. Colours aren't as vibrant on the TN screen, but that's almost where it ends. These new TN panels are quite exceptional, especially considering the ropey TN we've become used to. Sat on its own you'd be hard-pressed to state with any confidence that you weren't looking at an IPS display.

This is the more expensive of the two screens here, but given the AOC U2868Pqu's budget bent that's no surprise. The Asus panel is a 10-bit display, offering full 1.07bn colour depth, and includes EyeCare tech. That means it has a similar low-blue light/flicker-free setting to the recent BenQ gaming screens. The idea is to reduce eyestrain so you can keep gaming until you expire from malnutrition and not from bleeding eyes.

It also has a nicer chassis, with a slim bezel and full tilt/twist and height adjustment. That's supremely useful, because while the horizontal viewing angles of the TN panel are excellent, the vertical angles aren't so hot. Drop the height of the screen to eye level and that slight issue almost disappears. The only thing we miss is a USB 3.0 hub on the side of the display.

But can Asus justify the £100 difference between it and the AOC option? It's a hard question. If you're a graphics pro you might find the colour difference between a 10-bit and an 8-bit version worth the money, but for gaming types there is precious little in it. For us, the AOC gets the nod on the value front. It doesn't suffer for its 8-bit panel, and has that USB hub. Still, the PB287Q is a great monitor, offering 4K quality at an impressive price point. ■ **Dave James**

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★½

Astonishingly good value for a 4K screen, with an excellent TN panel and a quality feature set packed in to boot.

★★★★½

£499 MONITOR

AOC U2868PQU

Is AOC's budget 4K option a false economy?

VITAL STATISTICS

Price £499
Manufacturer AOC
Web www.aoc.com
Panel size 28-inch
Native resolution 3,840 x 2,160
Refresh rate 60Hz
Panel tech TN 8-bit + FRC
Response time 1ms GTG
Inputs D-Sub, DVI-D, HDMI, DisplayPort

You thought £600 was pretty good value for a 4K screen? Well, it is – the Asus PB287Q is less than half the price of its 32-inch counterpart. But AOC, ever one to jump in at the budget end, has undercut Asus to the tune of £100. At £500 this TN-sporting panel is the cheapest 4K screen we've had grace our test bench, and we're struggling to see the telltale signs of it being a 'budget' monitor.

AOC has used a different panel to Asus. Where the PB287Q is a full 10-bit monitor, the AOC uses an 8-bit panel with frame rate control (FRC) to boost the available palette up to the same 1.07bn colours. Essentially, it means the pixels can rapidly flash between two colours, mixing them to create a third tone not available to a standard 8-bit panel.

In some panels, FRC becomes visible in the darker shades as a noisy image, but we haven't been able to detect any dithering in the black tones on this AOC screen. In truth, though, the black reproduction on the Asus screen is superior to the AOC. In our other image tests, the U2868Pqu passes with 1.07bn flying colours. The white saturation levels are excellent, there's no banding to the gradient and the contrast levels are equally remarkable. And, like the Asus, the viewing angles on the TN panel are really impressive. Again you'd find it difficult to say for sure that you weren't looking at an IPS display. Considering this is the sort of price you'd pay out for a 2,560 x 1,440 27-inch screen, albeit an IPS one, the drop in pricing of 4K monitors is pretty astonishing – especially when you remember that to get a 2,560 x 1,600 panel you still have to spend upwards of £700.

Feature filled

AOC hasn't skimped on the overall package either. Normally, you'd expect a budget monitor (sorry to keep referring to a £500 screen as 'budget' – a pox on you, context!) to cut corners, but aside from the use of that 8-bit panel, it has everything you could want. Sure, the plastic surrounds and chunky base bezel hardly scream 'luxury!' but it has a full tilt/swivel, height-adjustable stand and a host of inputs.

To be fair, the VGA ports are largely irrelevant given that you can't drive the screen properly with either input, and HDMI and DVI-D will only offer 30Hz at the native resolution, but the options are there if you fancy the picture-in-picture route. One impressive extra the AOC has over the Asus is a USB hub on the right-hand side. It's got a pair of USB 2.0 and two USB 3.0 connections. Not having one isn't a deal-breaker for us, but it's definitely appreciated.

All in all, this is a great day for high-resolution gaming. When a 4K screen cost twice as much as the GPUs that you needed to game on it, that was a real barrier to entry. Now that they're essentially the same price, things are going to move rapidly. Both the Asus and AOC are great, affordable 4K options, though if pushed we prefer the image quality of the AOC despite the 8-bit panel. In comparison, the Asus screen feels a trifle washed out. But it's by such tight margins that these battles are decided.... ■ **Dave James**

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★★

A fantastic entry-level 4K screen, with some seriously impressive image quality and a solid feature-set.

★★★★½

Scan manufactures over 1,000 custom-built systems per month, so whether you want a ninja gaming rig, a small form factor media PC or a gaming laptop we can spec it and build it for you. Here are nine featured systems from our huge range, all of which can be fully customised with different components and cases.

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GAMING EXPERIENCE: ELITE ★★★★

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- 8GB Corsair Vengeance Pro 2133MHz
- Phanteks U-Type

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- 8GB Corsair Vengeance DDR3 1600MHz
- NVIDIA GeForce GTX 870M or 880M
- 500GB HDD
- 15.6in 1920 x 1080 screen

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3XS Z97 Performance GTX
- Intel Core i5 4670K overclocked to 4.4GHz
- 8GB Corsair Vengeance Pro 2133MHz
- 2GB NVIDIA GeForce GTX 770
- 250GB SSD + 2TB HDD
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- 8GB Corsair Vengeance Pro 2133MHz
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Scan 3XS Graphite LG1711
- Intel Core i7 4710MQ
- 16GB Corsair Vengeance DDR3 1600MHz
- NVIDIA GeForce GTX 870M or 880M
- 500GB HDD
- 17.3in 1920 x 1080 screen

£1116

3XS Z97 Vengeance 780
- Intel Core i7 4770K overclocked to 4.4GHz
- 8GB Corsair Vengeance Pro 2133MHz
- 3GB NVIDIA GeForce GTX 780
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£160 SSD

Technical analysis

Crucial has managed the neat trick of producing a range of drives that is both faster and cheaper than the one it is going to replace. The MX100 512GB drive also gives its M550 equivalent a good run for its money – so much so that it's a moot point whether it's worth paying the extra cash for a M550.

AS SSD Sequential read (MB/s)

AS SSD	(MB/S)
CRUCIAL MX100 512GB	509
CRUCIAL M500 480GB	488
CRUCIAL M550 512GB	514

0 200 400 600 800 1000

AS SSD 4k random write (MB/s)

AS SSD	(MB/S)
CRUCIAL MX100 512GB	56.21
CRUCIAL M500 480GB	59.61
CRUCIAL M550 512GB	57.51

0 20 40 60 80 100

AS SSD Sequential write (MB/s)

AS SSD	(MB/S)
CRUCIAL MX100 512GB	475
CRUCIAL M500 480GB	408
CRUCIAL M550 512GB	477

0 100 200 300 400 500

ATTO Sequential read (MB/s)

ATTO	(MB/S)
CRUCIAL MX100 512GB	531
CRUCIAL M500 480GB	539
CRUCIAL M550 512GB	542

0 200 400 600 800 1000

AS SSD 4k random read (MB/s)

AS SSD	(MB/S)
CRUCIAL MX100 512GB	24.72
CRUCIAL M500 480GB	22.53
CRUCIAL M550 512GB	24.45

0 5 10 15 20 25

ATTO Sequential write (MB/s)

ATTO	(MB/S)
CRUCIAL MX100 512GB	511
CRUCIAL M500 480GB	429
CRUCIAL M550 512GB	512

0 200 400 600 800 1000

CRUCIAL MX100 512GB

Crucial releases yet another range of drives at bargain prices

VITAL STATISTICS

Price £160
Manufacturer Crucial
Web http://uk.crucial.com
SKU CT512MX100SSD1
Memory 16nm Micron MLC NAND
Quoted sequential read: 550MB/s
Quoted sequential write: 500MB/s
Adaptive thermal management Power loss protection
Warranty 3 years

Do you remember a time when there was a pretty decent gap between launches of new SSD product lines? Crucial only released the M550 series some three months ago, and there is already a new range of drives to think about. To be fair to Crucial, the new MX100 line is more a replacement for the older M500 series than anything to do with the M550.

Whereas the M500 series topped out at 960GB, the MX100 flagship drive is a mere 512GB. In fact, there are just three drive capacities currently available for the MX100: 128, 256 and 512GB. This makes perfect sense because the real money is in the lower capacity mainstream market, with the sweet spot being around the 256GB mark. Very high capacity SSDs are seen by most people as niche products, although the prices for these large drives are tumbling. Anyway, if you need more than 512GB, there's the 1TB version of the M550.

As ever, Crucial has gone for an extremely competitive price structure for the new range. Capacity-wise, the drives don't match up exactly with the M500 series, and the MX100s are around 20 quid cheaper than the nearest M500 drive. The 128GB MX100 is £56, the 256GB is £78 and the flagship 512GB drive we're reviewing comes in at £160.

The low pricing of the MX100s comes down to their use of Micron's brand new 16nm MLC NAND, details of which are being held firmly in-house at the time of writing. What *is* known is that they are 128Gb dies and this density allows cost savings in manufacture. The 512GB drive uses 32 of these dies in 16 chips (two dies per NAND package), eight on each side of the PCB. Controlling them is a Marvell 9189 controller that offers small improvements in performance and – perhaps of greater importance – more efficient power saving than the 9187 in the M500.

Even though Crucial has used cheaper NAND in the drive to keep costs down, the MX100 still retains the power loss protection, the DEVSLP command, TGC Opel 2 and AES 256-bit encryption support as well as RAIN (Redundant Array of Independent NAND) support of the M550.

Crucial quotes sequential read/write speeds for the 512GB drive at 550MB/s and 500MB/s respectively, which is exactly the same as figures quoted for the 512GB M550. All three drives have the same quoted sequential read speeds, but the write speeds differ quite considerably – the entry level 128GB drive has to make do with just 150MB/s while the 256GB version has a quoted write speed of 330MB/s. In testing with the ATTO benchmark, the 512GB drive produced a read score of 531MB/s, which is a little bit shy of the official figures, and 511MB/s for writes. The 4K read/write performance of the MX100 is pretty much the same as the M550, with a read score of 24MB/s and a write score of 57MB/s. In real-life testing, the drive took just 30 seconds (127MB/s) to copy a 4GB image and 2 minutes 19 seconds to copy a 17GB Blu-ray image. These times are close enough to the M550 as to make no real difference in performance. ■ **Simon Crisp**

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★★

It is to Crucial's credit that the MX100 drives are not only faster than their predecessors, but cheaper too.

★★★★½

£111 SSD

Technical analysis

Plextor's M6S performs extremely well, but it has to do something about its pricing. In the current market it's just too expensive, especially as it lacks the features that the opposition is building into less pricey offerings.

AS SSD Sequential read (MB/s)

AS SSD	(MB/s)
PLEXTOR M6S 256GB	482
CRUCIAL MX100 512GB	509
CRUCIAL M550 512GB	514

0 200 400 600 800 1000

AS SSD 4k random write (MB/s)

AS SSD	(MB/s)
PLEXTOR M6S 256GB	64.72
CRUCIAL MX100 512GB	56.21
CRUCIAL M550 512GB	57.51

0 20 40 60 80 100

AS SSD Sequential write (MB/s)

AS SSD	(MB/s)
PLEXTOR M6S 256GB	421
CRUCIAL MX100 512GB	475
CRUCIAL M550 512GB	477

0 100 200 300 400 500

ATTO Sequential read (MB/s)

ATTO	(MB/s)
PLEXTOR M6S 256GB	516
CRUCIAL MX100 512GB	531
CRUCIAL M550 512GB	542

0 200 400 600 800 1000

AS SSD 4k random write (MB/s)

AS SSD	(MB/s)
PLEXTOR M6S 256GB	26.57
CRUCIAL MX100 512GB	24.72
CRUCIAL M550 512GB	24.45

0 5 10 15 20 25

ATTO Sequential write (MB/s)

ATTO	(MB/s)
PLEXTOR M6S 256GB	444
CRUCIAL MX100 512GB	511
CRUCIAL M550 512GB	512

0 200 400 600 800 1000

PLEXTOR M6S 256GB

Plextor's M6 range is the replacement for the popular M5 series of drives

VITAL STATISTICS

Price £111
Manufacturer Plextor
Web www.plextor.com
NAND 19nm Toshiba MLC Toggle
Quoted sequential read/write: 520MB/s read, 420MB/s write
Buffer 512MB DDR3
Controller Marvell SS889188
Warranty 3 years

Plextor is the ninja of the SSD world – one minute you haven't heard about any fresh products, and the next thing you know there's a whole new range to look at. It certainly doesn't go around announcing new products with a fanfare like *some* manufacturers we could mention.

Its latest family of SSDs is the M6 series, which replaces the highly popular M5 range. The new line comprises drives in a number of formats and capacities: M6S (2.5in 7mm format, 128, 256 and 512GB), M6M (mSATA, 64, 128, 256 and 512GB), M6e (HHHL PCI-E, 128, 256 and 512GB) and M6e M.2 2280 (M.2 PCI-E, 128, 256 and 512GB). There's also a M6 Pro, which is scheduled to launch pretty soon. Plextor is aiming the M6S at the mainstream market, and it's the 256GB version of this drive that we're looking at here.

Under the hood, the M6S uses a Marvell SS889188 four-channel controller (a cheaper alternative to the eight-channel 9187 controller used in the M5 Pro series), with custom firmware developed in-house by Plextor. The drive's storage capacity is made up of eight Toshiba second generation 19nm 128Gb die 32GB MLC Toggle NAND modules. Unlike the usual arrangement of an SSD's PCB, everything – including the NAND, controller and a 512MB LPDDR3 cache chip – sits on one side of the board.

Plextor quotes a sequential read speed of up to 520MB/s for the 256GB drive. This was confirmed by the ATTO benchmark, which produced a score of 516MB/s. Sequential write performance is given as up to 420MB/s, which the review drive surpassed with ease, giving a score of 444MB/s in the ATTO benchmark. The 4K performance is very good, with the M6S giving stronger figures than either the 512MB Crucial MX100 or the similar sized M550 drive. In real-world testing, a 60GB Steam folder (containing 29,521 items) was copied in a sharpish 14m 47s (at an average rate of 77MB/s). Compressing the same folder into a zip file took a lengthy 50m 38s, although just 24m 11s to decompress. Copying a 17GB Blu-ray image took 2m 32s (at an average of 120MB/s) while copying a 4GB image took a mere 32 seconds.

Take out the trash

The M6S uses the latest version of Plextor's own True Speed technology, which maintains the drive's performance after prolonged use. Think of it as an advanced garbage collection technology.

However, unlike Crucial's latest range of consumer drives, there is no power loss protection, thermal protection or support for advanced encryption technologies; if these are important features for you, then this is a drive to strike off your list. It does, however, support DEVSLP for extremely low power consumption when idle (2mW), Plextor says that the M6S has dropped the power demands by 30-50 per cent compared to the previous generation M5S.

The M6S is a drive that performs well, but Plextor has to do something about the pricing. In the current market it's too expensive compared to the opposition – especially as it lacks the features of some other drives. ■ **Simon Crisp**

PCFormat Verdict

Features ★★★½☆
Performance ★★★★½
Value ★★★★☆

Plextor is aiming at a market dominated by rivals with cut-throat pricing. Crucial's MX100 is cheaper with more features.

★★★★☆

£122 USB 3.0 MEMORY STICK

SANDISK EXTREME PRO 128GB

Take your external storage up a level, albeit for a huge chunk of cash

VITAL STATISTICS

Price £122
Manufacturer SanDisk
Web www.sandisk.co.uk
Capacity 128GB
Interface USB 3.0
Read/write speeds 260MB/s, 240MB/s
Dimensions 11 x 21 x 71mm
Warranty Lifetime

Context is everything. Especially when it comes to performance. When you're looking at throwing down this sort of cash for a USB stick, you need to know how it fits into the bigger picture of performance on your PC. How is the rest of your machine performing and what should you expect from your average external storage? With SanDisk marketing the fact that it'll take seconds to copy a movie on to the Extreme Pro 128GB, you need to know whether that performance is adequate.

Advances in memory interfaces mean that you generally won't be waiting long for most internal transfers – modern memory interfaces boast a throughput of 19GB/s. At the other end of the spectrum, the most common interface is the humble USB 2.0 connector, which struggles along with a theoretical throughput of 60MB/s; and you'll generally see half that in the real world. When you consider that the latest SSDs allow you to shuffle around data at 500MB/s, you can see that getting your data out of the PC tends to be the slowest area of modern computing.

The Extreme Pro offers up a two-pronged attack to this problem, aiming high on the performance and capacity fronts. This is a USB 3.0 device, which has a theoretical throughput of up to 625MB/s, although you'll do well to reach anything like that. At 128GB this is as big as many entry level SSDs and large enough to hold pretty much anything we can reasonably think of for normal computing. In fact, we're at a bit of a loss as to see why you'd need a USB drive this big beyond specific scenarios – a 32GB stick is fine for most normal uses.

When it comes to the performance, the AS SSD benchmark test shows that SanDisk's claimed throughputs are pretty close, with read speeds of 240MB/s and writes of 227MB/s. Access the drive over a USB 2.0 port though, and you'll hit 37MB/s and 35MB/s respectively, something worth considering if you're moving data to a slightly older, pre-USB 3.0 machine. These figures plunge when it comes to moving around smaller files – something highlighted by AS SSD's 4k transfer speed. But even here the 10MB/s and 8MB/s (7MB/s and 6MB/s over USB2.0) are reasonable for an external device. These are roughly half the speed of a modern SSD connected to your eSATA port, but in a more flexible form factor.

One thing we haven't mentioned so far is the design. This is an attractive device that combines an aluminium main body with a black plastic strip that houses a switch to retract the connector back into the body to help protect it. This clicks nicely into place when extended or retracted, and means you don't have a small plastic cap to lose on your travels.

Overall, the capacity is impressive and the performance is great for a small external drive. Which leaves the problem of price. At nearly £1/GB this is an expensive way of getting your hands on some storage (SSDs are less than half that). Even so, if you need a large external drive that is speedy in use, this is hard to beat. ■ **Alan Dexter**

PCFormat Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★½☆

A capacious USB 3.0 stick that is too pricey for day-to-day use, but easy to justify if you need to move around lots of large files.

★★★★½

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PC GAMER EDITOR'S CHOICE ★★★★★

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BATTLEFIELD 4

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It's not water in those tubes… it's lava

VITAL STATISTICS

Price £4,118
Manufacturer Overclockers
Web www.overclockers.co.uk
CPUx Intel Core i7-4770K @ 4.6GHz
Memory 16GB Corsair Vengeance DDR3 @ 2,200MHz
Graphics 2x AMD Radeon R9 295X2
Storage 250GB Samsung 840 Evo SSD, 2TB Seagate HDD
OS Windows 8.1

Every now and then you've got to forget about the bottom line and simply appreciate the technical brilliance in front of you. That's exactly what we had to do when we looked at AMD's dual-GPU beast, the Radeon R9 295X2. The fact that you had two of the finest GPUs AMD has ever made on one PCB, both running *faster* than in their single-GPU progenitors, meant you had one hell of a powerful graphics card. Its price of over a grand made some sense, given the extra cooling design and the fact that a single R9 290X card will set you back over £400 even today.

Therefore, we have to kind of stop looking at the price of this monstrous gaming PC from Overclockers, given that it's got two of these £1,100 graphics cards sitting in a quadfire configuration, as well as a seriously overclocked CPU and tweaked memory system.

Putting price aside for the moment, let's take a look at what these four GPUs are capable of. If you want a real idea of the potential gaming performance on offer in the Infinity Vesuvius, then look no further than the Heaven benchmark. Heaven takes everything out of the performance equation – apart from the graphics silicon – and highlights the impressive scaling these GPUs can deliver.

Moving from the dual-GPUs of a single R9 295X2 up to this quad-fire array offers more than a 70 per cent boost to the frame rates at 2,560 x 1,600 and at the supreme 4K resolution of 3,840 x 2,160.

While those numbers are pretty spectacular – especially when that 4K boost translates into an average 52 frames per second – there is the problem that Heaven is still just a synthetic benchmark. Looking at real-world performance, things don't seem quite so exciting; four is faster than two, but nowhere near as nippy as in the Heaven test.

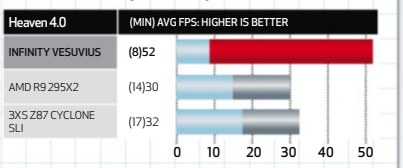
With the Unreal Engine 3-powered *Bioshock Infinite*, you're looking at around 30 per cent higher average frame rates, while *GRID 2* offers around 40 per cent extra performance at 4K and *Battlefield 4* benefits by some 15 per cent extra from having another two AMD GPUs in action. The big difference for *BF4* is that we saw much higher minimum frame rates at 4K with the second 295X2 in play. Unfortunately, the dreaded micro-stutter is still very much in evidence across the board in our tests. It's a shame that despite the enormous amount of power on offer with this £2,200 graphics card setup, we still can't get smooth gameplay. That's not a hardware problem – as evidenced by the Heaven benchmark – but one of drivers and software.

You might expect the rest of the components to match the graphical behemoths. Sadly, Overclockers have only gone with the quad-core 4770K rather than a six-core Extreme edition CPU. There's a somewhat miserly 250GB Samsung Evo SSD; we'd have much preferred at least a 512GB SSD and preferably the superior Samsung 840 Pro. It may be a beautifully presented and gorgeously built machine, but we're struggling to figure out what the other £2,000 has been spent on… ■ **Dave James**

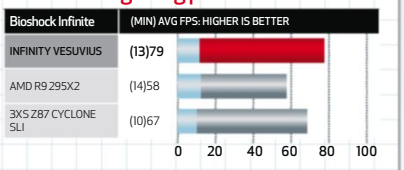
Technical analysis

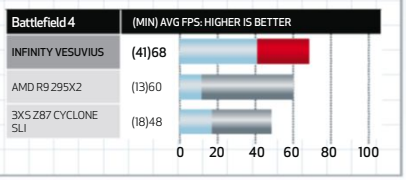
The nearest rig we've seen to Overclockers' opus is Scan's Cyclone SLI. That only has a pair of GTX 780 Ti cards, but is over £500 cheaper and has double the solid-state storage. Still, the overall performance of this quad-GPU rig is considerably ahead of the Scan machine, even if there is still the spectre of micro-stutter hanging over both.

4K DirectX 11 synthetic performance



4K DirectX 11 gaming performance





PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★½

Some serious multi-GPU power is on offer in this machine, but the performance just isn't consistent enough for the money.

★★★½

DinoPC.com

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- Gigabyte G1 Sniper Z97 Motherboard
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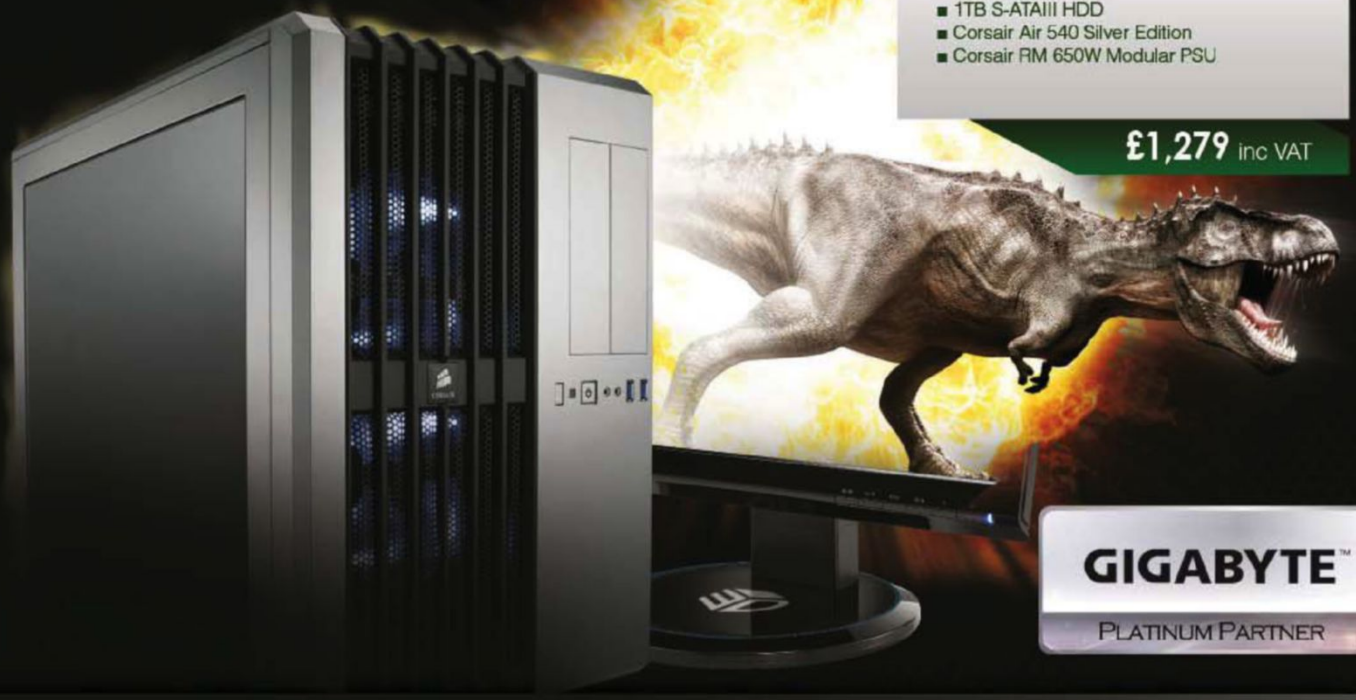

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£550 GAMING PC

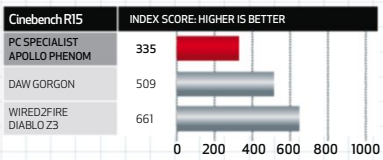
PCS APOLLO PHENOM

PC gaming performance in a pint-sized package

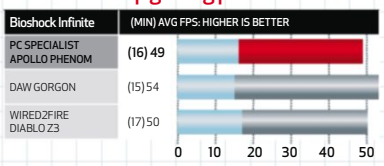
Technical analysis

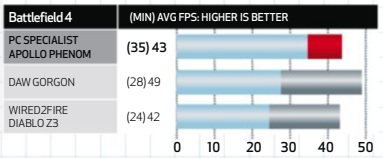
We've seen a few budget machines over the last few months, but this is the cheapest by £100, but still manages to remain very competitive in gaming terms if not in processing power. The build quality of this machine also belies its price tag, delivering decent 1080p performance in a great package.

CPU rendering performance



DirectX 11 1080p gaming performance





VITAL STATISTICS

Price £550
Manufacturer PC Specialist
Web www.pcspecialist.co.uk
CPU Intel Core i3 4130 @ 3.4GHz
Motherboard Asus H81M-Plus
Memory 8GB DDR3 Kingston HyperX single channel
Graphics Nvidia GTX 750 Ti
Storage Seagate 1TB SSHD
OS Windows 8.1

You could call us out here on *PC Format* and accuse us of going from the sublime to the ridiculous when we've got a PC on our test bench with a £4K+ price tag, and now we're checking out a budget rig from PC Specialist that costs just £550.

We'll let you decide which is sublime and which ridiculous, but both have a place in our hearts. One is a PC packing an unprecedented level of 4K gaming prowess and a hefty amount of processing power in a hulking ATX chassis, and the other is an affordable 1080p machine in a small form factor case. These two demonstrate the great variety available in modern PC gaming, and while the ultra-expensive PC is definitely the more powerful option, this budget offering shows you can still get a great gaming experience even if you're not a Russian oil baron who owns half of London.

The Apollo Phenom is housed in a special edition BitFenix chassis, called the GeForce GTX 'Claw' Phenom, Nvidia has been trying to push the small form factor PC through various channels, and this green highlighted chassis with Nvidia branding is testament to that.

The Apollo Phenom is based on a micro-ATX Asus H81 board with an Intel Core i3 CPU doing the processing work. It's an i3 4130, which makes it a dual-core, quad-thread processor, but without the Turbo functionality. That last part isn't too much of an issue, as it will run at a steady 3.4GHz all day long. The great thing about Intel's Haswell tech is that even in these lowly dualies there's enough processing power to run your graphics card without hindrance. That means the Apollo Phenom's GTX 750 Ti is being held back by the processor. It's no high-resolution monster, but the Maxwell-powered GTX 750 Ti is an impressively pacey 1080p card with seriously low thermals, and it doesn't gulp greedily from the PSU either.

In our tests, only *Metro: Last Light* gave it any pause for thought at 1080p, and *Battlefield 4* on 'Ultra' settings was running beautifully up at 43fps, dropping down to 35fps as a minimum. That shows just how smooth an experience you can get out of this machine on the most popular gaming resolution around.

Silence of the fans

The Apollo is gloriously quiet, too. Even when it's being seriously stressed in-game, the machine's cooling array barely rises above a whisper. Realistically that's going to have something to do with the fact that even in *BF4* running at 2,560 x 1,600 (where it still manages a respectable 24fps on average), the peak platform power draw from the plug is a paltry 128W. To put that in perspective, that wouldn't even power *half* of one Hawaii GPU in AMD's R9 295X2.

This PC Specialist machine really does demonstrate the breadth of PC gaming right now. It's a pretty diminutive, practically silent machine, which draws about the same amount of power as a PS4 and is capable of greater feats of gaming grandeur. You may not have the processing power to get too productive with the Apollo Phenom, but the gaming performance will not disappoint. ■ **Dave James**

PCFormat Verdict

Features ★★★½☆
Performance ★★★★☆
Value ★★★★★

A great little budget 1080p machine that wont put too many demands on either your wallet or the energy reserves.

★★★★☆

£989 GAMING LAPTOP

GIGABYTE P34G V2

Thin and light gaming joy

VITAL STATISTICS

Price £989
Manufacturer Gigabyte
Web http://uk.gigabyte.com
CPU Intel Core i7-4700HQ@2.4GHz
Memory 8GB DDR3
Graphics Nvidia GTX 860M
Storage 128GB Liteon SSD
Display 14-inch
Native res 1,920x1,080

Gigabyte's laptop strategy is a strange one. It created the Aorus gaming offshoot, with machines like the SLI X7 we checked out a couple of issues ago, but it's also still making its own, less pseudo-sexily-named gaming laptops too. These more sedate-looking machines may not have the bizarre, lost-in-translation call to arms of the Aorus range ('challenge your embedded weakness'), nor the vaguely Alienware chassis styling, but the P34G v2 still has it where it counts – in the component stakes.

The big thing for a gaming laptop, especially one with a full HD 1080p display, is the graphics subsystem. Not only has Gigabyte gone for a powerful GPU, but it has picked one with a mobile focus. The Nvidia GTX 860M chip in the P34G v2 is the Maxwell-powered version, as opposed to the Kepler GTX 860M we've seen in so many other systems.

The Kepler variant may have more CUDA cores and a bit more power than the Maxwell GPU, but the newer Nvidia silicon is much better suited to mobile gaming as it doesn't tend to melt at the slightest hint of a textured, anti-aliased polygon. And it doesn't need a power supply the size of Sellafield to keep it fed either. That doesn't mean it is lacking gaming power though. Even on the highest settings at full HD, it's playable in a host of our test bench's games, only really stumbling over the *Company of Heroes 2* and *Rome 2* benchmarks. But even in this case, dropping down to 'high' settings sans AA delivers huge increases in performance.

Nvidia's GeForce Experience really comes into its own on a gaming laptop. Prioritising native resolution GFE will set your compatible games to run at their smoothest settings, which makes a real difference on a machine like this. Sadly, as we've seen in other Gigabyte gaming laptops, thermals are an issue. Not so much for the Maxwell GPU – that tops out at a respectable 72°C – but the CPU cooling means the processor is throttling back even with the fans winding up.

In CPU benchmark terms, the P34G v2 is a notably behind other Core-i7 laptops we've tested. For gaming performance that's not a great issue, but the fans are really pushing the air around keeping the CPU cool enough to continue running, and that makes it a loud machine. It's not an issue with a decent headset, but anyone nearby may not take so kindly to it.

Storage hunters

This lower-cost version is also a little light on storage; with just 128GB of SSD capacity you'll swiftly run out of space. There are other versions available with either a slow 1TB HDD or a 256GB SSD combo, but those add a fair chunk of cash to the ticket price.

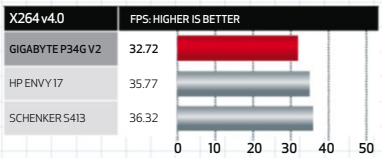
We're not massively fussed on the build quality of the chassis either. It's certainly slim, at slightly over 2cm thick, and pretty lightweight with it, but the plastic surrounds are a little flimsy and don't seem to fit too well on our sample.

Still, for a genuinely gaming-capable Ultrabook-ish machine, Gigabyte's P34G v2 does a great job. It may not be much of a looker, but it's packing the gaming goods under the hood. ■ **Dave James**

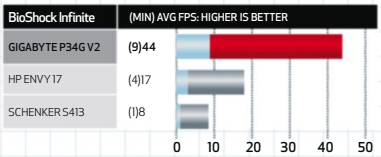
Technical analysis

Put up against the more expensive HP machine and the Iris Pro from Schenker, the P34G v2 does struggle in CPU terms. But as soon as you start throwing any gaming benchmarks at the Maxwell GPU, this Gigabyte machine really pulls away from its competition.

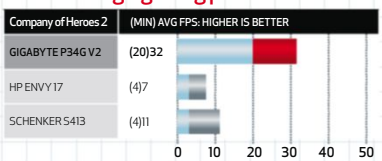
CPU encoding performance



DirectX 11 'Ultra' gaming performance



DirectX 11 'High' gaming performance



PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½☆

A quality little gaming notebook with impressive performance, but slightly lacking in some other areas.

★★★★☆

£1,200 LAPTOP

HP ENVY 17 LEAP MOTION SE

A leap of faith into the future of gesture recognition?

VITAL STATISTICS

Price £1,200
Manufacturer HP
Web www.hp.com
SKU 17-j171sa
CPU Intel Core i7-4702MQ @ 2.2GHz
Memory 12GB DDR3
Graphics Nvidia GT 750M
Storage 1TB 5,400rpm HDD
Display 17.3-inch touchscreen
Native res 1,920 x 1,080

While you might think it quite enjoyable to maintain a snarky disposition when it comes to new product releases, that's not actually why we got into tech journalism. Yes, it's more fun writing about something that's plain terrible than writing about something that's just adequate – but it's even more pleasing to write about a bit of tech that is genuinely worthwhile or exciting. That's why we do this; we're enthusiasts first and foremost, and want to be enthusiastic about things.

And that's why we wanted to look at HP's Leap Motion laptop – because we wanted to be passionate about it. Sadly, the gesture-recognition technology in the Envy 17 is less *Minority Report* and more *Ernest Does Tech Design*.

This version of the Envy 17 is a pretty standard 17.3-inch 1080p notebook, with a middling Core i7 mobile CPU housing eight threads and a decent Turbo frequency. It also has a discrete Nvidia GPU, though it is only of the GT 750M variety, so it has little to offer in gaming terms at full native resolutions.

The Leap Motion tech is really all there is to make this notebook stand out. The sensor is a black strip to the right of possibly the worst trackpad I've ever had the misfortune to use. The idea is that the sensor creates an area around the keyboard that can recognise your hand, including individual fingers, to offer gesture control for your PC. We found it very tricky to get a consistent response from the sensor, even after multiple calibrations. For many of the Leap Motion apps, the sensor divides the area above the laptop into two areas: a hover zone and a touch zone. The hover zone tracks motion, such as the movements of a cursor, while the touch zone is the area closest to the screen and is used to denote the pressing of buttons.

Hover hands

It's hard to know where each area begins and ends, which means there's a lot of trial and error, mis-clicks and random movements in-app. The sensor will also sometimes lose track of your hand or fingers mid-way through an action, which means that using the machine is often a rather frustrating experience. We want gesture tracking and recognition to be effortless and, above all, consistent. The Leap Motion implementation on the Envy 17 is anything but.

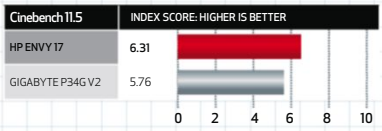
But it's also suffering because Leap Motion is really a platform rather than a controller. It doesn't work on the applications you use on a day-to-day basis – only ones picked up through the Airspace store. With touch becoming ever more accurate – and the screen on the Envy 17 is touch-ready and as reliable as you could wish – and the mouse still being the best option for fine-grain control, a tertiary, flaky method of interaction seems rather irrelevant.

This is especially true of laptops; when you're this close to the screen, touching it is hardly a chore. With a desktop machine, however, an accurate and integrated method of gesture control could be an excellent secondary controller. Right now though, Leap Motion isn't it. ■ **Dave James**

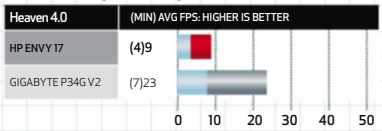
Technical analysis

The slightly cheaper Gigabyte machine from the previous page may not have the thermal performance to operate its CPU at the sort of Turbo the larger HP Envy 17 can manage, but the Maxwell GPU inside the P34G gives it the gaming edge. The premium you're paying for the Leap Motion sensor, which is likely to sit there unused for much of its life, simply isn't worth it in comparison.

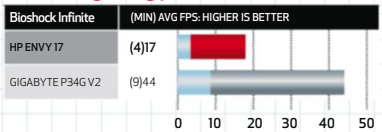
CPU rendering performance



DirectX 11 synthetic performance



DirectX 11 gaming performance



PCFormat Verdict

Features ★★★★☆
Performance ★★★☆☆
Value ★★½☆☆

An expensive, middling performance laptop with a headline feature not worth the sticker price, but does have potential.

★★★☆☆

£280 GAMING CONTROLLER

THRUSTMASTER WARTHOG

How can you justify such a high price tag? Ask Thrustmaster… it just has

VITAL STATISTICS

Price £280
Manufacturer Thrustmaster
Web www.thrustmaster.com
Separate throttle Yes
Programmable buttons 22 (5 on stick, 17 on throttle)x
Hat switches 4x 8-way (3 on stick, 1 on throttle) 2x 4-way (1 on stick, 1 on throttle)
Z-axis rotation No

When a controller turns up that makes the Saitek X-55 Rhino look like a budget option, you know you've got something special on your hands. Well, *in* your hands anyway. And that is exactly what Thrustmaster's beautiful HOTAS Warthog has done this month.

We got all excited when we first pulled the X-55 from its packaging, loving the action of the throttle and the weight of the two controllers. But that was nothing compared to unboxing the Warthog.

It may be some £120 more expensive, but you can feel every extra penny in terms of materials and build quality alone. We admit, we have a bit of a crush on this fantastically-priced flightstick/throttle combo, and that's only grown from using it in-game. There's also the fact that anyone who passed by the testing setup felt utterly compelled to lay hands on the throttle and give it a push. And their reaction? Without exception it's been an almost post-orgasmic sigh.

The action on that throttle is beautiful, and if you don't agree you can tailor it to your liking using the on-the-fly resistance adjustment. There isn't the same adjustment available to the joystick itself though (points to the X-55 for providing different resistance via the replaceable springs), but that doesn't really matter because it moves reliably and smoothly in all angles of attack. There is one thing missing from the Warthog's joystick, and that's the Z-axis rotation. The X-55 has a twist axis in the joystick that allows you to use it as the yaw/rudder control – with the Warthog you have to assign that elsewhere.

There's a host of different toggle, rotational, hat and three-way switches to make up for that slight shortfall in operation. There's even a little analog joystick on the front of the throttle that makes a good rudder control. This lack of functionality is all down to the basis for the Warthog's design – namely the titular aircraft upon whose controls this stick has been based. It's incredibly faithful, and hence there is no twist to the stick.

Weight of expectation

The difference in weight between the Warthog and the X-55 Rhino is incredible. That's all thanks to the sheer amount metal Thrustmaster has used in the construction of both throttle and stick; it might well have you reinforcing your desk, if not the floor it sits on. It feels mightily robust, and has the build quality to match.

The reason we're likening it to X-55 Rhino is simple: it's the best of the rest of the flightstick brigade and is a good way ahead of the competition. The X-55 Rhino is a close approximation of the Warthog; in fact, it's almost as if their designers were sitting side-by-side at the drawing board. They say imitation is the sincerest form of flattery, but the X-55 has clearly been made for those who want a serious flight-controller and can't stretch to the incredibly high price of the Thrustmaster.

If you can afford the HOTAS Warthog, you shouldn't think twice about grabbing it. While the X-55 is a very close second, the Thrustmaster setup is simply the very best flightstick and throttle you can buy for your gaming PC. ■ **Dave James**

PCFormat Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★½☆

There will be no buyer's remorse once you've pulled the Warthog from its box and plugged it into your PC. Beautiful.

★★★★½

£46 GAMING HEADSET

GAMDIAS EROS GHS2200

Teach yourself obscure languages and mythology, courtesy of *PC Format*

VITAL STATISTICS

Price £46
Manufacturer Gamdias
Web www.gamdias.com
Drivers 40mm
Friequency range 20Hz to 20KHz
Cable length 3m
Weight 328g

The Nazis believed their Enigma cipher was unbreakable, yet the smartest minds in Blighty managed to crack it. Question is, how would they get on trying to decipher what Gamdias means? Well, here goes: 'dias' is Latin for 'god', but then you probably knew that, as *PC Format* readers are a superior breed. GAM is an acronym of 'Gaming Art in Motion', hence this is a headset made by a gaming god. I used to think Jack Wills defined pretentiousness, but clearly everything's relative.

Actually that's not true. With a name this audacious, these cans better be the very best darned things you ever let near your noggin, bar none. First impressions aren't exactly godlike though. The deity designer responsible for the styling must have been having an off-day, judging by the questionable combination of a matte black headband coupled to glossy ear cup brackets. Likewise, the bog-standard leatherette ear and head cushions don't inspire much awe or wonderment.

Still, perhaps the features list will be more inspiring, especially as the box makes some pretty bold claims: 'innovative' ear cushions which guarantee maximum comfort, a boom mic that pivots up and down, and – get this – nine levels of headband adjustment. Wow. Who cares what tech Apple packs into the iPhone 6? This is where it's at.

The Eros does have a couple of somewhat less generic features though, like a useful in-line remote for volume adjustment, plus 7.1-channel virtual surround sound. Gamdias describes this as 'thrilling', but in reality the improvement it makes over standard stereo is more subtle than the differences between the UKIP and BNP manifestos.

Deus ex auris

However, its performance is far harder to criticise. The pseudo surround sound isn't much cop, but the rest of what comes out of these cans is mighty impressive. God knows – literally – what Gamdias has stuck inside the Eros, but the result is sound quality up there with headsets costing more than twice the price.

Tight tonal separation and brilliant overall clarity extract plenty of detail from gaming soundscapes and films. The *Dark Knight*'s DTS soundtrack punishes most headsets, but the Eros does it justice with pin-sharp treble and pounding bass. Things aren't quite as amazing musically, where mid-range frequencies are lacking transparency and treble can sometimes sound a tad harsh during vocals, but these are minor quibbles.

By this point the iffy styling is long forgotten, and though the ear cushions and headband are overhyped, they must be doing something right as the Eros fits snugly and is easily comfortable enough for an all-night gaming marathon. That rotating boom mic works a treat and clearly captures all your jabbering, plus you also get a braided USB cord that's a whopping three metres long. Who needs wireless?

Stellar sound and excellent ergonomics make the Eros well worth the money, but there's a final feature that's priceless. Eros is the god of love, hence this is way more than a headset – it's your new guardian angel, and should give you one hell of a gaming edge. ■ **Ben Andrews**

PCFormat Verdict

Features	★★★★½
Performance	★★★★★
Value	★★★★★

Greece must be on the up, as its gods are producing some mighty fine headsets. A great budget offering.

★★★★½

£80 GAMING HEADSET

COOLER MASTER SIRUS-C

Just when your eardrums thought they were safe…

VITAL STATISTICS

Price £80
Manufacturer Cooler Master
Web http://gaming.coolermaster.com
Drivers 44mm + 40mm
Friequency range 20Hz – 20KHz
Microphone range 100Hz – 10KHz
Cable length 3m
Weight 425g

Some things work better in pairs. Graphics cards, certain bodily appendages, Batman and Robin. Now Cooler Master has applied the 'dynamic duo' theme to its latest headset with 2.2 channel speakers. Rather than a single driver each side struggling to cope with all frequencies, two 44mm main drivers take care of the midrange and treble, backed by a pair of 40mm woofers for banging bass.

To ensure these are powered to the max, the Sirus-C packs built-in sound processing and amplification, plus an in-line remote to control the main volume, chat level and mic. The remote itself is hardly compact though, and the headset could do with a diet too, tipping the scales at a podgy 425g. Keep these cans on too long and people will think you're related to Stewie Griffin. But at least the transition into deformity will be comfortable, as the wide, thickly-padded headband and super-soft ear cushions effectively cosset you from the bulk beyond.

Speech impediment

More mass also translates to substantial build quality, with materials and hinge points that feel like they'll last the course. Subtle all-black looks add to the premium vibe, and the CM Storm ear cup logos light up so you can hunt the headset down easily in your gloomy gaming grotto.

There's also a third light at the end of the mic, which illuminates when the boom is lowered. However, mute the mic and this stays lit, just inside your peripheral vision, at the perfect position to be reflected by your PC's screen. The question isn't *if* you'll be driven to stick gaffer tape over it, but *when*.

The mic is keen to be seen, so it's a pity it doesn't deliver better results. You'll be heard just fine, but the flat, slightly muffled speech capture isn't ideal if you're craving clarity.

Those dual-driver speakers do a somewhat better job of living up to expectations, creating an open and expansive sound quality that noticeably boosts the sense of scale in gaming and movie audio. This could have the side effect of vague tonal separation, but the Sirus-C maintains clearly-defined treble, midrange and bass.

Things aren't perfect though. Sure, twin drivers should theoretically give enhanced dynamic range, but there simply isn't the high-end sparkle and low-down punch you're expecting. It's not like there's even any improvement over a single-driver setup either, as the Gamdias Eros manages a more pronounced performance at either end of the frequency spectrum. Don't get us wrong; listening to the Sirus-C is still a pleasant experience, but the so-called 'groundbreaking' 2.2 channel design breaks about as much ground as fracking will under Downing Street.

Console support for the Xbox 360, PS3 and PS4 is more beneficial though, and when you factor the lounge-spanning braided cable with its USB and 3.5mm connections, this headset isn't short on versatility. Unfortunately it's not short on marketing hype either, but treat all this with a fistful of salt and the Sirus-C isn't far off making all the right noises. ■ **Ben Andrews**

PCFormat Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★½

Though its performance isn't as awesome as the specs suggest, the Sirus-C still makes a decent all-rounder.

★★★★½

£53 GAMING KEYBOARD

CORSAIR RAPTOR K40

Can a few macro keys make up for a switch from mechanical to membrane?

VITAL STATISTICS

Price £53
Manufacturer Corsair
Web www.corsair.com
Key technology Membrane switch
Backlight LED
Rollover Full N-key
Polling rate 1,000Hz
Controls Win-lock, backlighting, media, volume

Corsair has made snobs out of us. When the first Vengeance mechanical switch board dropped into our laps, all thoughts of using a regularly membrane keyboard went out of the window. While the tactile feel of mechanical vs membrane can be subjective, there's no getting away from the fact that the components of a mechanical switch board will outlast their membrane equivalent.

And that's why they command such a premium price tag. We've looked at a lot of gaming boards over the last few months and the cheapest mechanical switch keyboard we've been able to find – that we'd actually use – has been around £85. The awesome Vengeance K70, on the other hand, is around £105 and the new RGB backlit version is only going to make it pricier.

So it's no surprise to find Corsair releasing alternative gaming keyboards for a cheaper price, and we've now got the K40 keyboard under its Raptor brand. You have to jettison all thoughts of mechanical switches and pin your hopes on a decent membrane implementation. But while it's taking all its design cues from its Vengeance brethren, it sadly can't use the same high-level components or materials.

Where the K60 and upwards have used a brushed aluminium base, the Raptor has an all-plastic frame. That means it doesn't have the weight or rigidity of higher-spec boards, but is still impressively robust. Corsair has also ensured that a lot of the functionality has been kept intact – the analogue volume wheel has been replaced by volume up and down buttons, but you still get the same Windows key lock and media controls.

You also get some additional macro keys. The six keys on the left-hand side of the keyboard can be programmed on the fly and there are three profile switches to essentially give you 18 macro keys. That's a neat addition, somewhat offsetting the rest of the board's budget leanings.

Yet we can't help but miss those mechanical keys, and no amount of extra macros will change that. The membrane switches on the K40 do have some tactile feedback to them, but they don't feel as clean as something like the Cherry MX red switches in the K70 and K95 boards. It's not as comfy to type on either, partly due to the missing wrist-rest the Vengeance boards come with. Corsair has angled the lower keys slightly, but there is still strain on your wrists.

The Raptor K40 is very much a cut-price version of Corsair's Vengeance keyboards, but at around half the price it can make a pretty good account for itself in the value stakes. Fifty quid is still a lot of peripheral cash, but the gaming functionality is there and the K40 has some of the better membrane switches we've used. Exactly how they'll feel after six months of *Battlefield 4* gaming, we're not quite so sure, but given the general build quality oh show, they might well be fine.

We're not going to be setting aside our K70 keyboard just yet, but the Raptor range is making a bit of a name for itself at the budget end of the gaming spectrum, and that's no bad thing. ■ **Dave James**

PCFormat Verdict

Features ★★★½☆
Performance ★★★½☆
Value ★★★★☆

A decent budget alternative to the higher-priced Vengeance boards, but we still miss the mechanical switches.

★★★½☆

£43 GAMING MOUSE

CORSAIR RAPTOR M45

Wherever you stand on the optical vs laser debate, Corsair has you covered

VITAL STATISTICS

Price £43
Manufacturer Corsair
Web Corsair
Sensor PixArt PMW3310
Type Optical
Dpi Up to 5,000
Polling rate 1,000Hz
Programmable buttons 7

We'd assumed that the whole point of Corsair's Raptor range of gaming peripherals was to offer low-cost versions of the Vengeance range. After all, it's all mechanical switches and high-spec laser sensors in the Vengeance camp and dead-action membranes and LED optics over on the Raptor side. It was a clear delineation we could get behind. But this Raptor M45 has kind of got us a little confused. Y'see, it's not actually that 'budget'.

Our confusion lies in the fact that the M45 is the same price as the excellent Vengeance M65 laser mouse. Yet the M45 has a lower-sensitivity optical mouse sensor, a plastic chassis and fewer buttons. Ordinarily, that would be a source of confusion and consternation. The Raptor K40 keyboard is very much the cheaper cousin to the Vengeance K70, but makes up for that by being around half the price.

But whereas the Raptor K40 is a demonstrably weaker product than the Vengeance keyboard, the Raptor K45 isn't that far behind the K65 mouse. The decision between the two rodents is actually more down to personal preference than raw technical details.

If talking about straight numerals, the max 5,000dpi of the PixArt optical sensor in the M45 is long way behind the 8,200dpi of the laser sensor in the M65, but it's not an appley comparison. When it comes to the optical vs laser debate in gaming mice there are few more divisive techie issues this side of the great AMD vs Nvidia shouting matches.

There are many folk who will always side with the optical sensor – for fast-paced gaming they can be consistently more accurate than their laser-bearing cousins, as long as you have a good mouse-pad. Laser sensors are more reliable on a wider range of surfaces.

Optical illusion

But the M45's optical sensor in the M45 is an impressively reliable option. I didn't feel any twitchiness at its highest 5,000dpi setting – and realistically you won't want to game at anywhere near the super-sensitive maximums of the top-end laser sensors, so that maximum isn't really going to be a limiting factor.

The fact remains that the Corsair mouse design is still one of the most comfortable and simple around. We're fans of the ultra-ergonomic Ballista MK-1, but the M-series rodents are more accommodating for different grips and hand sizes. The only slight disappointment with the M45 is that it's entirely plastic and lacks the aluminium skeleton of the M65. That does make it lighter, which again is a preference of some serious gamers – just look at MadCatz RAT TE. There are three weights in the base of the M45, however, so you can make some alterations if you want it even lighter still.

We can understand why this optical Raptor mouse is retailing for the same cash as the laser Vengeance. It's all down to preference, as both are excellent gaming mice. We can't help feeling that the cheaper materials Corsair has used in building the M45 ought to translate to a little saving for the austere gamer, but if you want a top-quality optical gaming mouse you'd have to look a long way to find one that can better this. ■ **Dave James**

PCFormat Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½☆

A great quality optical gaming rodent, perfect for those who find the average laser mouse a little too twitchy.

★★★★½

RIG BUILDER

Whether you're upgrading your PC or starting anew, this is the best kit

One of the joys of owning a PC is that you can upgrade it as you go. Need higher frame rates in games? Drop in a newer graphics card. More power elsewhere? Grab a new processor or go for that old favourite: a memory boost. There's a wealth of upgrades that can transform your machine, and you can change slowly over time to suit your budget, so you rarely have to suffer a sluggish rig for long. Every now and then, the best possible upgrade is to dump your current rig and start afresh by building a whole new machine from scratch.

What sort of machine should you build, though? Which items are important? Which work well together? How much should you be budgeting for? That's a lot of questions, and to get the right answers means having to go and research all the current trends in order to make the best decision. Before you do that, though, take a look to the right. You'll discover that we've taken the hard work out of the equation and presented you with three machines that fit three different budgets.

On these pages are our usual recommendations for putting together a budget, mainstream and silly high-end machine. These rigs all include a screen and peripherals in the ticket price, so if you're keeping your existing goodies then you can spend more elsewhere. And what's our choice? Either get a larger SSD or a more powerful GPU. Happy building you lovely people! ■ **Dave James**

HOW TO... BUY A MOTHERBOARD

Your choice of motherboard almost entirely dictates what sort of PC you end up with. It will determine whose CPU you go for, and what range you can pick it from. It also decides what storage you can use, how many graphics cards you're able to fill out your PC with and, almost more importantly, it dictates how big your final build can be.

The key thing to remember is that you don't *have* to go for a full ATX spec board if you want high performance any more. A micro-ATX or Mini ITX board can be just as capable of offering serious PC grunt as their larger brethren. You don't have to be restricted on the overclocking front either. Since Intel relaxed the draconian restrictions on overclocking with the Haswell range, you're not limited to the Z-series. In the new line-up both H97 and Z97 allow overclocking, and in the previous generation the lowly B85 chipset could also be tweaked. These days, it's a much more flexible motherboard market.

BUDGET £534

When every pound counts, spend them wisely

MOTHERBOARD £65
Gigabyte GA-970A-DS3

AMD has carved itself out a rather comfortable niche in the low-end market, and Gigabyte is helping. With SATA 6Gbps and USB 3.0, this mobo covers all your needs.

CPU £84
AMD FX-6300 BE

The FX-6350 may well be here, but the FX-6300 still has better OC chops and a lower price point. The fact you can hit 5GHz with one of these makes it a favourite.

MEMORY £34
Crucial 4GB 1600 DDR3

Memory pricing continues to be incredibly volatile, but it's still a great time to squeeze more sticks into your rig. You really should see 4GB as the minimum these days.

GRAPHICS CARD £114
MSI GTX 750 Ti OC

Nvidia's latest GPU is quite a feat of engineering because of that brand new Maxwell architecture. The MSI card is a bargain at this price too.

HARD DRIVE £43
Seagate 1TB Barracuda

Taking advantage of the SATA 6Gbps connection on the Gigabyte mobo is this Seagate drive. It's not going to give you SSD speeds, but it's not bad and gives you enough space for gaming.

POWER SUPPLY £40
SilverStone Strider E 500W

We may be talking about a budget rig here, but it's still a rather hefty chunk of cash to risk on a no-name power supply. This 500W SilverStone PSU will give you peace of mind and all the PCIe leads you need.

CHASSIS £52
Corsair Carbide 200R

Much more impressive than its price tag may lead you to believe, the clean lines and added extras of this chassis make it the budget case to beat. An understated bargain.

SCREEN £85
AOC E2250SWDNK

This 21.5-inch panel has a native resolution of 1,920 x 1080 and looks pretty good despite that price tag. You'll need a minimum of £150 for IPS, but this TN ain't bad.

OPTICAL £17
LG GH22LS50 DVD-RW

It's hardly the sexiest component, but until games and OSes come on USB sticks, this is your best option to get your rig up and running.

CPU COOLER N/A
AMD Stock Cooler

Coolers make a big difference for tweaking high-end CPUs, but the standard one that comes with the 'retail' processor is just fine for this rig.

MAINSTREAM £1,000

You don't have to spend a fortune to get a stunning rig

MOTHERBOARD £114
Asus Z97-A

We're still in the early stages of the new 9-series motherboard releases, but this well-priced and impressively-specced Asus board is the best we've seen so far. Good start!

CPU £180
Intel Core i5-4690K

For almost the same price as the ol' 4670K you can pick up one of the newer Devil's Canyon CPUs. It's only got a 100MHz clock boost, but the new TIM should help overclocking.

MEMORY £58
Corsair Vengeance LP 8GB

This pair of 4GB sticks will give you all the performance you could ever want, and they're in stormtrooper white. They'll only take up two slots in the board for upgrading, too.

GRAPHICS CARD £170
Nvidia GTX 760

Unfortunately, the ol' HD 7870 XT is hard to get hold of and rather pricey now. Thankfully, the GTX 760 has arrived for less than £200 and offers some serious gaming performance, too.

SOLID STATE DRIVE £150
Crucial MX100 512GB

Crucial has made a big splash in the SSD market with this chunky drive. The 512GB version is quicker, larger and cheaper that the 480GB M550.

POWER SUPPLY £52
OCZ ModXStream Pro

If you want to build a performance machine, you're going to need a powerful PSU. This 500W baby will power the rig, with extra to spare. It's quiet as well.

CHASSIS £60
Cooler Master CM690

The CM690 eschews silly gimmicks in favour of producing a no-nonsense chassis that has plenty of cooling options for your mainstream rig. There's space aplenty inside, and all at a reasonable price.

SCREEN £123
Viewsonic VX2370Smh-LED

For years, we've been lamenting the constant use of TN panels in our gaming monitors, always preferring the delights of the IPS screen. Now they can be yours for just £123.

KEYBOARD £65
Corsair Vengeance K65

We love a good mechanical switch keyboard here on *PC Format*, and Corsair is making some of the best. The K65 is a great compact option, with a compact price to boot.

CPU COOLER £28
Enermax ETS-T40

Enermax has simply amazed us with this, its first CPU cooler. The performance is excellent, the price is astonishing, it's easy to fit and it isn't so big that it limits your case or mobo choices.

HIGH-END £3,967

If you really want to treat yourself, this is how to do it

MOTHERBOARD £236
Asus P9X79 Pro

Asus has really gone to town on the X79 platform, spamming the market with a host of boards (and most of them are pretty darned good, too). This here P9X79 Pro is a great little performer.

CPU £850
Intel Core i7-4960X

With the same six-core setup as the previous gen, there's not a lot of extra stock performance, but if you're after the fastest CPU, this is it right now.

MEMORY £97
Kingston HyperX 16GB

The quad-channel memory config of the X79 makes for a great opportunity for RAM makers to ship new kits. This XMP 1.3-compatible kit is a tasty 16GB package.

GRAPHICS CARD £791
Nvidia GTX Titan Black

The GTX Titan Black Edition has the full-fat GK110 core of the GTX 780 Ti, but with 6GB VRAM and the double precision maths turned back on. Perfect for serious work.

SOLID STATE DRIVE £389
Samsung 840 EVO 1TB

It's been a while coming, but we're finally seeing terabyte-class SSDs, and for a decent price. The 840 EVO uses some impressive algorithms to offer high speed, too.

POWER SUPPLY £171
CM Silent Pro Gold 1000W

Cooler Master continues to impress with its power supply units, and this wonderful box of tricks managed to scoop the gold award in our exacting test way back in *PCF*246.

CHASSIS £286
CM Cosmos 2 Ultra

Cooler Master was always an impressive maker of cases, but it has truly stunned us with this chassis. Yes, it's expensive, but if you can afford it, go for it.

SCREEN £922
HP ZR30W 30-inch

HP's 30-incher is exactly what high-end gaming means to us and if money is no object, this is the screen to buy. You'll need the GTX Titan to really show it off.

KEYBOARD £120
Corsair Vengeance K70

Corsair's update to the older Vengeance keyboard rights all its older sibling's wrongs. It's also a truly stylish gaming board.

CPU COOLER £105
Thermaltake Water 2.0 Ext.

Why settle for a reasonable overclock when you can hit 5GHz? This kit is speedy, boasts incredible performance and is quiet in operation.

Silicon photonics

Bit rates are about to take a big jump with Intel's new fast fibre connectivity tech, where lasers are printed right on the wafer

What is silicon photonics? "It started a little over a decade ago. We had the vision that there would be higher bandwidth requirements because of the growth in data, and that growth would be in the data centre, because you have these billions of devices connected," says Jeff Demain, Intel's business development director for the silicon photonics group. Demain works with Intel Labs' projects, and one area the company has been concentrating on is the huge infrastructure necessary to make the way we use smartphones today possible – cloud-based, web-service focused and always passing data back and forth. The problem, Demain admits, is that while Intel predicted the growth in user data, it underestimated the magnitude of that growth.

"Over a decade ago, you couldn't forecast how many YouTube videos there are, or tweets there are, or such growth in email – whatever anybody's number was over a decade ago, it certainly went larger. When we saw that, we realised we needed an interconnect that would begin to assist when the scaling of copper interconnect became challenged," he continues.

Intel is targeting data centres for now, but has plans for home users too

Standard copper wiring is still used for almost every computer connector, from a phone's micro-USB to the high-bandwidth cable in data centres. Connectivity in data centres is ludicrously complicated, with vast bundle of cables coming out of every server bank that can even obscure airflow, making it harder to keep the servers cool. If data centres need higher bandwidth on copper wiring, they need either larger diameter cables or shorter distances between connections, neither of which is very practical.

Optical connectivity has always been the potential alternative, but it hasn't been suitable in the past. "The issue with the current optical technologies are that they're not scalable as far as bandwidth is concerned going into the future, and they're manufactured in a methodology that doesn't allow for very high volume manufacturing," explains Demain. Intel says that for most current optical technology, the laser and other components are put together with tweezers, making them laborious and expensive to produce, and impossible to create at the rate needed for data centres.

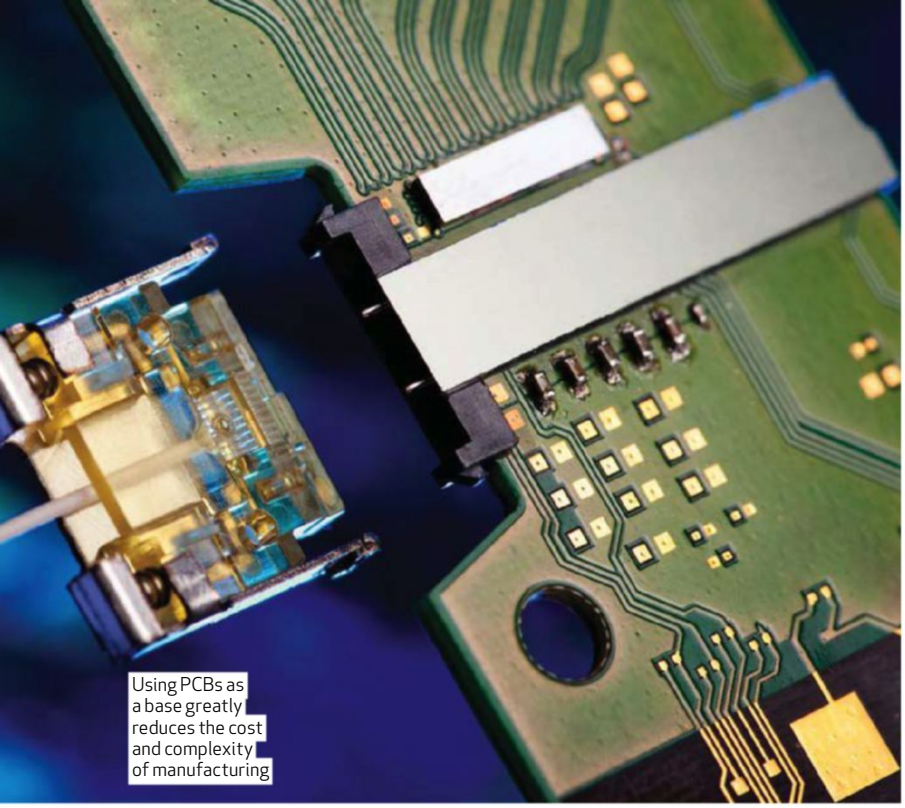
There is, however, another way of making optical connections. Lasers can be printed directly onto silicon in a standard chip manufacturing process, making them not only tiny, but possible to produce on a mass scale. And Intel is good with silicon.

THE FUTURE'S BRIGHT

This way of creating optical transmissions is called silicon photonics. Each circuit involved in receiving a transmission is created by taking a layer of silicon and adding a layer of germanium on top. When a photon sent through the optical cable hits this structure, it generates an electric signal, which is then interpreted by the rest of the system. When you have entire arrays of these circuits, the amount of information you can send and receive gets big – really big. By using several colours of light through a single cable, you can increase bandwidth with no penalty – the wavelengths won't interfere with each other, so by sending different data packets in different areas of the spectrum, you send more information at once.

Intel has created a new kind of cable and connector (known as MXC and about the size of a USB cable and connector) for its silicon photonics interconnects, and the first cable type it will introduce is rated for up to 1.6Tbps of bandwidth. There's no typo there – that's 1,600Gbps. And it's not hitting the limit of the technology.

"Each fibre is carrying data at 25Gbps through the cable. If we move the fibre line rate up to 32Gbps or 56Gbps, that itself goes up as well. Since an optical signal



Using PCBs as a base greatly reduces the cost and complexity of manufacturing

has no phenomena like electrical signal – there's no magnetic field, there's no interference, the skin effects on the cable are gone – we can increase line rates of the optics, and use that same connector. We use the 1.6Tbps as an example as a starting point, but from there we can scale that up," says Demain, sounding pretty pleased.

Perhaps unsurprisingly, the reality will be more pedestrian at first. For its roll-out, Intel has demoed 100Gbps silicon photonics connections at shorter distances, and the ability to send data at 25Gbps over 820 metres – which could make a huge difference to telecommunications infrastructure.

Optical cables are also suitable for industrial environments full of electromagnetic interference, and Demain points out that they'd be lighter and simpler to use for complex electronics in things like (possibly self-driving) cars.

HOMEWARD BOUND

Though Intel is only pitching silicon photonics at data centres and telecoms companies at the moment, it's also intended for home use. "Our entire design philosophy and approach has been one of: let's address this as if we were entering a consumer electronics market," explains Demain. "So we had a focus on cost and simplicity, ease of use, ease of manufacturing…"

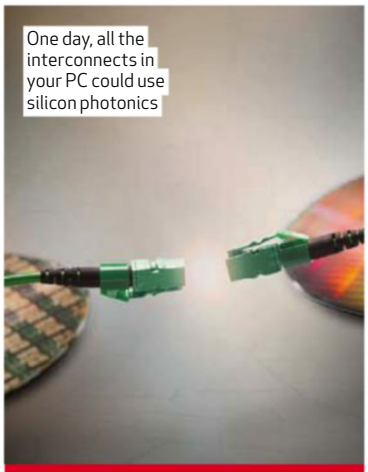
Intel has targeted the highest-end business customers first because they have a pain point that needs fixing today, and the money to make producing silicon photonics worthwhile immediately. Although the cable itself could be relatively cheap because it contains no active electronics (unlike Thunderbolt), the cost of the whole system needs to drop before a home-user launch. Demain says that will happen after economies of scale are reached by increasing manufacturing.

What might drive a need for 100Gbps data connections in the home? Demain thinks 4K displays will be the start. "If you wanted to do 4K uncompressed, you have over 100Gbps running in into those monitors. There isn't an interconnect that exists today that can do that in a light, simple energy efficient way, other than a silicon photonics solution. 8K [already being prepared for broadcast in Japan] goes beyond 200Gbps, so you have data centre bandwidth levels going into displays!"

Silicon photonics could make copper cables in data centres redundant

There's also potential for building computers in new ways using optical PCIe (see 'The dawn of disaggregation') – and eventually, the tech could be used for all internal interconnects in a PC. "The visionary stage is the ultimate integration, where you find it completely embedded in the devices," says Demain, adding that we might not even have imagined where it will be most useful. "Look at the laser itself… I don't think they thought 'There's going to be a CD player or a DVD player; you're gonna scan your groceries because of my invention.'

"You know if you look at electronics, at one point it was vacuum tubes, it moved its way to discrete transistors, and then it moved to integrated circuits. This is one of those big steps for optics." ■



One day, all the interconnects in your PC could use silicon photonics

The dawn of disaggregation

With a fast enough connector, we can change how we build server farms

The ways Intel expects silicon photonics technology to be used – even in its early days – are as spectacular as the high numbers it's quoting. Along with demonstrating running the system at 100Gbps in the real world, it has introduced the idea of 'disaggregated' servers. The gist is that instead of hosting an entire system on a rack, and having rows and rows of those, each rack would be of a specific component – so you would have great swathes of CPUs in one rack, huge grids of memory in other, and so on. This would mean data centres could manage their components in a totally different way, and think about how best to optimise for particular tasks (Facebook is going to be Intel's first partner for building disaggregated servers, with the concept seeming particularly suited to certain analytics tasks at the kind of data volume Facebook deals with), and to think about cooling in different ways.

Silicon photonics is the key to achieving this – the ability to run huge numbers of those 100Gbps cables in parallel means that you can actually shift data around fast enough to avoid bottlenecks in the connection. With current PCIe technology maxing out at 8Gbps per connector, it simply wouldn't have been practical before – the masses of cables already used in data centres impede cooling and take up huge amounts of space.

Whether we would ever get any benefit from this use of the technology at home is a different matter. Silicon photonics has obvious advantages for high-performance computing, and it's tempting to imagine sticking a beastly GPU setup in the loft (perhaps using its heat to provide hot water for the house…?) that could provide its power to any number of slimline computers around the house when you want to game on them, but we don't expect to see it as an option any time soon.

Tech Porn

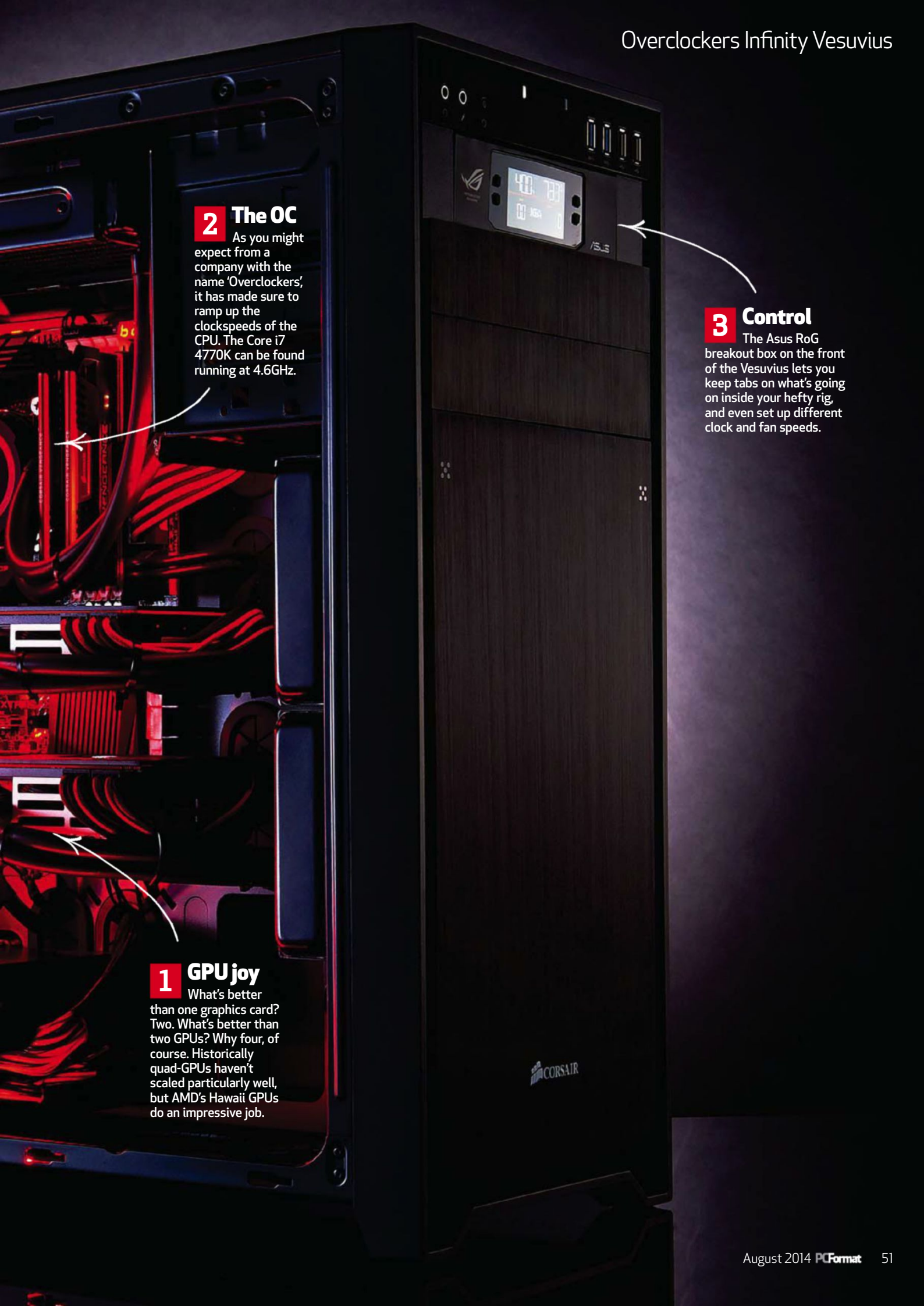
Performance kit laid bare

OVERCLOCKERS INFINITY VESUVIUS

Techgasm. We've said it before, and we'll likely say it again, AMD's dual-GPU R9 295X2 is an exercise in what can be done when you forget about the sense of it and just go all out for the tech of it. And Overclockers UK has, inevitably, taken that a step further and dropped two of these graphics behemoths into a single system, the Infinity Vesuvius.

With a pair of R9 295X2 cards installed into the gorgeous rig, you're left with four of AMD's top GPUs doing the graphical grunt work. And they do it mighty well, especially when you consider how difficult it is to get a 4K screen filled with fluid gaming frame rates.

The £2,200 worth of water-cooled graphics components account for more than half of the Vesuvius' exorbitant £4,118 price tag. The rest of the money is spent on some decent back-up components, and one hell of a beautifully-presented PC build as well. GPU techgasm and no mistake. ■ **Dave James**



2 The OC

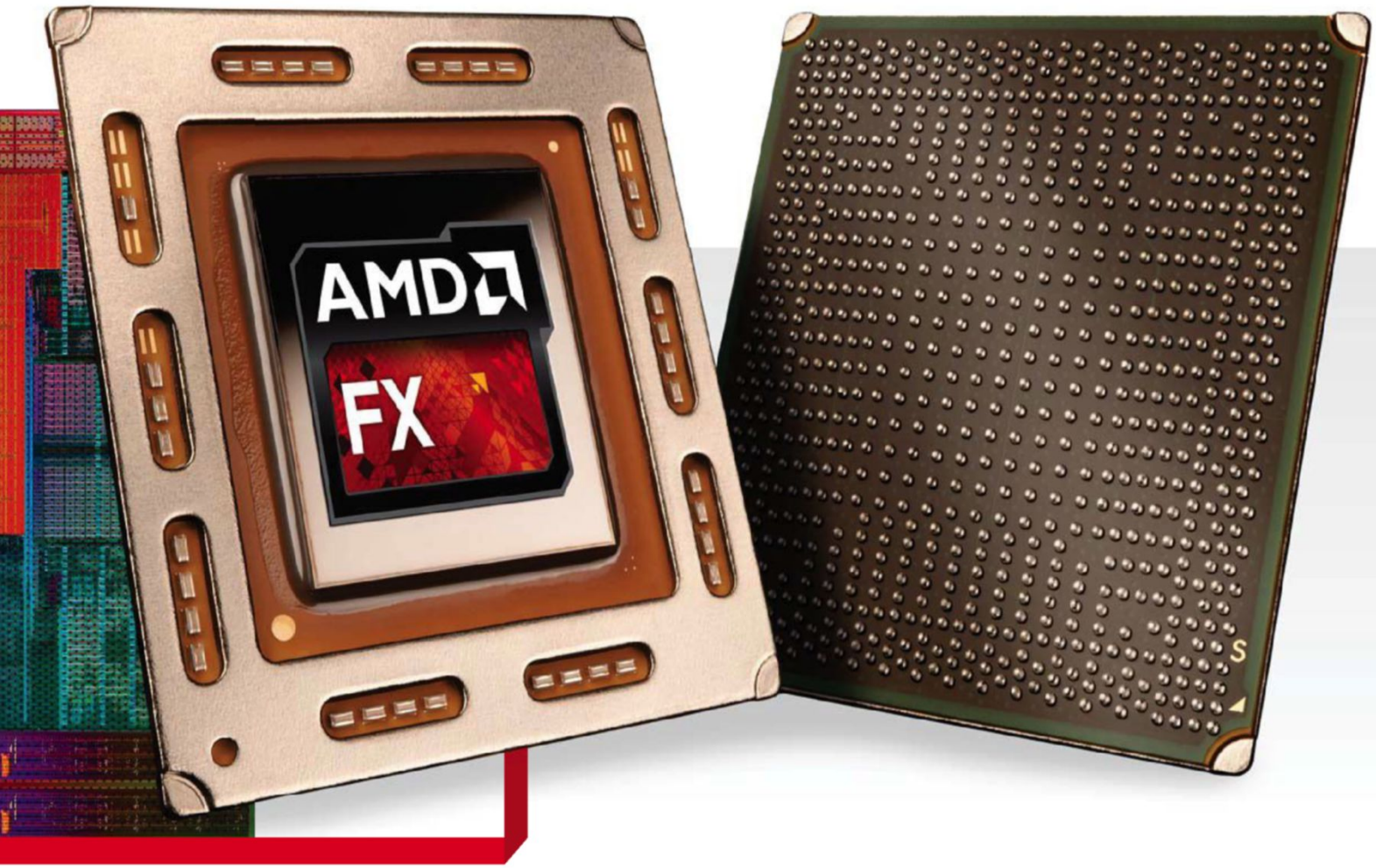
As you might expect from a company with the name 'Overclockers', it has made sure to ramp up the clockspeeds of the CPU. The Core i7 4770K can be found running at 4.6GHz.

3 Control

The Asus RoG breakout box on the front of the Vesuvius lets you keep tabs on what's going on inside your hefty rig, and even set up different clock and fan speeds.

1 GPU joy

What's better than one graphics card? Two. What's better than two GPUs? Why four, of course. Historically quad-GPUs haven't scaled particularly well, but AMD's Hawaii GPUs do an impressive job.



AMD KAVERI GOES MOBILE

The latest graphics-heavy APU from AMD finally gets portable

VITAL STATISTICS

SKU AMD FX-7600P
CPU technology AMD Steamroller
CPU cores 4
CPU clockspeed 2.7GHz (3.6GHz Turbo)
L2 cache 4MB
GCN cores 512
GPU clockspeed 686MHz
TDP 35W

The FX processor is back. That's right, AMD has finally launched a new FX processor, based on the latest Steamroller CPU architecture.

So that's a brand new eight-core, multi-threading monster, right? Sadly no, but this new FX brand has been rolled out in the mobile laptop world rather than the desktop space. AMD is using it to denote the top gaming SKUs of its most powerful integrated graphics part – the new mobile Kaveri APU.

So we found ourselves in a Dutch hotel overlooking the watery expanse of the IJ, with an unbranded AMD Kaveri whitebook all to ourselves, a private booth and a whole day at our disposal to do whatever unspeakable things we wanted with it. So, with our full test bench loaded onto an SSD, we went hard and fast at the new FX-7600P APU to see what it could deliver.

It's been over six months since the desktop version of AMD's latest APU hit the halls of CES in January and, despite claims of a focus on mobile being the reason for a lack of new straight FX CPU parts, this laptop Kaveri silicon has been held back an awfully long time. In January, I was told by AMD that the mobile Kaveri tech was ready, but AMD's director of PR Chris Hook explained: "we sell a lot of Trinity, we sell a lot of Richland, we need to protect that stack."

So why is AMD releasing it now? Well, it's all down to when the most laptops are sold, and that's around 'back-to-school' time. This means the hardware has to be with laptop makers right now and the buzz has to start somewhere.

Whitebook

The unbranded laptop we tested was running the top FX-7600P Kaveri APU. The 'FX' part denotes this chip's standing above the A10 option, which itself had previously been the high-end part. AMD's new 'Compute Core' classification means it's running a full 12 cores, just like the A10-7850K desktop Kaveri APU. And, like the desktop A10, it has a pair of Steamroller modules at its heart, offering four cores for standard processing malarkey.

The Steamroller cores apportion more silicon to the pair of discrete 'cores' in each module compared with the Piledriver architecture in the current desktop FX chips and the last generations of top-end APUs. That gives them a bit of an advantage on the actual instructions per clock (IPC) count, to the tune of about 20 per cent. In the top FX APU, that modest IPC boost is helped by an additional 200MHz on top of the Richland clockspeed.

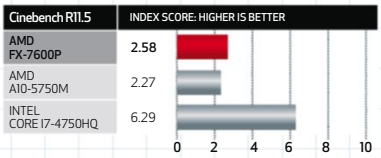
The combination of increased IPC performance and higher clockspeed means that this top Kaveri APU can best the top Richland part by about 14 per cent in the Cinebench rendering test, and by some 20 per cent in the X264 HD video encoding benchmarks. That's not a bad generation-on-generation boost in CPU terms, especially when you're talking about the same 35W TDP too.

The bigger news on the Kaveri front is that it features the same AMD Graphics Core Next GPU architecture as found in its high-end Hawaii GPU. Richland, by contrast, was using the outdated VLIW4

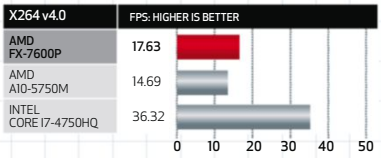
Technical analysis

In CPU terms, the extra integer performance and the increased clockspeed give Kaveri a boost over its Richland forebear, but the mighty Intel chip is far and away the superior straight CPU. If you factor in compute power, however, the gap closes significantly, and when you talk about GPU gaming, the far cheaper AMD APU just about has the beating of the top Intel Iris Pro part.

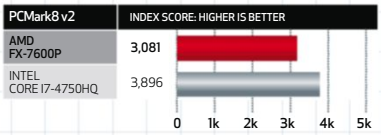
CPU rendering performance



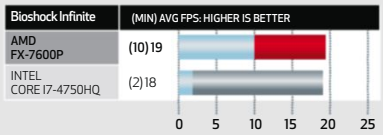
CPU encoding performance

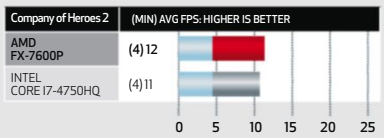


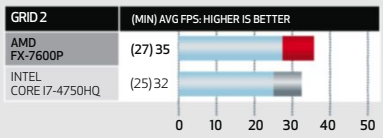
OpenCL accelerated performance

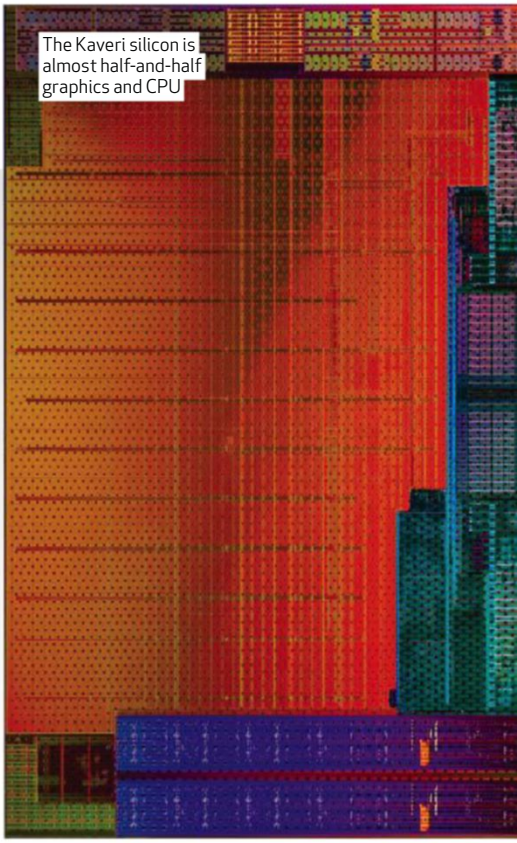


DirectX 11 gaming performance








The Kaveri silicon is almost half-and-half graphics and CPU

graphics technology. And as well as offering higher-spec GPU cores, AMD has also chosen to throw a lot more of them at the FX-7600P. The A10 Kaveri chip, the A10-7400P, will come with the same 384 shaders as the previous A10 Richland chip, but this top FX-7600P comes with the same full 512 shader count as the desktop part.

The potential upside of that for us gaming-centric folk is that it introduces the possibility of having proper dual-graphics and impressive gaming performance in a low-powered mobile platform. The graphics component of mobile Kaveri is denoted as R7, so the R7-265M should be the perfect partner and could get close to doubling the GPU power, offering another 384 GCN shaders to the mix.

Chip-to-chip

In terms of the competition, AMD is training its sights on the low-power variants of Intel's Haswell generation, with the FX Kaveri taking on the i7-4500U. But for us, the more interesting target here is the high end of Intel's mobile stack – namely the i7-4750HQ. That may be a 47W part packing a full eight threads of serious Intel Core architecture processing, but the really intriguing part of that particular chip is the Iris Pro graphics it's sporting.

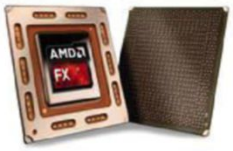
Intel has been very excited about the graphical power that Iris Pro can offer, but in our head-to-head gaming tests the R7 graphics of the cheaper Kaveri chip can easily stand up to the might of the GT3e graphics in the ultra-expensive Intel chip. Iris Pro – in mobile form – is only really available in £1,000 laptops, while the unbranded prototype machine we were testing was estimated to be equivalent to a $600-$700 laptop. Essentially half the price, then. It is, of course, a long way short in terms of raw processing power. If you just take the Cinebench scores alone, the FX-7600P is less than half the speed.

> "IN HARDWARE TERMS, AMD'S NEW KAVERI APU LOOKS LIKE A PEACH"

Okay, surely we can stop comparing these two different processors now… but that's not the whole picture, according to AMD.

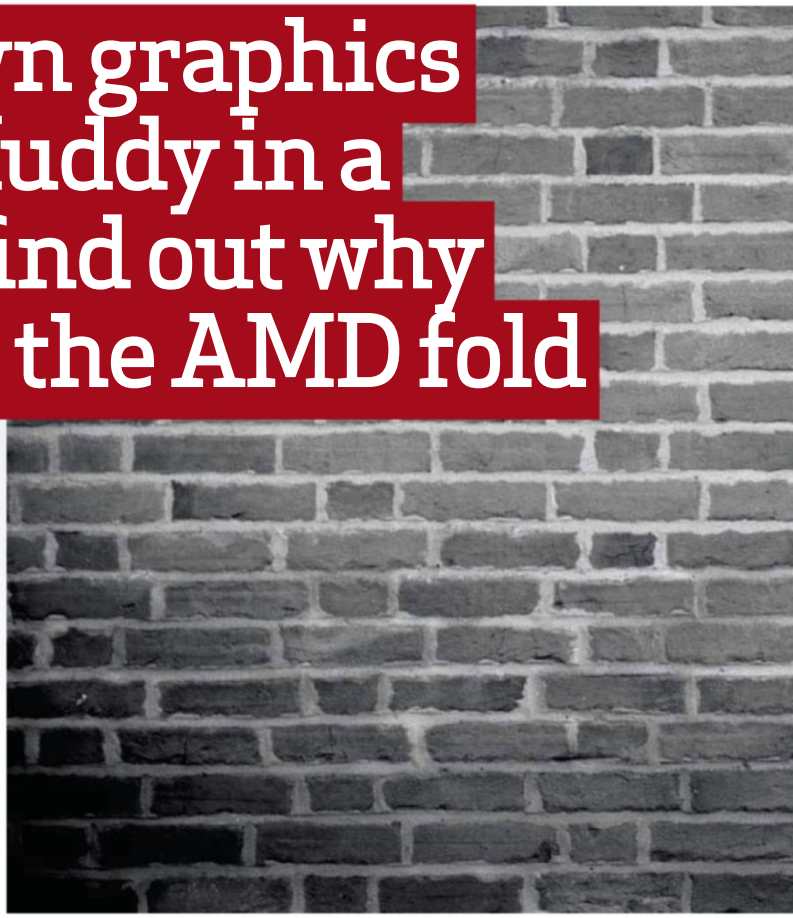
The real bonus of AMD's heterogeneous system architecture (HSA) is that both GPU and CPU components have equal access to the same shared memory space, and through this system it's able to use the total potential GFLOPs power offered by both parts of the APU. With GPU accelerated applications using the power on offer, that can offset a large part of Intel's advantage. The OpenCL accelerated benchmark in PCMark8 involves a host of everyday tasks such as photo editing, web-chatting and browsing – when you look at these figures, the results are a lot closer. The cheaper Kaveri chip is suddenly only 26 per cent slower than the pricier Intel version, and when you consider that those are the tasks we're likely to put to our laptops the competition becomes a lot closer.

So, in hardware terms, AMD's new Kaveri APU looks like a bit of a peach on the mobile side. But these things are rarely about which side has the better, or more efficient technology – they're about who can get their products into machines that people can actually buy, and this is always where AMD has fallen down. Despite selling a lot of Trinity and Richland machines, it was still miles behind Intel in market share. We could see some impressive Kaveri laptops this autumn, but we reckon they will still be few and far between compared with the Intel alternative. This would be a shame, especially given that you could get some mightily affordable, gaming-capable little laptops – with serious battery lifetimes – from a Kaveri base. I'm hoping we see some well-priced dual-graphics Kaveri laptops coming after the summer, but that's going to be down to the laptop manufacturers and not us, or even AMD.



Together again...

We tracked down graphics guru Richard Huddy in a London pub to find out why he's returned to the AMD fold



Richard Huddy has been around a bit. That's not to do the man a disservice; when he started out in the graphics game with 3DLabs in the late '90s there weren't a lot of folk about in the burgeoning market of 3D graphics. After 3DLabs he moved on to work at Nvidia in the early 2000s, before transferring to ATI in 2004. After seven years heading up ATI's – and subsequently AMD's – developer relations team, he made the move over to Intel's graphics team in 2011. There he's been championing its improving graphics silicon and its work with game developers including The Creative Assembly and Codemasters. But now he's coming home again, working in the office of the chief technology officer at AMD along with old sparring partner Raja Koduri.

So, he's done the rounds, but he's had an impact wherever he's been. Whether he's been playing a part in the original development of DirectX, pioneering new visual effects like HDR with AA, making Intel seem like it gave a damn about graphics or appearing in the first *Max Payne* as a mad scientist, Mr Huddy has been at the forefront of the PC graphics industry. So it's quite a coup for AMD to have him back again.

PCFormat: You've been away from AMD for quite some time now, so what was it that brought you back?
Richard Huddy: There's a really great, really exciting opportunity in front of me at AMD, which pretty much anyone would be a fool to turn down. Working in the office of the CTO, being so directly connected with games developers and influencing the experience for games players very positively. That's hugely attractive to me.

PCF: Why now, and why AMD?
Huddy: AMD has a focus on gaming which is unmatched at my previous employer. Having a good experience on a medium laptop, having to disable MSAA, that's not really the be-all and end-all of gaming. Being able to deliver the very best experience is the big deal for me. The unwavering focus on gaming at AMD is very attractive. I could've considered going to other places, but the deciding issue is not actually the role. The deciding issue is the kind of ethos of the company, how it's built, what it believes in. When I left Intel, I did so because I wanted a positive thing, I wanted more graphics and more gaming. The reason I didn't choose Nvidia is because they don't go down the 'righteous path' I believe in.

PCF: Was there an opportunity then for you to go back to Nvidia?
Huddy: I suppose you'd need to ask Nvidia, and I don't know what they'd say, but I wouldn't feel comfortable working there. There are things they do which, although they generate money, just make me feel a little bit dirty.

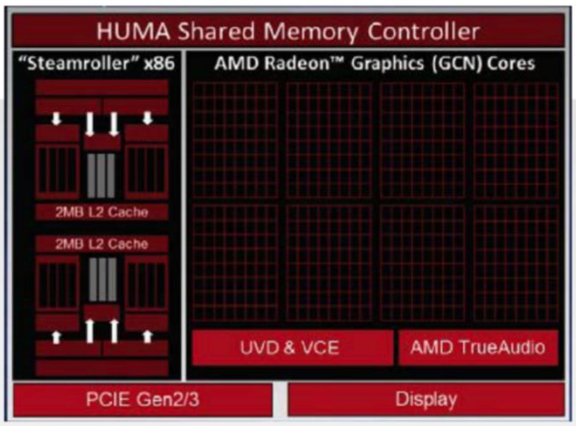
PCF: What have you learnt from your time at Intel?
Huddy: Certainly an understanding of what Intel's priorities are is helpful; to understand the way your competitors think. When I was at AMD previously, I had this sense that Intel wanted us dead. I still think that Nvidia feel that way about us. You know that for them, this is a zero sum game: 'We get AMD out of the way, all we've got to do is get them out of the way and then we can go on to the next opportunity.'

It's very clear that actually Intel doesn't think that way at all. Intel is interested in finding new opportunities to develop markets, like getting into the tablet space. It's not that head-to-head competition I thought was going on between AMD and Intel.

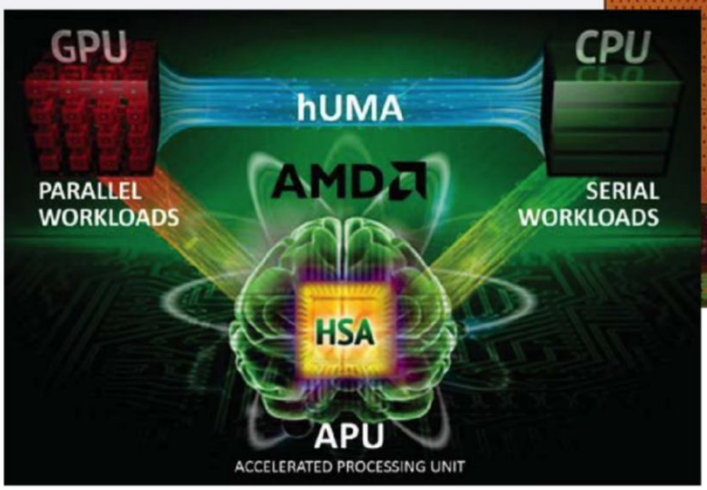
One of the other quite interesting observations about – very, very much from my own perspective – Intel as a whole is that it doesn't have the same emphasis on gaming and doesn't have the emphasis on graphics that I love. And I'm not going to get that at Intel no matter how hard I try. They sell an awful lot of graphics silicon – they just don't *sell* it. It kind of just goes along for the ride.

"I WOULDN'T FEEL COMFORTABLE WORKING THERE. THERE ARE THINGS THEY DO WHICH, ALTHOUGH THEY GENERATE MONEY, MAKE ME FEEL DIRTY"

Richard Huddy has worked for them all: ATI, AMD, Intel and Nvidia



The shared memory controller is what enables AMD silicon to compete with Intel



The Heterogeneous Sytem Architecture (HSA) is a real step forward for the PC

PCF: Although AMD is in the unprecedented position of providing the hardware for both the major consoles of this generation, you're focused on the PC side. Is PC gaming still something that excites you?

Huddy: I think that Microsoft and Sony both sold around 70-80 million units in the last generation, which is a very respectable number of players. But if you add those together, you get around 150 million or so, and I think there are 130 million subscribers to *League of Legends*. Just one game! What is going on?! That's more than the total install base of any console that's out, so PC gaming is clearly in a healthy state of affairs.

PCF: What benefits do PC gamers stand to gain from having AMD hardware in those consoles?

Huddy: We used to have to drive ISVs [independent software vendors] to switch to two cores or four cores and try and keep things loaded up, make sure you're making good use of the silicon. But the fact that this PC generation is surrounded by other hardware in the same ecosystem at the same time means PC gamers are benefiting quite nicely from it.

PCF: What's excites you most about AMD's take on PC gaming at the moment?

Huddy: Mantle is brilliant. It's great from a developer's point of view and ISVs are picking up Mantle faster than they picked up DirectX 11. I believe that during 2014 – the first year of Mantle's existence – there will be more titles that ship on Mantle than there were DirectX 11 games during its first year.

Games developers are going to it in droves, because it's a great technology and then, fundamentally for me, it's becoming an open standard. AMD will always tune it for the GCN architecture, but we are going to put it out in 2014. This is a public commitment to open standards. The point here is about driving standards forward. Other people will be able to run things like *Battlefield 4* on Mantle. It'll be able to run on Nvidia hardware or Intel hardware – if Nvidia and/or Intel choose. It's just their choice – that's the only thing that's required – and they can produce a driver.

That's really unlike how other companies work, and I'm thinking here about the choice I made when I looked around the 3D graphics business. So, I love gaming? Yeah, you could think of other places I could go, but the way AMD works really makes me enthusiastic about it.

PCF: Looking to the future for a minute, Mantle is fixing the API problems and AMD's open FreeSync standard is looking to eliminate tearing and the need for VSync, so when do you think we can expect to ditch anti-alisasing? Is 4K a high enough resolution to help us move on?

Huddy: The research I've seen suggests that anti-aliasing is not going to go away. That did surprise me. The first time I thought about AA, I thought, "Well, all you've got to do is go up to a high enough resolution, beyond that of the eye." It's obvious that each step up reduces the relevance of AA, but that's not really the case yet.

It depends on the quality of your vision, of course – I've had my eyes lasered, so my eyes are a bit rubbish these days – but I think the human eye is typically about 8K resolution. If you have 20:20 vision then an 8K monitor that fills your field of view is pretty much at the limit of what you can see. So a 4K monitor, which fills your field of view, is actually a fair deal short of that. You still need to achieve something like another quadrupling in pixel density before you could argue that aliasing actually goes away.

You need an awful lot of horsepower on the GPU for that. Which is okay. It suggests we have a great future ahead of us. ■

Gaming &

Because gaming is a way of life

"Uplay, that irritating DRM system that Ubisoft thinks we all want, has managed to ruin *Watch Dogs*"

This month prose puppeteer Dom Reseigh-Lincoln hasn't had much chance to play games as he's now got TWO children to look after. Yes, little bag o' baby Alfie William has joined the Reseigh-Lincoln clan. Like his brother Ollie, he'll probably be hooked on *Skylanders* and old *Spyro the Dragon* games by the time he's crawling. His father is a bad influence.

Oh Aiden, where did it all go wrong? In the summer of 2012, Ubisoft knocked everyone's socks clean off when it revealed a brand new IP with a near 10-minute gameplay video that made the internet collectively blush with desire. *Watch Dogs* was set to be the poster boy of a new era that would see games rendered in a gorgeous and, more importantly, *consistent* fidelity. Two years and a couple of delays later, Ubi's baseball cap-wearing hack-fest is finally out in the wild – but if you happened to pick up the game for the PC, well, you're in for a surprise.

First off, the dreaded Uplay has reared its ugly head again. Yes, that irritating and pointless DRM system that makes you spend more time in menus than actually playing the game you just spent 30 quid on. As if the fiasco with *SimCity* wasn't enough of a sign that DRM has no place in the modern gaming sphere, Ubisoft seems happy to batter the point home. Sorry, rant over. The point is that Uplay has essentially stopped most players from even accessing the game, with loading screens that annoyingly freeze at 90 per cent before informing you that the servers are down. For those who do make it into the fictitious Windy City, issues with broken graphical drivers equals a further slap to the face as the game limps along with mind-numbing lag. Ubisoft has promised that a PC patch is its "highest priority", but with E3 closing its doors for another year, it seems most people will have long forgotten the new IP that almost ruled the world.

P64 WILDSTAR

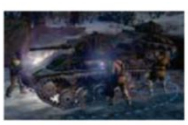
In happier news, *Unreal Tournament* is back. Well kind of, and not for a while. So it's still happy, just, you know… taking its time. But still, *Unreal Tournament*! I think my soul would implode with depression/pride if I ever found out just how many happy hours I spent playing the original, and the idea of a brand new take on the franchise that cuts away all that single-player nonsense and focuses on the one thing that makes it great – frag-filled multiplayer mayhem – makes me giddy with glee. Epic Games even debuted a video showing an uber-early build of the game. Okay, it was just a few of the developers running around a untextured square map with Bio Rifles for a minute and a half, but still, Bio Rifles! It's going to be free-to-play (boo) and it probably won't get a beta release until late next year at the earliest (double boo), but regardless, a world with a brand new version of *Unreal Tournament* is a better one for it.

The Digital Trips that let you play as a giant mechanical spider are fun. Wait, you can't access that bit? Awkward…

RECOMMENDED

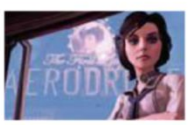
Smite
Hi-Rez Studios
PCF293 p66
An addictive game makes the lane-pushing genre more approachable with smart tweaks to the formula.
★★★★★

Diablo III: Reaper of Souls
Blizzard
PCF292 p64
This awesome expansion has made *Diablo III* even better, and includes some fun little goodies. We like.
★★★★★

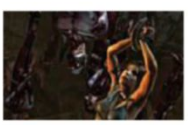


Company of Heroes 2
Relic Entertainment
PCF281 p62
This may not be a flawless epic like the original, but it's still a relentless compulsive RTS mixing campaign and MP brilliantly.
★★★★★

Metro: Last Light
4A Games
PCF280 p92
Metro: Last Light offers a brilliantly realised world, wrapped around a tense and emotive FPS experience.
★★★★★



BioShock Infinite
Irrational Games
PCF279 p94
Ken Levine and developer Irrational Games return to the *BioShock* franchise, and create a truly stunning FPS.
★★★★★



Tomb Raider
Crystal Dynamics
PCF278 p94
Lara Croft and the *Tomb Raider* legend are reborn with this gritty reboot of the series. A stunning return to form.
★★★★★

HotWired

IN THE NEWS

Google users want to be forgotten

It sounds a like a prophesy pulled from the pages of a Philip K Dick novel, but the European Court of Justice has decreed that we "have the right to be forgotten". No, the EU isn't wilfully pulling a continent-wide rendition of *Men in Black* – those words actually refer to a recent legal amendment that's forcing Google to partially expunge the details of individuals who make a formal request, and at the time of writing some 12,000 EU citizens have jumped on the chance to be partially dodge the information-scouring nets of the all-seeing search engine.

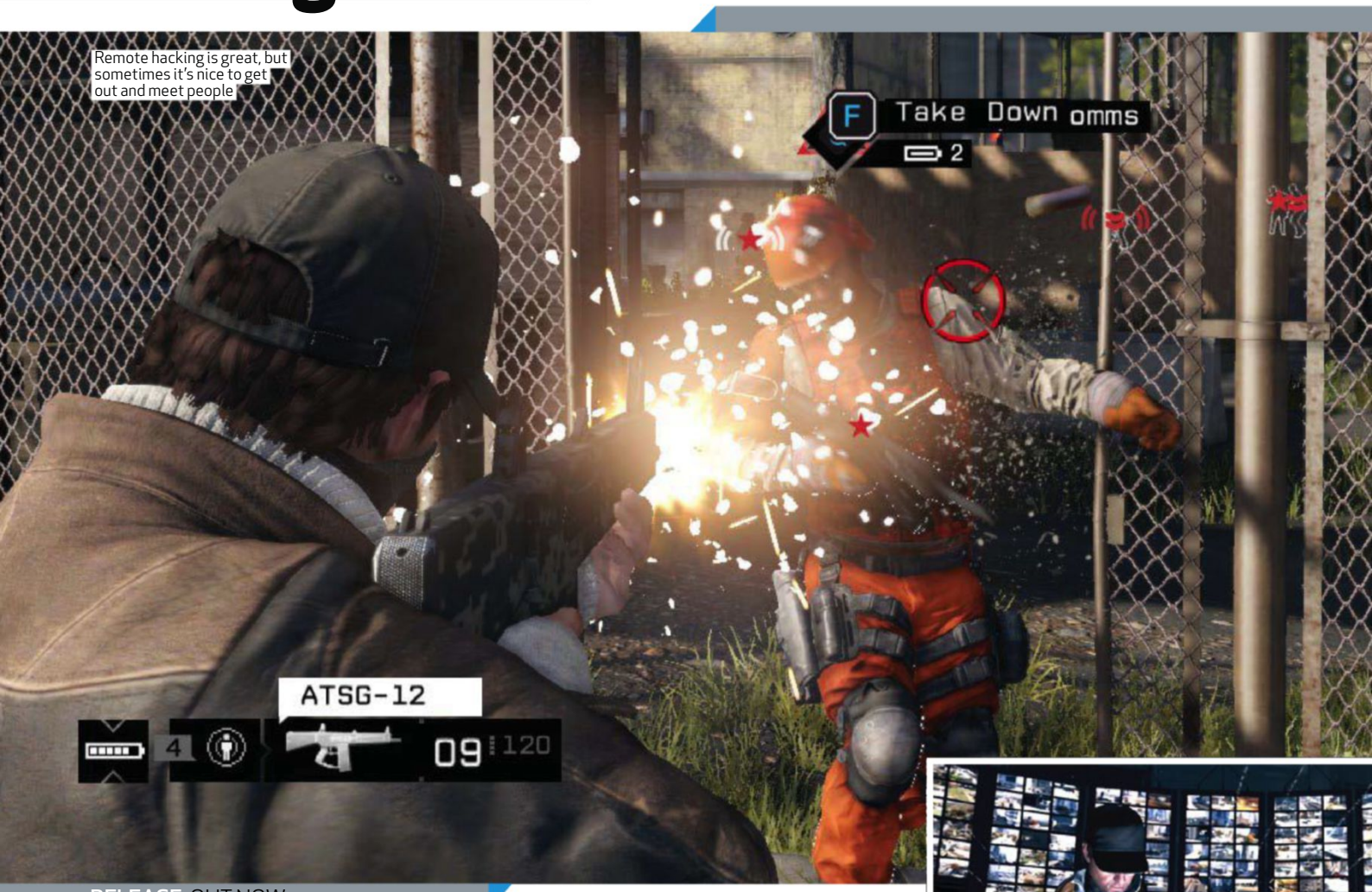
The process is relatively simple: users can submit a webform citing a particular link that contains information they feel is "inadequate, irrelevant or no longer relevant, or excessive in relation to the purposes for which [it was] processed". This, along with an acceptable form of photo identification, is used to determine whether or not said page or website is in breach of an individual's right to personal privacy. So far, most of those 12,000 requests have been from convicted criminals, those affected by media scandals and individuals whose character has been called into question. The legal ruling was made following a case involving a Spanish man who requested Google remove details of his house repossession from its search results.

Google described the ruling as "disappointing"

ALL IN THE WRIST

Is your tennis game in need of a little tune-up? How about a new gadget that can help you turn those sloppy slices into peerless points? Aussie entrepreneur Rob Crowder is thinking just that with Smash, which is a small bracelet that acts as bespoke training companion. The device contains a magnetometer, a gyroscope, a Bluetooth chip and a three-axis accelerometer, and it's designed to do much more than just take snapshots of your stats during a given session. If the Kickstarter-based project is to be believed, it could help shape your ongoing training, with a program that records everything from the number of shots taken, right through to the speed of your hits and the amount of wrist rotation you make with each one.

HIGHLIGHTS THIS MONTH



Remote hacking is great, but sometimes it's nice to get out and meet people

RELEASE OUT NOW

Watch Dogs

This has hard drives to hack and hard cars to drive


It makes me feel like the electronic ghost of Batman

I'm racing a stolen motorbike through a cityscape, cop cars wailing in pursuit, when I smash into a car, shoot through the air like a missile, and slam face-first into a wall. Nothing new – I've done this many times, in many games.

While I'm sailing through the air, my smartphone informs me the driver of the car I've struck is Martin Huntley, age 39, who works as a telemarketer, makes $24,000 a year, and is into autoerotic asphyxiation. Okay. That part's new.

There's no shortage of the familiar in Ubisoft's third-person open-world action game *Watch Dogs*, beginning with its moody protagonist, Aiden Pearce. He's got a few days of beard stubble, speaks in a whispery growl, and has zero sense of humour. He's haunted by, and feels responsible for, a tragedy in his past, and he's out for revenge – or is it redemption? To find those responsible for his misery, Aiden needs to uncover a shadowy conspiracy involving secret organisations, organised crime, and government corruption, and will employ the help of – get this – an eccentric cast of oddball characters, some with secrets of their own. There is one new and interesting thing about Aiden: he's got a really cool phone.

I have a lot of issues with *Watch Dogs*, but Aiden's phone is due a lot of credit for how much I enjoyed it. In profile mode, the phone identifies citizens around me and enables me to hack into their phones with a keypress, downloading bank information and eavesdropping on their calls. And it tells me their secrets. Miles Renner is late with child support payments. Conner Eggers is on probation. Bill Woods is affiliated with a racist organisation. Think of everything you've ever typed into an email, text message, or search engine – yes, even in incognito mode – and then think about some mopey, stubble-faced man in a stupid futuristic coat, standing on the opposite street corner, reading all about it.

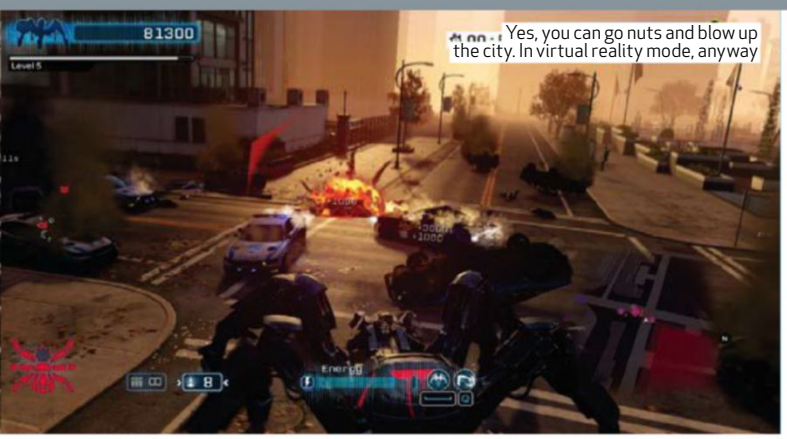
VITAL STATISTICS

- **Price** £40
- **Developer** Ubisoft Montreal
- **Publisher** Ubisoft
- **Web** www.watchdogs.ubi.com
- **Multiplayer** Up to 8 players
- **DRM** Uplay
- **Recommended spec** DirectX 11-compliant GPU, 8GB RAM, 3.5GHz CPU

Game of phones

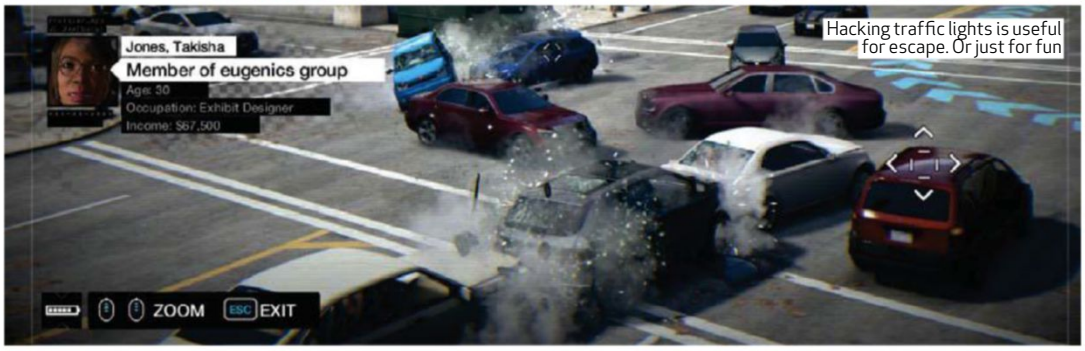
My phone has access to ctOS, an omnipresent computer network that manages the entire city of Chicago. I can change traffic lights to cause accidents ahead of me (useful if I'm pursuing someone) or behind me (handy if I'm the one being pursued). After a few skill upgrades, I can blow up steam pipes buried beneath the streets, raise barricades and tyre spikes, disrupt radio transmissions, cause massive blackouts and disable helicopters.

Where the magical smartphone truly shines is during the infiltration of secure locations crawling with armed guards. No need to rush in, just scout the perimeter until you spot an external security camera on



Yes, you can go nuts and blow up the city. In virtual reality mode, anyway


Aiden's too moody to be part of your community



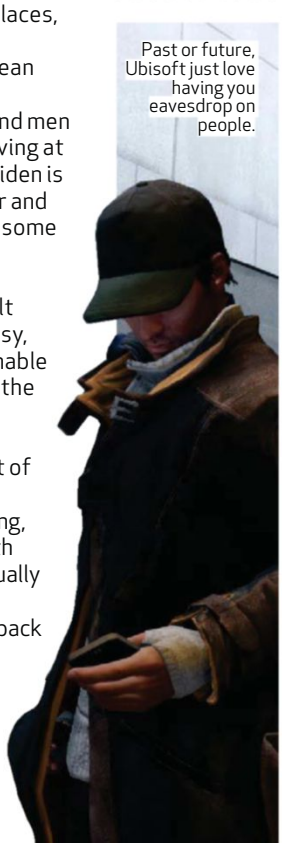
Hacking traffic lights is useful for escape. Or just for fun

the side of a nearby building. Accessing it with your phone enables you to 'hop' into the camera and look through its lens. If you spot another security camera with the one you're controlling, you can project yourself into that one, and so on, forming a chain of digital leaps Aiden refers to as "riding the cameras." There are entire buildings you can infiltrate and escape from, all while standing safely outside on a street corner, looking like just another dude absorbed with his mobile phone.

Remote hacking and camera riding gets you into a lot of places, but many missions require a personal touch, by which I mean stealthily sneaking through buildings, shooting a thousand men in the face with guns and driving at top speed all over the city. Aiden is gifted in the ways of parkour and silent takedowns, not unlike some assassins I could name.

The gunplay was mostly satisfying: mouse-aiming felt natural without being too easy, the bigger guns had a reasonable amount of recoil (except for the full-auto shotgun, which has none), and the single-shot grenade launcher got me out of more jams than I can count.

Less satisfying is the driving, which was fairly awkward with keyboard and mouse. I eventually switched to my wireless 360 controller for this, swapping back to mouse and keyboard for everything else. On the plus side, the game detects what you're using, instantly updating any on-screen prompts to reflect your control scheme. Also, brace yourself for yet another irritating checkpoint save system. Did you enjoy that lengthy phone call at the start of the mission so much you want to hear it again? Interested in re-killing those first 20 goons before getting to the boss goon who killed you? If your answer to any of these is "no," never fail a mission in this game.


Past or future, Ubisoft just love having you eavesdrop on people.

Chicago itself feels a bit bigger than *GTA IV*'s Liberty City, and the areas are all seamlessly connected (the only loading screens you'll encounter are while fast-travelling). I found the city attractive if not particularly memorable, perhaps because there are no planes to pilot over it, nor infinite parachutes to leap off its buildings with.

As far as the citizens themselves go, they're not as loud, profane nor as obnoxious as those in *GTA* or *Saint's Row*, which makes them considerably less fun to terrorise.

Busy signals

There's also plenty of extra work in *Watch Dogs* for the eager vigilante. Notifications pop up (a little too often for my tastes) alerting you to upcoming crimes in the area. Some hunting around will reveal either the potential crook or possible victim, and you can tail them, covertly witness the crime, and then chase down and punish the offender.

The city also has mysteries to solve: codes that can only be viewed from certain cameras, a serial killer stalking the populace, and audio files to collect and use to piece together additional stories. And, of course, you can unlock vehicles, buy guns, and visit shops to purchase slightly different versions of your stupid coat. There are lots of fun things to do in *Watch Dogs*, along with a main storyline that takes a little over 20 hours to complete.

I was a bit worried I wouldn't have time to check out *Watch Dogs*' multiplayer modes, but that problem was solved for me when I was notified that multiplayer was, in fact, checking me out. Another player was in my singleplayer game hacking into my data. In *Watch Dogs*' one-on-one hacking game, you have to use your phone to locate the intruder (who will be disguised as a normal citizen) and kill them before they can finish their download and slip back out of your game.

Suddenly realising another human player is in your game is wonderfully unsettling, especially since they've potentially been there for several minutes. Thematically, it's perfect, given all the spying you do in *Watch Dogs*, and it's especially fun when you're the invader. In one heart-pounding match, I sat hunched behind the wheel of a parked car in a busy part of town, watching my mark circle the area again and again, frantically scanning for me among the NPCs. My hack slowly climbed to 99 per cent – so close! – before he finally spotted me and ran toward my car. I gunned the engine and screeched away into traffic, his gunshots thunking into my bonnet, and lost him after jumping a drawbridge, safely returning to my game with most – not all – of his data. Incredible fun.

I found little to like in *Watch Dogs*' story. Aiden's gloominess and introspection are tiresome, and the best character, a fixer named Jordi, gets almost no screen time. There's also a sex slave auction that seems to serve no purpose but to provide another woman for Aiden to rescue.

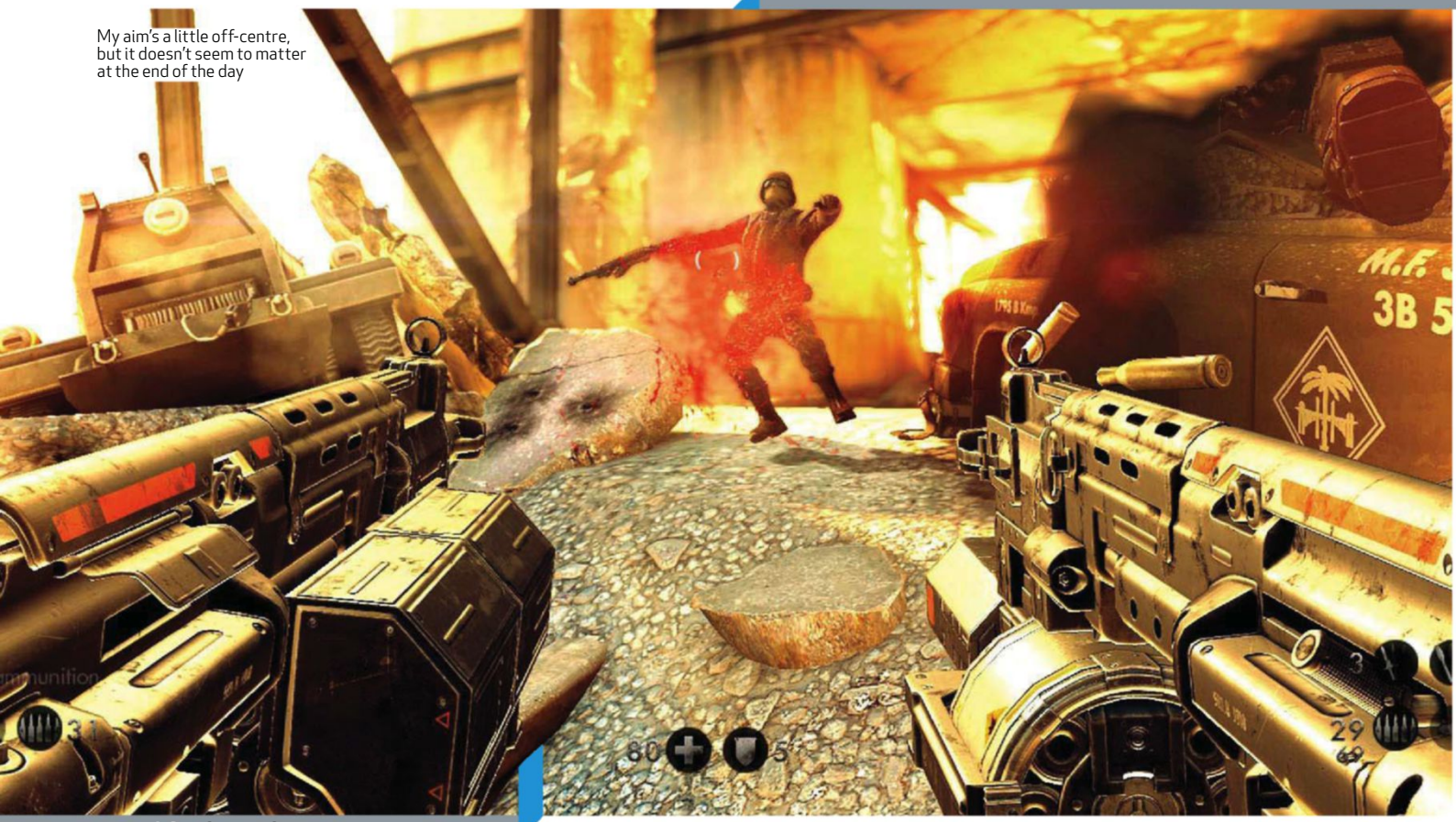
Watch Dogs can seem like a game we've played before. But when it deviates from the familiar, it really soars: hacking the city and all its cameras, communications and utilities is freeing and fun, while invading the games of other players is an unusual and welcome thrill.■

Christopher Livingston

PCFormat Verdict

Creative hacking and covert multiplayer brings exciting new life to an otherwise familiar open-world shooting experience.

★★★★½



My aim's a little off-centre, but it doesn't seem to matter at the end of the day

RELEASE OUT NOW

Wolfenstein: The New Order

Loud, violent, and smarter than you might think

Bethesda title *Wolfenstein: The New Order* has been made with love. This might not be obvious to you when you are giving a Nazi both barrels as the world around you collapses in a shower of bone and blood and concrete. I would forgive you for missing this care and attention to detail when you wrench a lasergun from its fixed emplacement and use it to mulch a charging column of Third Reich roboguys.

But it is there if you go looking for it. This vision of Nazi-dominated 1960s Europe has been constructed with extraordinary style. *The New Order* is *Inglourious Basterds* by way of *Moonbase Alpha* – an X-rated episode of *Captain Scarlet* starring the world's most heavily militarised jacket potato.

BJ Blazkowicz returns during a last-ditch Allied assault on a Nazi compound in 1946. This game is technically a sequel to Raven's 2009 *Wolfenstein*, but all you really need to know is that the Nazis have somehow figured out how to graft a gigantic staple remover onto a dog's face. Advances like this one have given them the edge, and BJ is left in a 14-year coma when that final assault goes south. He wakes up in a world controlled by the Third Reich and becomes the cornerstone of a resistance movement.

VITAL STATISTICS

- **Price** £35
- **Developer** Machine Games
- **Publisher** Bethesda
- **Web** www.wolfenstein.com
- **Multiplayer** None
- **DRM** Steam
- **Recommended spec** Quad core CPU, 4GB RAM, 2GB GPU

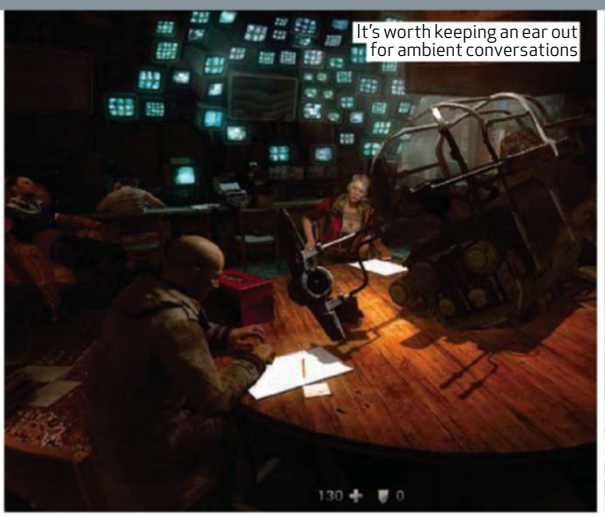
History is treated like a toybox when it comes to providing you with evils to revolt against. *The New Order*'s basic thesis is that this is okay: concentration camps, secret police and brutal eugenics can be used as motivators for violent entertainment. If these ideas make you uncomfortable, or if you are otherwise disturbed by body horror, scalpels or surgery, it might be best to stay away.

Could be wurst

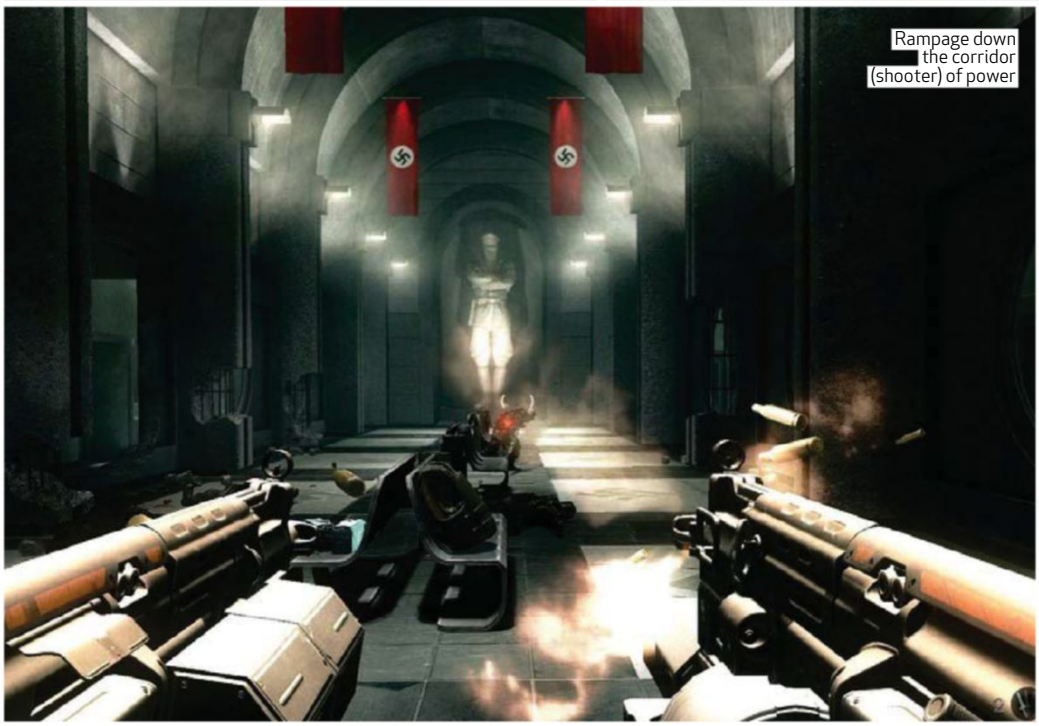
For all that brutality, though, this is a far more thoughtfully written and well-acted game than it has any right to be. It's never explicitly ironic – that would get tiresome – but its characters are intelligent, larger-than-life and invested in the world around them. You'll periodically return to the resistance HQ for some non-combat missions, and well-written backmatter makes this space well worth exploring.

There are exceptions, of course – stock situations, stock characters and heroic sacrifices that you see coming hours in advance. This game does not deserve to be put on a pedestal for its presentation of history – unless that pedestal also includes a pair of thundering megashotguns and a Nazi who doesn't have arms any more. But it's better than you'd expect, and I pressed eagerly through the campaign's eight to nine hour running time and would do so again.

An array of collectibles and difficulty modes encourage a second run, which is a welcome inclusion for a singleplayer game. Machine Games have invested a remarkable amount of time in this optional material: the game includes collectible recordings of '50s and '60s pop songs in their alternate universe… German language versions. Plus, a decision you make in the prologue has an influence on the campaign: you'll


It's worth keeping an ear out for ambient conversations


He doesn't need to be able to see to crush your face


Rampage down the corridor (shooter) of power


There are no nice doggies in the Nazi-controlled future


The marksman rifle can clear rooms quickly if you're accurate

either be able to pick locks or hotwire devices depending on your choice, granting you access to different routes and upgrade paths. It's also – and here's the important bit – a very good shooter. Weapons have tremendous weight, animation is top-quality, and levels are divided up into arenas that are, in the main, fun to fight across.

Major encounters normally include one or two commanders who will continuously summon reinforcements to the area if they're alerted. If you play *The New Order* as a straight shooter, enemies will continue to arrive until you fight your way through to the commander and kill him.

The best thing about *The New Order* as a stealth game, though, is that it's fun to fail: fumble a takedown and you transition seamlessly into Rambo. I found myself adopting an all-or-nothing playstyle, going in quiet at first before gleefully transitioning to the double shotguns.

BJ picks up an upgradable laser cutter that can be used to carve freeform shapes out of certain fences and vent covers, but beyond a few puzzles its potential goes unexplored. The laser should be *Wolfenstein*'s gravity gun, but it's really just another gun.

History repeating

The game is further held back by a lack of new ideas in its second half. It remains a very good shooter, but the underlying structure never escapes familiar patterns. I've also got a gripe with its damage indicators – it's often quite tricky to tell when you're being attacked from the sides or behind; as enemy numbers ramp up this can lead to some unfair-feeling failures at higher difficulties. The AI's love of flanking manoeuvres is laudable, but a bit of warning would be nice.

At the time of writing, the game has driver compatibility issues that impact performance. A bit of Googling should turn up a solution – either upgrading or downgrading your drivers, normally – but it's a hindrance, as is the abundance of texture pop-in that occurs just after you load a fresh game.

That said, the game is great fun to play. It really is a pleasant surprise and a reminder of a time when a shooter's singleplayer campaign was the main event – a time when titles of this genre were made with attention to detail, care and a bit of love. ■ **Chris Thursten**

PCFormat Verdict

You can – and probably should – blow a Nazi to pieces among some lovingly-designed 1960s soft furnishings.

★★★★★

A tiny legion in a single zone; this could take a while...

RELEASE OUT NOW

WildStar

Pack provisions: you could be wandering for some time

Icons identify your group's Tank and Healer

Over the nine years since *World of Warcraft*'s release, plenty of other MMORPGs have tried to capture Blizzard's magic. The problem, for many, was a fundamental misunderstanding of what that magic was. Rather than start with a wish to give people expansive worlds, deep rule-systems and engaging lore, those later games were conceived out of a realisation that having millions of regular subscribers would look good on an annual earnings report.

Having played *WildStar* for more than 50 hours, what impresses me is that it feels less cynical in its approach and less insecure about its inspirations. *WoW*'s DNA is unmistakably present – you can see it in the questing, the structure, and, more than anything, the expressive cartoon style. But Carbine has tweaked that formula to create something distinct.

VITAL STATISTICS

- **Price** £35
- **Developer** Carbine Studios
- **Publisher** NCSoft
- **Web** www.WildStar-online.com
- **Multiplayer** Massively
- **DRM** Account log-in
- **Recommended spec** 2.66GHz Quad-Core CPU, 128MB GPU, 8GB RAM

At the start of the game you pick one of two factions. The Exiles are a ragtag bunch of space refugees, who have come to *WildStar*'s planet of Nexus to make a new home. The Dominion are the guys who exiled the Exiles. Neither side is particularly fond of the other.

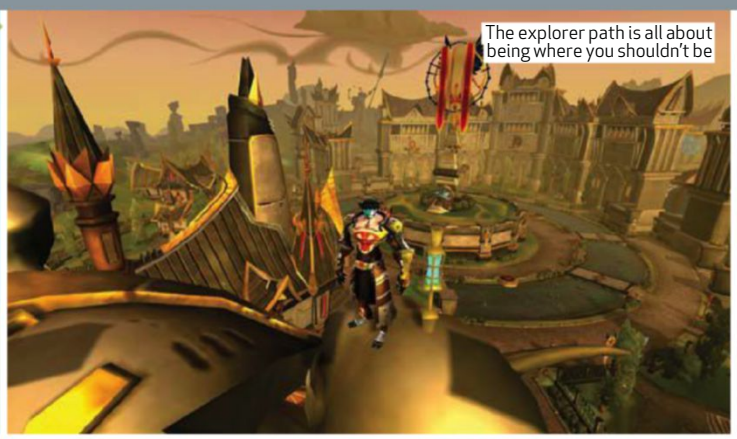
Your character has been chosen to represent their faction in the impending Exile vs Dominion ruckus. You serve as a solution to your faction's many problems – a bit like Harvey Keitel in *Pulp Fiction*, if he had bunny ears or was a robot.

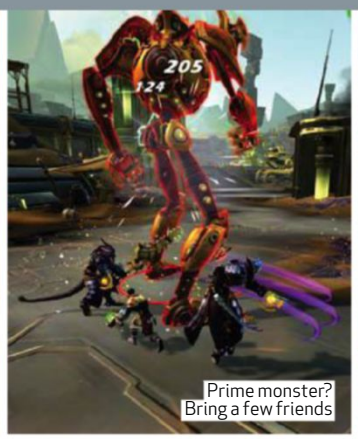
Wild at heart

Each mission is categorised by its impact on the story at large, with World, Zone and Region types in descending order of importance. At times it can feel like you're being bogged down in the trivial, when one camp requests you clear an area of its troublesome inhabitants. But there's variety and humour sprinkled throughout, and it's easier to forgive *WildStar* its blander episodes when you're embroiled in, say, the administrative bickerings of a corporate race of green clones.

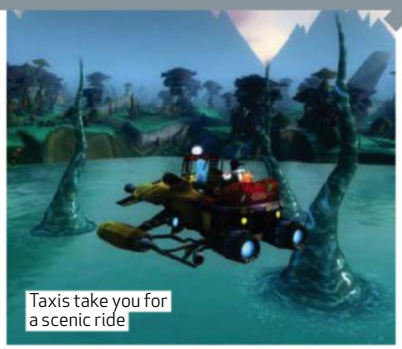
Questing, similarly, has its standout moments. You're going to be killing a lot of things, and, when you're not, you're probably going to be activating or collecting a set number of objects by running up to them and pressing [F]. But then there are the moments when the game's penchant for silliness kicks in, and you're chasing a naked rabbit around town, attaching a rocket to a cute pig-thing, or looking for erotic fiction in a spider-filled woodland.

Such highlights would be useless if the general questing was an enthusiasm-sapping churn of endurance. It's not; in fact it's here that *WildStar* starts to stand out for more than just its tone. While many of the quests ask you to kill a particular category of enemy or

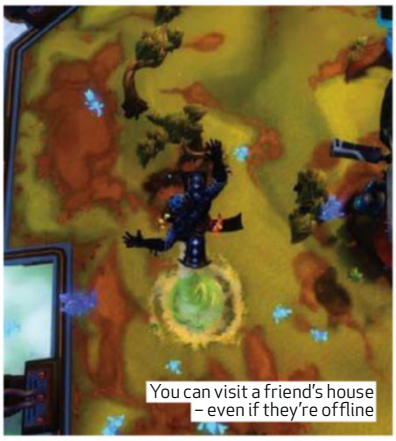

The explorer path is all about being where you shouldn't be



Prime monster? Bring a few friends


Taxis take you for a scenic ride


Dungeon bosses can have some unusual attacks


You can visit a friend's house – even if they're offline

monster, they don't ask for a set number. Instead, a percentage bar increases as you carry out your task. For the biggest reward, take on the Prime monsters, denoted by their menacing red sheen. These are much tougher, and should generally be tackled by more than one person. As other players are likely doing the same tasks, I found that, after a brief dance of hesitation, most could be coaxed into assistance.

Every player selects a Path, and these provide secondary set of objectives. Scientists scan the plants and wildlife of the world, settlers build stations that give a temporary buff to players, soldiers are offered a variety of special combat scenarios, and explorers chart each zone, uncovering secrets and jumping on things. I picked the latter, and was given plenty of opportunities to suspend my to-do list in favour of climbing mountains or scavenging for secrets.

Kill something and you might activate a challenge – a timed objective to dispatch as many of that specific enemy as possible. Find a public noticeboard, and you'll be offered a group quest to take down an especially tough beast. Or, you might stumble upon a public event, in which players from around the area are called to work towards some large-scale attack.

In addition to that, special activities are unlocked at various stages across the levelling process. Shiphand missions take you on a trope-filled sci-fi adventure that scales based on the number of players in your party. 'Adventures' are five-player branching stories that repurpose existing zones for specific, varied quest chains. Then there are dungeons, which provide some of the most difficult and tactical pre-endgame encounters.

These instanced quests help alleviate the issue of open-world grouping. There's no level scaling in *WildStar*'s open zones, which means it can be very difficult to adventure with friends. Even during launch – with guild-mates of a similar level – finding moments when our quest-logs aligned was rare.

All of which means that now, as I approach level 25, I've got a variety of potential options available every time I log in. And I've almost always achieved something when I log out. That could mean completing any of the above activities or winning a PvP match. Alternatively, I might find a new table for my house – a terrifyingly compelling *Animal Crossing*-like piece of land that can be upgraded in various ways.

On target

The biggest factor in keeping me actively engaged is the combat. It's hotbar driven, but nonetheless lively and fluid. In that respect it feels closest to *Guild Wars 2*, where evasion of attacks and positioning are invested with the same level of importance. The difference is there's no tab-targeting, so every skill needs to be manually aimed. Hold down a number key and the range of your attack will be shown in blue. Let go, and you'll activate that ability, damaging everything in the highlighted area.

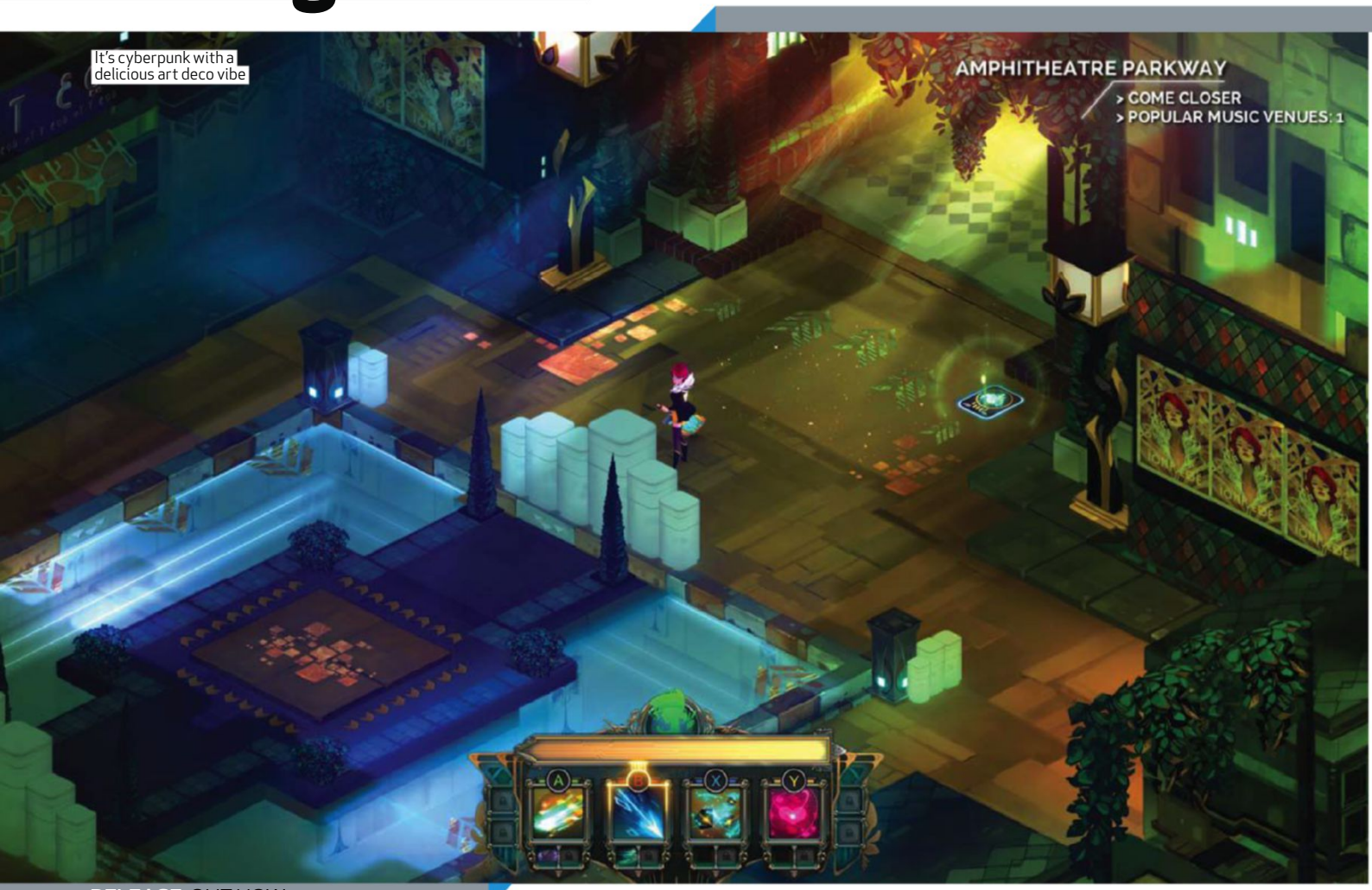
Enemies follow the same rule for any attack above their most basic. Not only are you required to land your own abilities, but also to dodge the red zones that telegraph theirs. It's while grouping that the system really comes alive. In PvP battlegrounds – *WildStar*'s 10v10 objective-based matches – the floor becomes a constantly shifting patchwork of blue, red and the regenerating green of your healers.

Carbine has created a brilliant foundation for a successful MMO, but there's a lot riding on the days and months to come. *WildStar* has a subscription, and also a system called Credd. This, like *EVE Online*'s Plex, is game time bought with real-world money that can be traded to other players for in-game gold. As of writing, it isn't active, which makes it impossible to predict if it will prove a reasonable alternative to a monthly fee.

If *WildStar* is to be worthwhile in the long-term, its developers will need to keep it regularly and substantially updated. For now, the game is a love letter to MMO fans, with more than enough content to justify its initial cost. ■ **Phil Savage**

PCFormat Verdict

Clever questing and a stand-out combat system make foar an entertaining MMO that is as large as it is full of character.



It's cyberpunk with a delicious art deco vibe

RELEASE OUT NOW

Transistor

The sword proves mightier than the pen

***Transistor* begins with a woman, a dead body, a talking sword and a dying city. Red is a singer with no voice, trapped in a sprawling digital metropolis that's being erased by white robot programs called the Process. Byte by byte, block by block, Cloudbank is vanishing.**

But Red has the Transistor, a mysterious sword. She is the hero, but the Transistor is narrator and star. Eight hours after grasping that sword, I reached the end of Red's journey in love with the Transistor's nuanced combat abilities – and disappointed that the rest of the world felt so shallow in comparison.

Like *Bastion*, Supergiant's first game, *Transistor* is an action-RPG. The Transistor can freeze time and initiate a planning mode called Turn() for queuing abilities called functions against the Process. Walking around the map and queuing abilities fills up an action bar, and more powerful abilities eat up more space on the bar. After you've committed to a sequence of attacks, the world snaps back into action and enemies move in slow-mo as Red attacks in real time. There's a great cadence to the combat. I'll sometimes spend a full minute planning the most efficient turn, then watch Red execute four of the Process in as many seconds.

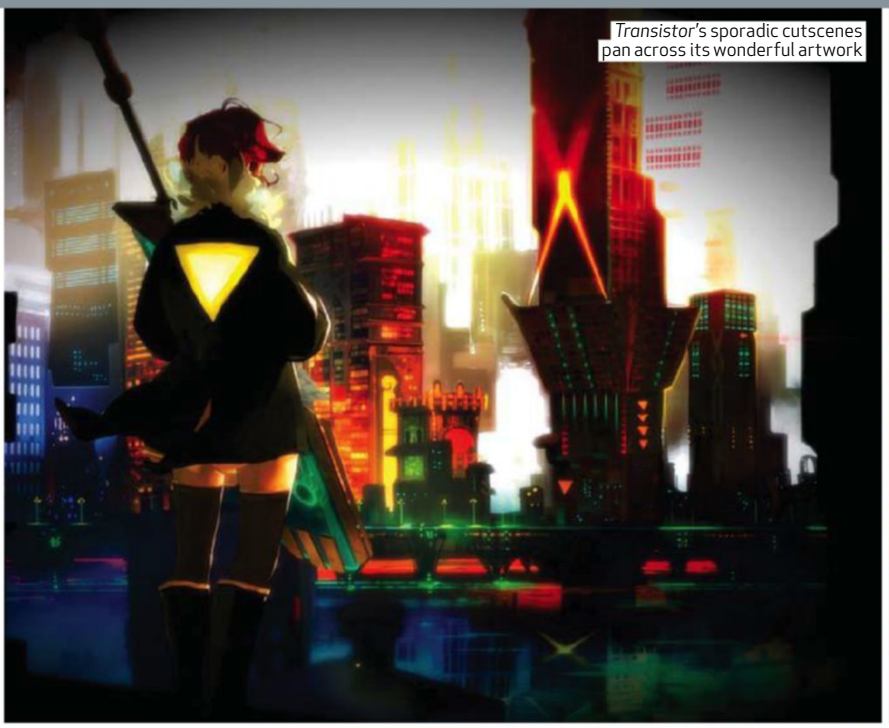
Transistor's combat is malleable thanks to the sword's functions. All 16 of these can be used as active abilities – stuns, explosive AoEs, cloaking fields, dodges – or as upgrades that augment the effects of other functions. Early in the game, I upgraded the slow-but-powerful Breach function with Jaunt, which made the attack trigger instantly and let me use it while my meter was recharging.

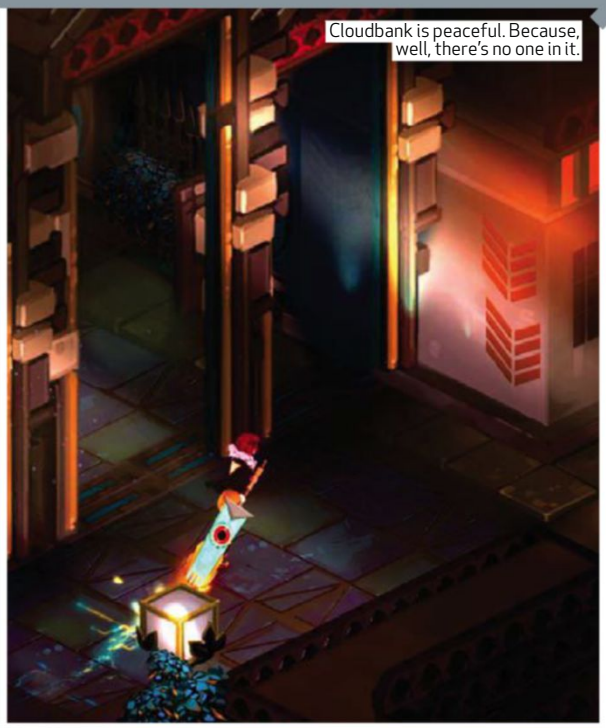
As if there weren't enough active and upgrade combinations, all 16 functions have another effect when equipped in a 'passive' slot. As an active function, Help summons an AI companion to assist in battle. Equip it as passive, and it offers a 25 per cent chance to become a SuperUser when triggering a turn, which grants unlimited movement range and a one-hit-kill attack. Purge, a damage-over-time active, is an automatic counterattack when equipped as a passive.

Transistor is built to be played with a controller, as each function is mapped to a face button and Turn() is controlled with the triggers. The default mouse/keyboard controls are a little clunky – pressing [1]-[4] will highlight a function, and the right mouse button triggers it – but an alternate option will fire off the function instead of highlighting it. The keys can also be remapped, and *Transistor* has the most impressive on-the-fly UI switching I've ever seen for controls. Touch the keyboard or mouse, and all the in-game UI elements will show PC controls. Touch the controller, and they'll automatically switch to

VITAL STATISTICS

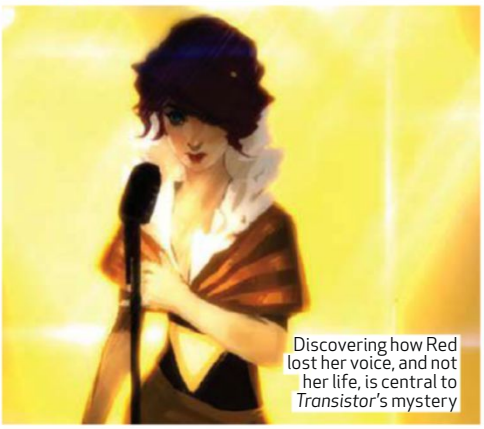
- **Price** £15
- **Developer** Supergiant Games
- **Publisher** In-house
- **Web** www.supergiantgames.com
- **Multiplayer** None
- **DRM** Steam
- **Recommended spec** 2.6GHz CPU, 4GB RAM, 1GB GPU


Transistor's sporadic cutscenes pan across its wonderful artwork


Cloudbank is peaceful. Because, well, there's no one in it.


Boats are cool


What? It's a very heavy sword


Discovering how Red lost her voice, and not her life, is central to *Transistor*'s mystery

controller prompts. It's one of those little touches that's so slick, you wonder why it's not in every game.

Combat is on the easy side, though – I only died twice in the game, and I played at least half of it with a combination of 'limiters' equipped. These unlock throughout the game and make the Process spawn in greater numbers, hit harder, or gain protective shields. Fighting with limiters engaged earns Red more experience.

While *Transistor*'s combat only gets more fun in New Game+, I also rolled into a second playthrough with the forlorn hope that there was more to *Transistor*'s story than I'd got the first time around. Unfortunately, there wasn't.

Questions unanswered

The city of Cloudbank is stunning, a lusciously detailed, hand-drawn cyberpunk future built atop the memory of a red-gold art deco past. As the Process consume it, streets awash in vivid green, red and purple lighting fade to austere white.

Exploring the empty streets of Cloudbank had me as entranced as the first time I stepped foot into *BioShock*'s Rapture. Supergiant's 2D art is compelling, and the blend of sci-fi and classic architecture promises a fascinating backstory. I was still waiting for that backstory when the game ended.

I thought the narrator's cryptic references to Cloudbank's past were building up to a moment that would do the city justice, but that moment never comes. I hoped that I would encounter people and learn their stories, but after battling the Process from empty environment to empty environment, that hope shrank. Only a few terminals offer any insight into the city's culture.

Like *Bastion*, *Transistor* is focused on a hero and a narrator traversing the ruins of their world. But as the mystery of *Bastion* unfolded, it tied the fates of its characters to that of its setting. Red's story feels like a sliver of what is interesting and compelling about Cloudbank. *Transistor* is disappointingly linear in a city that begs for exploration.

The story *Transistor* does tell is dished out in tantalising morsels, and I had to spend some time reflecting on the ending to decide what happened. Perhaps because of that vagueness, *Transistor*'s emotional climax didn't hit me like *Bastion*'s did. Supergiant's games are, in that sense, mirror images – the first with shallower combat but a powerfully told story, the second with deep, tactical battles but a story that doesn't fulfil its promise. Then again, that promise lives on after the credits roll. I hope the developer isn't done with the world of *Transistor* – there's so much more I want to know. ■ **Wes Fenlon**

PCFormat Verdict

A brilliant and rewarding combat system propels a story that never becomes as interesting as it seemingly should.

★★★★☆

Alyx Vance's expressions were unlike anything we'd seen before

CHARACTER BUILDING

GAMING HAS BROUGHT US NEW HEROES, TERRIFIC STORIES AND MEMORABLE BAD GUYS – BUT HOW DID WE GET HERE, AND WHERE ARE WE GOING?

A strange new world has turned hostile. You've fought your way through it so far, dodging the oppressive forces and slipping by unnoticed. But now you're genuinely screwed. Guards to the front, guards to the rear, no escape. One attacks and your vision whites out. The crackle of radios segues into the sound of arses being whooped, and you hear a female voice among the chaos.

Your vision fades back and you see her. She looks straight into your eyes, and smiles wryly but reassuringly. "Doctor Freeman, I presume?" she asks. Before you can introduce yourself, a security announcement grabs her attention. She looks around, flustered. "We better hurry. The Combine can be slow to wake, but once they're up you don't want to get in their way."

The introduction of Alyx Vance in 2004's *Half-Life 2* was nothing short of revolutionary. For the first time gamers found themselves looking at what was, to all intents and purposes, a living, breathing human being. Her eyes would follow you around the room. She would react with horror or astonishment or fear as she joined you in exploring City 17.

Half-Life 2's gunship battles, river chases and coastal shoot-outs may be forgotten, but Alyx is the element, the character, that most people remember. Indeed, it's Alyx's fate, not silent protagonist Gordon's, which is surely the cause of the miasma of excitement and intrigue around the forever delayed prospect of *Half-Life 3*.

"It's not what she said that made her character so brilliant – it's the way she looked," says industry legend and 22Cans boss Peter Molyneux. "That was the first time that we really had characters that used expressions. That sideways look in the elevator that she gave you was incredibly telling. That was the moment where we all turned round and started say, 'well, hang on, this is the world we want to get into'."

A rough draft of *Sniper Elite 3*'s protagonist

That world has its roots in 1972's *Pong*. There are no intricate backstories here, and the only arcs are those of the ball. And yet, this ball could be considered the very first game character. Yes, we're going there. Its single purpose is to react to the player's actions, and despite its square shape we understand that it's a ball through the way that it bounces and moves across the screen. It's our ability to fill in the gaps of 'what it represents' that is crucial to the ongoing development of game characters.

Pong's single-celled organism divided and multiplied. Tomohiro Nishikado's *Gun Fight*, released in 1975, brought us the first humanoid characters: a pair of duelling cowboys. And, of course, the first thing it did was to kill them – the cowboys squaring off against one another and moving around the screen to avoid being shot with single-pixel bullets. It drew upon gamers' understanding of movie clichés to build its world: the stetsons, the spurs, the cacti and the covered wagons, no matter how crudely drawn, instantly reminded us that we were in a simulated version of the Wild West.

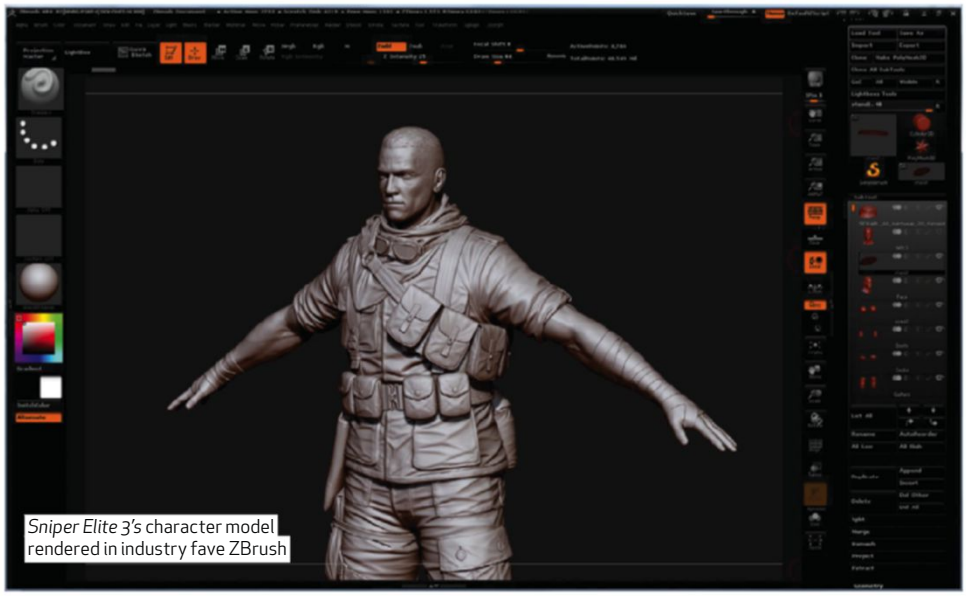
Through the 1970s, games moved from a novelty entertainment form to an entire industry. Taito's 1978 game *Space Invaders* challenged players to defend Earth from alien hordes. In 1980 *Pac-Man* gave us what was arguably gaming's first icon, based on a pizza with a slice missing.

The '80s got off to a flying start with Nintendo's *Donkey Kong*. The world's first platform game had a story (a princess has been kidnapped by a giant ape), a hero (Jumpman, who was tasked with rescuing her) and a formidable challenge (ascend the platforms while avoiding the tumbling barrels). Jumpman would later be renamed Mario, and creator Shigeru Miyamoto would build worlds for him to explore, packed with characters such as his brother Luigi and antagonist Bowser.

The final version of *Sniper Elite 3*'s protagonist

THERE AND BACK AGAIN

While *Donkey Kong* told its story visually, text adventure developers were weaving narratives in with good ol' fashioned words. Melbourne House's 1982 game *The Hobbit*, based on JRR Tolkien's novel, told Bilbo Baggins' familiar story, using clever text parsing to understand the player's 128-character instructions. While not as visually gratifying as other games, text adventures were able to flesh out their characters more than a handful of pixels ever could.



Sniper Elite 3's character model rendered in industry fave ZBrush

By the time the 1990s came around, the games industry was in full swing, and increasingly capacious storage mediums resulted in more detailed characters than ever before. *Sonic the Hedgehog*, introduced by Sega in 1991, was punky and brightly-coloured – a perfectly-designed anecdote to the more asinine characters that came before. Full-motion video meant actual people could be integrated into game worlds – even if only for cutscenes, for which the *Command & Conquer* series became famous.

The advent of 3D engines and CD-ROM storage meant that characters could be more fully-realised than ever before. 1996's *Tomb Raider* introduced Lara Croft, the first icon of 3D gaming. Equally important was the notion that a female could be cast as the player character – even if she was improbably proportioned and impractically clothed.

Mood Visual's *Hitman: Absolution* poster

Thief: The Dark Project, also released in 1998, manipulated the FPS into a weird new form, merging it with RPG elements in a steampunk city setting. As the protagonist and entry point into this world, it was crucial for developer Looking Glass Studios to get Garrett absolutely right. Thankfully it delivered both a cinematic character arc and, with Stephen Russell's gravelly voice acting, a personable and likeable master thief who inhabited the shadows between light and dark.

MILLENNIAL MEN

Half-Life and *Thief* set a high bar for the first decade of the 2000s, and games became more cinematic as a result. *Deus Ex* brought us JC Denton, a mysterious government employee with shades of *Blade Runner*'s Deckard and *The Matrix*'s Neo. More ambitious still was *Grand Theft Auto: Vice City*, which took inspiration from 1980s television and movies (*Miami Vice*, *Scarface*) to create a colourful array of characters that toed the line between parody and homage, but still managed to give protagonist Tommy Vercetti a story worthy of a Tarantino film.

Equally important was the notion that a female could be cast as the player character

Alyx's introduction in 2004's *Half-Life 2* gave the games industry a new focus, and female non-player characters became a norm. 2007's *BioShock* nicely played with the cute female character in the shape of the little sisters, who could call upon their oversized aides, the Big Daddies, when they needed help. This formula was perfected with Elizabeth in *BioShock Infinite*, a seemingly innocent girl who was key to the floating city of Columbia.

L.A. Noire, released in 2011, used facial capture technology to add to the theatrical quality of contemporary games, throwing character actors you vaguely recognise into a digital facsimile of 1950s Los Angeles. It was an important moment in gaming, which invited players to judiciously study facial expressions in order to assess whether a suspect was lying or telling the truth. It was the first time that facial animation bore a resemblance to actual people.

We've come an incredibly long way since the days of *Pong*, and developers are building game worlds bigger and more complex than ever before. But there's still an ongoing problem of how to make our characters feel and act like real

Around this time, LucasArts was in its heyday with point-and-click adventures such as *The Secret of Monkey Island*, *Sam & Max Hit the Road* and *The Dig*. CD-ROM storage meant that these games could have characters fully-voiced by professional actors, bringing them to life more than ever before.

The first *Half-Life*, released in 1998, utterly changed the way we think about games. Based on a modified version of the *Quake* engine, it took the 3D shooter template and turned it into something more cinematic and believable. Although its handful of characters – scientists, security guards, and the mysterious G-Man – were often copied and pasted throughout the game, they delivered exposition without cutscenes and made the Black Mesa research laboratory in which the game takes place feel like a functional institution instead of a series of levels.

In the mood

WE GRILL RASMUS BERGGREEN OF MOOD VISUALS ABOUT CREATING CONCEPT ART FOR COMPUTER GAMES

Rasmus Berggreen: good with a pencil

PCF: Where do you guys fit into the process of making a game?
Rasmus Berggreen: Depending on the project and how much we are involved, we start with the pitch material. This is the phase where you start visualising your thoughts so others can believe in your game. In games, the concept phase can be relatively long, as you start with high concepts that define the universe.

PCF: How much creative freedom are you given by studios?
Rasmus Berggreen: Every studio has its own process. Some just want to be inspired, in other cases your work has to fit into work that has already been done. But what I find is that the studios most often believe in you and the creativity, and love seeing all the visual work being made. I think there is a huge freedom, as long as your work is going in the right direction.

PCF: How does creating game art differ to films?
Rasmus Berggreen: It seems games need more design and concept work done over a longer period, mainly due to a demanding outsourcing process. Also, I find it easier to design for film as the stage is set and you can control what the viewer will see on the big screen. In most games the user has the freedom to walk around or something, so you are more designing a stage than a frame.

PCF: How did you come up with the character posters for *Hitman: Absolution*?
Rasmus Berggreen: We had a long process where we jammed ideas around and had input from director, creative director, marketing and others. It was a lot of fun, and in the end we had some different variants. It started very experimental and later on things were narrowed down. We had to sell the fantasy, so in the end it is about how you sell it the best.

Use the Broforce

HOW FREE LIVES TEAM IS BRO-ING UP 1980S MOVIE ICONS AND CHARACTER DESIGN

Big studios can spend millions on creating characters, but indie developers have to work with low budgets. It's critical that smaller games look good so they can capture an audience and stand out from the crowd. *Fez*, *Limbo* and *Braid* all took the platform genre to interesting places, and joining them is Free Lives' sublimely daft *Broforce*.

The game takes its influence from the golden era of action movies, marrying recognisable characters with ridiculous amounts of pixelated carnage and destructible environments, drawing on classic arcade games such as *Metal Slug* and *Contra* for its running and gunning.

In the game, 'Bro-ed' versions of John McClane and Rambo are joined by Mr T, Blade and Judge Dredd, and a big part of the game's joy lies in seeing who will turn up next. Free Lives has an ongoing thread of public ideas for Bros. "We've been getting new character suggestions from the community all the way through development."

Once the team has settled on an action icon, the design process begins. "We start with a brainstorming session to flesh out the character's primary and special attacks, defining what's going to make him or her fun," the Free Lives team says. "Nights re-watching said movie

are essential to this process. We then concept, go to sprite sheets and then art."

At the time of writing *Broforce* is still in beta, but it's a polished experience which has smashed the enjoyment scale, and despite heavily leaning on a retro aesthetic, it's taken off in ways the team couldn't imagine.

people. You can employ the world's greatest writers, animators and artists to create a character that would be perfectly suited to a movie, but they won't necessarily fit in to a game.

"As an industry we've been on this amazing journey where part of us, being gamers, have wanted to have fantastic games, and another part of us wants to have fantastic stories with amazing characters," says Molyneux. "It's always been a struggle when you're creating a game to actually pair those two things together; great gameplay and great stories with great characters. They take time to craft and time to roll out to the player."

MOLYNEUX'S MORALS

Molyneux has a great amount of experience with game storytelling, with a particular focus on morality. God game progenitor *Populous*, released in 1989, invited the player to help or hinder the population through divine intervention. *Syndicate*, *Theme Park* and *Dungeon Keeper* built upon *Populous*' top-down perspective and explored ideas of identity, capitalism and good versus evil. *Black & White* provided an interesting return to the genre he started, while the *Fable* series moved into a full-blown RPG world in which the character could either be nice or embrace the dark side.

Fable, released in 2004, presented Molyneux with a huge challenge in character development, requiring him to give the player backstory and development without interrupting the flow of the gameplay. There was a simple solution: "walk and talks", as he dubs them, in which a character would speak to the player while they were traversing the landscape. A great idea in itself, but it didn't quite work as characters would say things like "I was beaten up as a child," while they were wondering through a pastoral glade. "It seems completely wrong to say that emotive statement as you're jogging through countryside," says Molyneux. "You just want to stop the player, and you want to make sure the player's looking into that character's eyes. It's such a challenging thing to do."

Broforce delivers some surreal amounts of 16-bit style carnage

> "I've played *Thomas Was Alone* and it's a cube for Christ's sake. I like those sorts of characters as well"

For Molyneux – and the majority of the games industry – the most recent game to really push the medium in terms of building character is Naughty Dog's PlayStation 3 survival game *The Last of Us*, which tenderly depicts the relationship between a middle-aged man and a teenage girl as they travel through a virus-

The *Black & White* series built on the top-down perspective

Grand Theft Auto: Vice City's Tommy Vercetti provided a smorgasbord of '80s cliches

Fable III's Dog acted just like a real canine

ravaged vision of America. "The characters in *The Last of Us* are best in class," Molyneux says. "You realise that they're far more subtle than just having big brutish heroes; they can be a vulnerable young girl who needs to be looked after."

TV ON THE CONSOLE

While *The Last of Us* is pushing character development in all the right directions, games themselves are increasingly vying for people's free time with another medium: television. When we flick between blowing up cyber Nazis in *Wolfenstein: The New Order* and trying to understand just what is motivating Rust Cohle in the *True Detective* series, the cracks begin to appear. But there are certainly similarities between the two mediums that could be embraced further: both can feature 20-hour plus runtimes, and both tend to be episodic by nature.

Molyneux believes the gaming industry can learn from and aspire to the sudden growth in high-calibre TV shows. "The world has moved on a lot from the *Final Fantasy VII* days where there were these pre-canned animations that were just played over and over again, and it's moved through into the *Half-Life 2* days, through the *Grand Theft Auto* days, and I think we're making great progress." he says. "But there's still a hell of a long way to go before we really get up to the *Breaking Bad* characters. That's the dream, isn't it? Imagine you played in the *Breaking Bad* world, and you were as emotionally involved with the in-game characters. I think that's possible."

There's an even bigger challenge facing developers in the emergence of online gaming. Telling a story to one or two people playing a game means you've got a captive audience, but when there are tens or hundreds of people in a game world, Molyneux says, it "throws every pretext of characterisation out of the window. There are a lot more online games now where people's characters are coming through their avatars."

However, Molyneux believes that we're already most of the way there. "I think we've got all the bits of the puzzle that we need," he says. "To do great characters you need great animation, you need motion capture studios, you need fantastic voice actors, you need directors and stages. There's a whole team of people that you need to reach that fidelity bar. I have no doubt that because *Last of Us* was so successful, that there are lots of people focusing on more character-driven games than ever before. I'm incredibly excited about all that."

It remains to be seen whether *Half-Life 3* will give us a new character that again pushes our understanding of how games work, but Alyx's ground-breaking influence on the industry still lives on. It could be that the most effective character is one which comes out of nowhere, though. "I've played *Thomas Was Alone* and it's a cube for Christ's sake and I like those sorts of characters as well," says Molyneux. "It's just a fascinating thing." ■

Elite Squad

REBELLION'S HEAD OF ART CHRIS PAYTON TELLS US ABOUT CREATING CHARACTERS FOR BALLSACK SHOOTER *SNIPER ELITE 3*

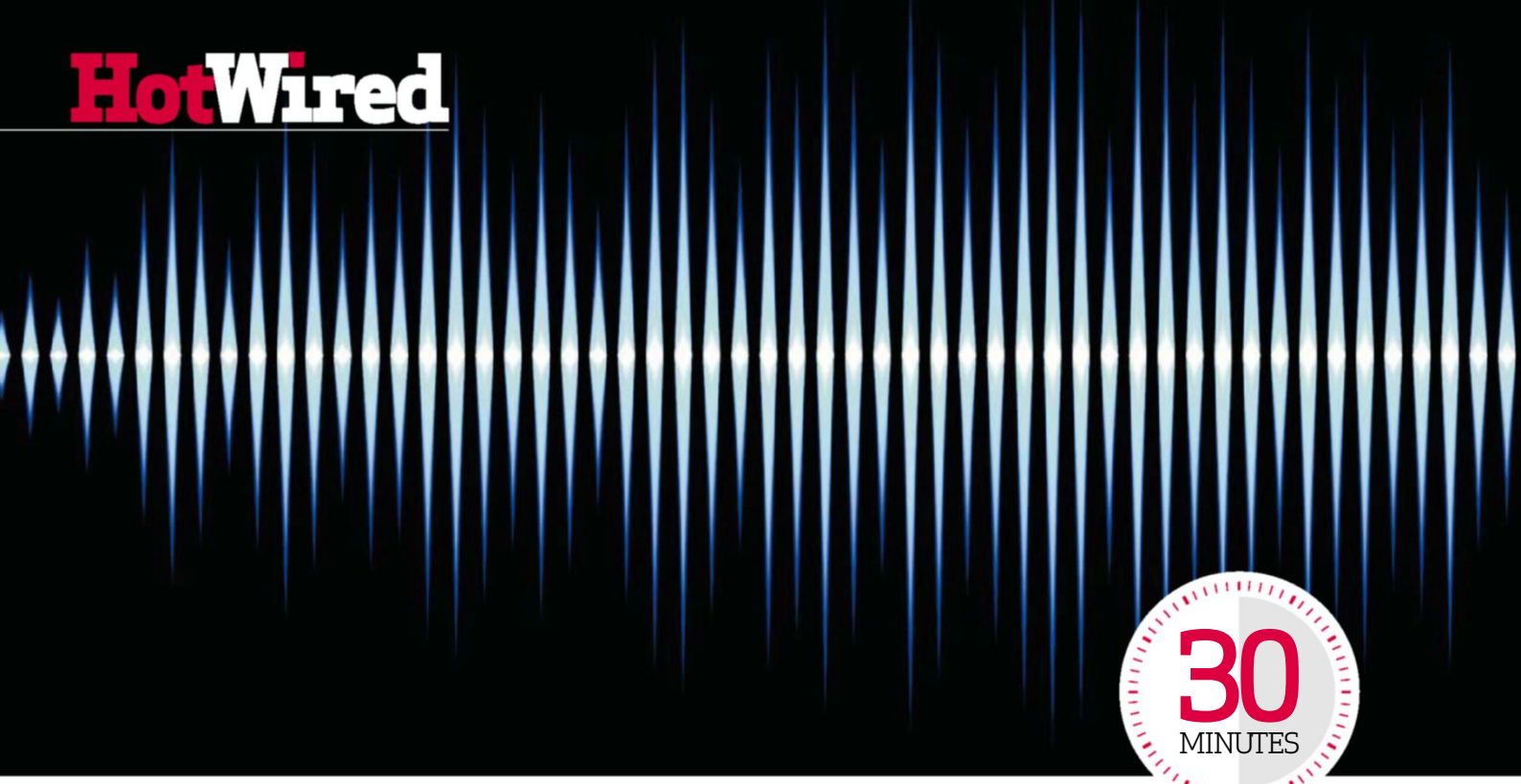
We want Chris Payton's job

PCF: Could you talk us through the process of creating a character?
Chris Payton: If it's a principal game character, then there's probably already some structure about them defined from the overarching game design. From there, we typically give our character artists and concept artists space to experiment with proposals which typically result in a mix of bespoke concept art and collages of reference images. These designs will be distilled into a final proposal which will be looked over by senior members of the art and design team to comment on. Typically, changes will be requested and we'll revisit the design before reaching a point where we're happy to put the character model in to production.

PCF: What are the most important elements of designing non-player characters?
Chris Payton: Keeping them distinct from one another is an absolute must, because a games design requires the characters to have different rank/type that the player needs to learn so they know at a glance how to deal with a situation. For *Sniper Elite 3* we spent a lot of time collating reference and reading up on uniforms that were used by that nation, in that theatre of war and also how this varies by rank.

PCF: How does designing a character for games differ to designing one for, say, films?
Chris Payton: One huge advantage is that we have complete creative control over the appearance and physique of our characters. We don't have to audition actors and see who turns up – if we want a six foot tall American with muscles we just create one.

PCF: Has this changed as computers have become more powerful?
Chris Payton: As computers become more powerful, then the calibre of our character needs to improve. This generally requires a greater investment of time and money – not just for the 3D model itself, but for a more complex animation rig, with motion captured data applied, rendered with special skin shaders, hair that blows in the wind. It probably takes three times as long to make a character in 2014 as it did in 2002.



30 MINUTES

Clean up audio

James Russell shows how to patch up less-than-awesome audio recordings

PROJECT GOAL

Improve sound quality

Whether you're working on audio or video, here we'll show you how to remove noise, buzzing and pops to boost what you've got.

REQUIRES

Reaper

This pro-level audio workstation by Cockos is cheap and comes with a generous evaluation period. Reaper can load third-party plug-ins as well as its own, and lets you edit audio non-destructively, changing parameters until you get a result that works. Commit changes permanently by exporting.

A lot of things can record audio these days – phones, cameras, laptops, video-making devices… and probably top-of-the-range microwaves, too. But unless you've got the latest dictaphone or microphone, the emphasis on a product's design is usually thrust upon its other features such as video quality and speed. These gadgets may be capable of providing crystal-clear HD image quality, processing multiple terabytes of information in a second and making top-notch toast, but the audio you get out of them may leave a lot to be desired.

A poor audio setup will always give you bad results, and there are plenty of things that can go wrong. Sinister hums and eerie clicks will give an amateur result, while user error during a recording can render a clip unintelligible. Then there's the environment – wind noise, sounds travelling through tables and bad-sounding rooms (there is such a thing!) can all put paid to a good result.

Get it right

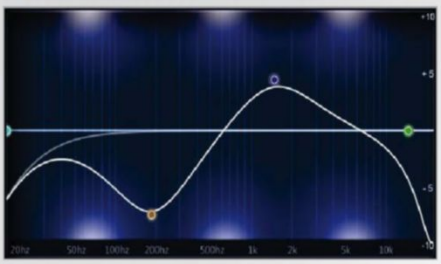
But there's often a digital solution for poor-quality off-the-cuff recordings, and the good news is that you will usually have more time to put into correcting audio files than you had to prepare for the recording itself in the first place. Yes, help is at hand from algorithms, as many have been designed for the tricky business of restoring decaying archive tapes and remastering classic records.

Wind noise is a common result of recording outside without great equipment, but you can get rid of a lot of it. Ironically, some

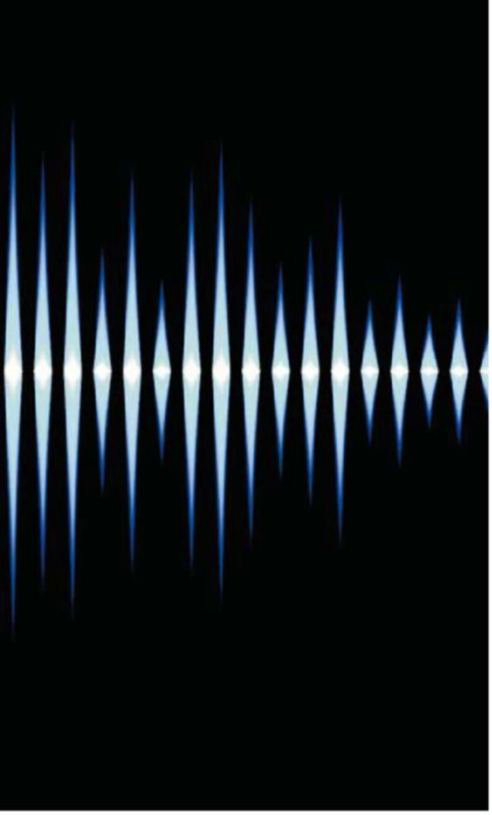
What are EQ and Filtering?

A lot of the fixes we'll apply use EQ or filtering. Using a volume control raises the level of a piece of audio, but filtering and EQ control the levels of individual frequencies. Higher or lower 'pitches' or 'notes' can be reduced and removed, while the rest of the audio signal stays in tact.

A lot of consumer gear offers a low-resolution equaliser (EQ), so you may have come across the concept on media player software, TVs or hi-fi systems. On those units, you can boost or reduce signals set at bass, treble or in between. The EQ that we'll use can be set entirely to your needs, cutting or 'notching' out very specific, thin bands of audio. Filtering is similar, but reduces all regions from high or low up until a specific point. If you lay the EQ or filtering on too thick, it's possible to degrade the signal – this will do more harm than good.



Reduce high and low audio with EQ



microphones are so small that they hardly suffer from wind noise at all. The best thing to reach for is a filter/equaliser. Just like sound, wind is movement of air – but wind is much slower, which means the frequencies of the soundwaves it produces are much lower in pitch than human speech, birdsong, and many other things that outside recordings aim to capture.

Wind problems

Annoying wind noise can be removed with a High Pass Filter, one of which is usually available on an EQ. For clarification, see the box below titled 'What are EQ and Filtering?' By applying a High Pass Filter, you can cut down on the lowest frequencies/pitches in your recording so that only the higher ones will pass. The point at which frequencies start to be let through is adjustable, as is the volume of the reduced frequencies. This technique for wind removal will also apply to other types of low rumbling that is transmitted through floors or solid objects. Opposite to High Pass filtering is Low Pass filtering. This works in reverse by only letting the lowest frequencies be heard. This can be useful for high-pitched buzzing and scraping – just apply the same techniques in the opposite direction. We can also reduce specific bands of frequencies.

Ever been listening to something in a room and heard a leftover ringing noise coming after a sound? This is caused by the dimensions of the room supporting the wavelengths (and therefore frequencies) of that sound. It is the same effect, fundamentally, as the feedback loop which is created by a microphone and speaker loop being placed in the same room. It's all removable, or at least reducible, using EQ again. The same treatment may be able to help with reducing hissiness or electrical noises as well.

TOP TIPS

ANALYSERS

Visualising the sound you're trying to sort out may give you a better indication of what to do. Reaper has got a few analysers to choose from, including the one in ReaEQ.

Jargon buster

Frequencies
These are certain 'pitches' in an audio signal and can range from low to high, just like musical notes or the human voice.

EQ
Equaliser – a processor that can reduce or boost certain frequencies if you tell it to.

Often, an imbalance in ground level between two pieces of electrical equipment can result in an annoying humming sound. This is basically caused by the two pieces of equipment using a different reference voltage for their signal, and that difference becoming audible – it's not 'interference'. Usually, the sound is a bit too strong to be completely removed, but it can be brought down to a less annoying state.

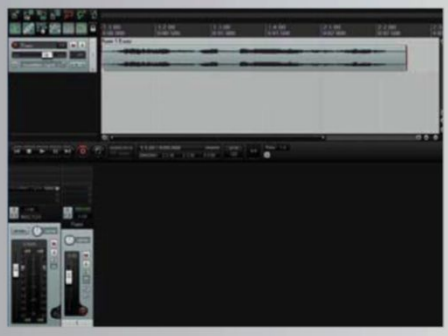
Nix the clicks

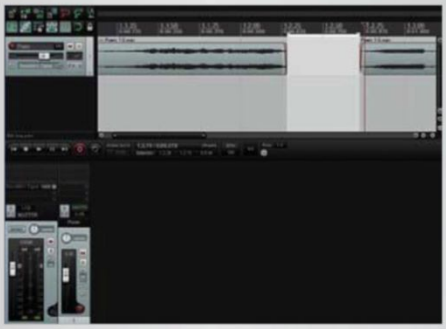
But what about clicks and pops? You may have to zoom in to see it happening, but the wave you see in an audio editor moves up and down around 0. This corresponds exactly to your speaker's movement forwards and backwards, and it should travel in a nice continuous wave. However, if there's a sudden vertical jump on that audio, the speaker will try to move instantly with it, and that's faster than it can shift. This is the reason behind many clicks and pops.

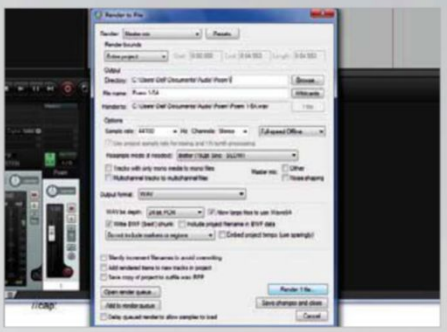
And finally: background noise. Removing this is the Holy Grail of audio editing. While there is not a 100 per cent perfect way to get rid of it, certain processes can make a very good go at it. You will need to demonstrate some of the noise signal in isolation first, in order to build up a profile of what to remove. You'll find out how to do this in the the tutorial on page 77.

Audio editing with Reaper

Sonic surgery requires the right tools and Reaper's got them all







1 Install Reaper

You can get an evaluation copy of Reaper from www.reaper.fm. Once you've downloaded and installed it, open it up and drag some audio from Explorer onto the timeline. A new channel will appear along the bottom row, next to the Master (output) channel. You can use the magnifier by the horizontal scroll bar to zoom as far as necessary into the audio file.

2 Edit audio

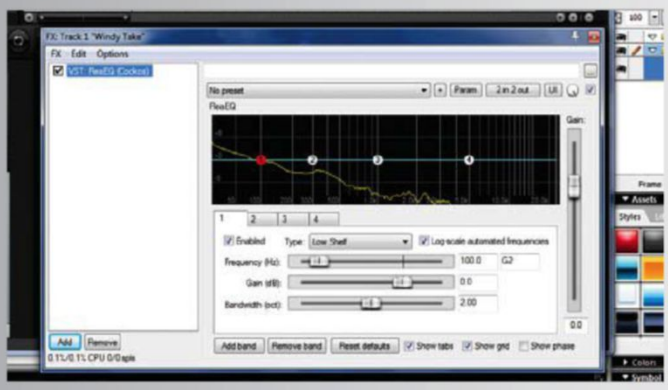
Use the magnet icon, or [Alt]+[S], to disable 'snap to grid'. This will allow you to select a custom area by clicking the timeline above the audio region. [Ctrl]+[Del] will chop an area out. You can loop your selected timeline region with the green button to the right of the play button. Click an audio channel's 'FX' button for a list of plug-ins to lay over the track.

3 Export the results

After any changes, the original audio file remains the same. To commit the changes made in Reaper, go to 'File > Render' or press [Ctrl]+[Alt]+[R] to bring up the Rendering options. You can render the whole lot or selected portions on the timeline. The default settings will be appropriate, so click on the 'Render 1 File' button to commit your changes to a new audio file.

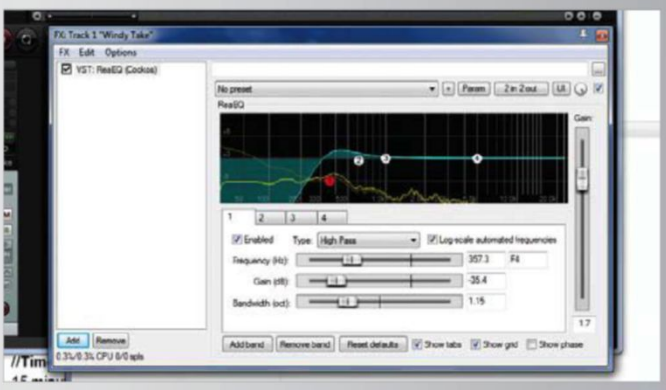
Solve common noise problems

Reduce wind, buzz and hum with EQ



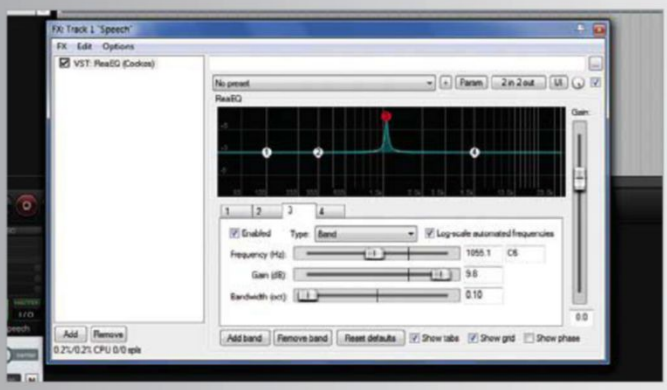
1 Block out wind noise

It's not unusual to be left with annoying wind noise after recording something in the open air. However, the chances are it can be blocked out. Import the audio into Reaper, click the track's FX channel, and then select 'ReaEQ'. When you can hear only the wind, its energy is towards the left of the graph.



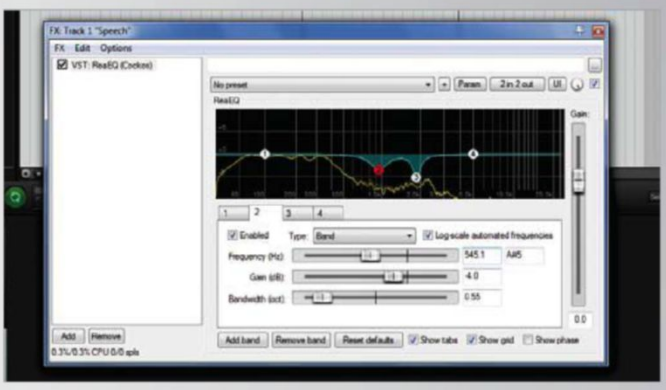
2 Use a filter

We can remove the left-side low-pitched audio using a Low Shelf or High Pass filter (band one in Reaper). Select 'High Pass', and drag node 1 down, and left and right. Moving node 1 to the right takes out more wind noise, but starts to remove some of the voice signal, especially with male voices. It's up to you to find the right balance.



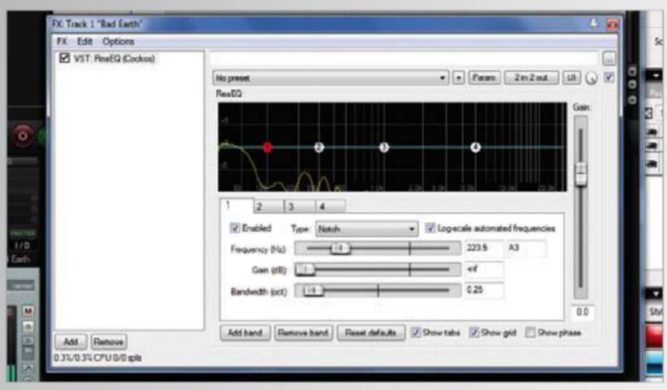
3 Reduce the ringing

Audio is only as good as the room it is recorded in. If your room is too resonant, it can sound as if a wine glass is left ringing after every word has been spoken. To sort this out, you need to throw your audio into Reaper, click 'FX' and select 'ReaEQ'. Drag node 3 as high as it can get, and reduce the Bandwidth to 0.10.



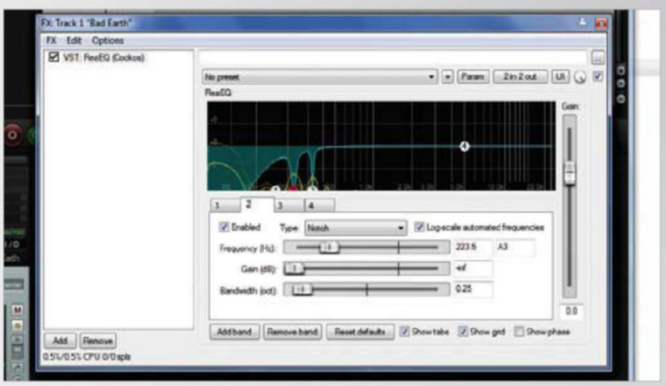
4 Improve the sound

Drag the node or tweak its Frequency slider while playing the ringy audio. This will emphasise certain frequencies. Search for the ringing sound; when you find it, crank the Gain down to below 0. Adjust the Gain and Bandwidth to reduce the ring and leave the desired audio intact. You may need to use multiband nodes and additional ReaEQs.



5 Reduce mains hum

Badly grounded equipment can introduce a 50Hz mains hum in your signal (60Hz in the USA). You can curtail it. Drag the audio into Reaper, click 'FX' and select 'ReaEQ'. This will bring up a customisable EQ and an analysis of the audio while it's playing. Try to isolate a part of the signal with the hum to make this easier.



6 Use an EQ

Pull down the numbered circles at the points where the hum is active. The blue dips should be placed to counteract the yellow bumps. You can change the 'thickness' of the cuts with the Bandwidth control – this can prevent the desired audio from being degraded. It's unlikely you will entirely remove the hum, but you can reduce it.

Common audio problems

Clicks, pops and background noise can be trimmed

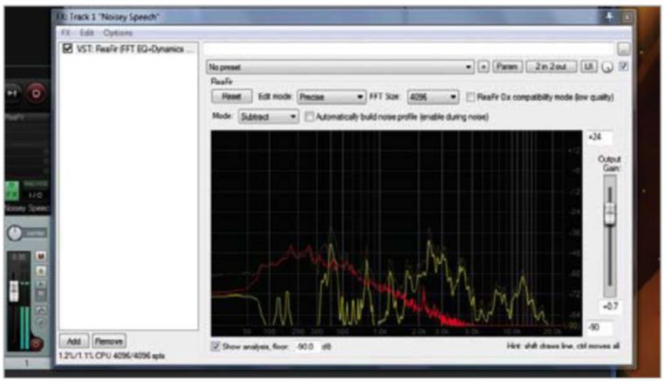
TOP TIPS
GET IT RIGHT FIRST TIME
A lot of audio mistakes can be patched over, but there's no substitute for the perfect take first time. Getting a great recording will save you ever having to read this article!

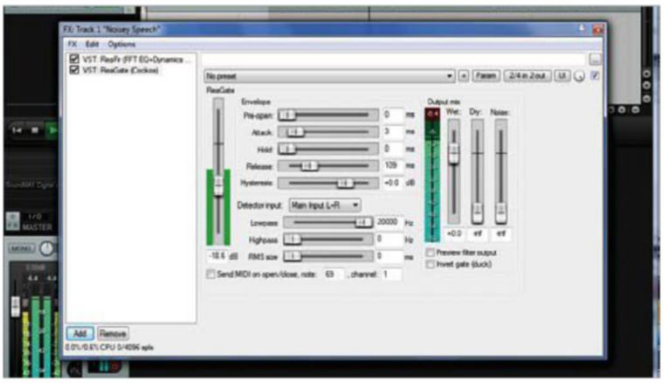
1 Get rid of clicks

This audio clip has been badly chopped into regions in another program and has then been exported as one file. Some chops have been made at inappropriate times, resulting in clicks when the audio is played. Zoom in as close as possible to the clicking point, and there should be a moment when the audio wave moves almost vertically.

2 Zoom and remove

Whenever Reaper makes a region, it creates a microscopic fade in/out, reducing the volume at the edges. The program used didn't do this. If we select the area around the vertical in Reaper and hit [Ctrl]+[Del], it'll be chopped out and will fade nicely between the waves on either side. You'll need to zoom in and find every click.





3 Reduce background noise

To reduce constant noise, import the audio into Reaper and click 'FX' in the channel below. Choose 'VST: ReaFir'. Change the Mode to 'Subtract', and tick the 'Automatically build noise profile' box. Play a part of your clip with only the noise audible – not any wanted parts – to build a profile. Untick the box, hit 'Play' and the noise should be reduced.

4 Use gating

Another way to reduce background noise is with a gate. Add ReaGate instead of – or as well as – ReaFir. Increase the level of the ReaGate to a maximum and play the audio. Nothing should be audible. Move the ReaGate down again while playing the audio until you reach a setting where the wanted material is audible, but the noise isn't.

Get the best, know your limits

There are plenty of ways to reduce, or even remove, common audio problems. But in doing so, consider the effect that the cleanup is having on the desired audio – sometimes it can be better to keep some of the unwanted sound if removing it completely would degrade the material. Human speech, for example, can easily lose its natural feeling and expression when it is messed around with too much.

There are certain things that just aren't possible to get rid of completely when editing audio. Background sound can be lessened, but the results depend on the type of noise. Constant noise that stays similar in level and content is easier to take away, but sounds with a more random character – crowd noise, for instance – can be irremovable.

There is no substitute for being properly prepared with the right equipment before recording anything in the first place, but that's all-too-often impractical or impossible. These techniques should be a last resort, but they'll also help you recognise what to avoid in future. To get the perfect take, spend time experimenting with the positions of both equipment and sound source by moving them closer together or further apart. Dampening a room by throwing in more absorbent materials can also help.


Getting the right results from the off is the best strategy

Once you have made your edits, save your project and let your ears take a break – returning to an audio processing task with a fresh perspective can help you really understand how your changes have improved things, and how they could have made them worse.

60 MINUTES

Create a music server

Turn your old computer into a music-oozing jukebox, says Linux guru Mayank Sharma

PROJECT GOAL

Get a music server
Transform an old computer – or even a Raspberry Pi – into a music system that you can control from any room in the house.

REQUIRES

Linux computer
Anything will do.

Mopidy
We love this music server.

Can you think of a more interesting use for an old, unused computer than streaming music to your hi-fi speakers? With a little bit of geekery, you can cobble together a music streaming server that can play locally stored tunes as well as music from online streaming services such as Spotify and Google Play. And you can control the contraption from another computer or even a smartphone connected to your local network.

At the heart of our setup is the Mopidy music server. Mopidy is capable of playing music from a variety of sources, so you can use it to stream music from online radio stations or services such as Spotify and SoundCloud just as easily as from the local hard disk.

The Mopidy server doesn't have a graphical frontend, and because we'll be controlling playback from a remote machine, you can simply install Mopidy on top of a bare bones Ubuntu Server installation to avoid putting any undue stress on the elderly machine.

Install Mopidy

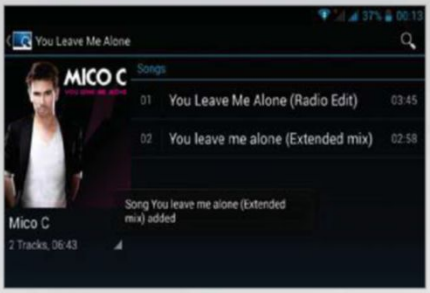
Start by assigning a fixed IP address to the computer that will

What is MPD?

The Mopidy music server implements its own version of the MPD server. But the original MPD server can do a lot more than what you can do with Mopidy.

MPD stands for the Music Player Daemon. It is a music player but, unlike typical desktop music players, MPD uses a client-server model. Separating the music player into two components has a couple of advantages. It means that MPD uses fewer system resources, but it also introduces interesting possibilities, such as remote playback and control, and the ability to use different interfaces.

MPD can also handle audio files in a variety of formats, including Ogg Vorbis, Flac, MP3 and other formats supported by the FFmpeg library. It can also play Ogg and MP3 HTTP streams, and read and cache metadata. It has native Zeroconf support and a built-in HTTP streaming server. This is why MPD is ideal for running on low-powered headless servers, while the client can run on any machine in the network. The Mopidy server's implementation of the MPD server inherits many of the features of the original MPD server. So, for example, you can control it remotely from any MPD client and search your music collection. However, there are several features that aren't available in Mopidy's MPD implementation. The biggest missing feature is that Mopidy cannot stream tunes from the music server to the client. This means that you can only use the MPD clients to control the Mopidy server. Also, while Mopidy's MPD doesn't currently let you modify stored playlists, this feature will be available in a forthcoming version.



MPDroid is an app that works with the Mopidy server

stream music. The most convenient way of doing this is from your router's admin page. For this tutorial, let's assume that the server address is 192.168.1.100. Log on to the server and enter the following: **wget -q -O - http://apt.mopidy.com/mopidy.gpg | sudo apt-key add**

This will then fetch the authentication key for the repository. When you've downloaded the keys, you can add the Mopidy package repository with the command: **sudo wget -q -O /etc/apt/sources.list.d/mopidy.list http://apt.mopidy.com/mopidy.list**

Once the repository has been added, you should refresh the package manager with the command **sudo apt-get update** before downloading the server with **sudo apt-get install mopidy**.

After the server is downloaded and installed, you can start it by simply entering **mopidy** on the command line. The music server creates a configuration file under your home directory: ~/.config/mopidy/mopidy.conf.

You need to edit this configuration file to adapt Mopidy to your setup. Before you make any changes to the file, make sure that the Mopidy server isn't running. You can stop the Mopidy server by pressing the [Ctrl]+[C] key combination in the terminal.

Configure the server

Mopidy has a lot of config values you can tweak, and the default configuration file lists some of the most useful ones. Mopidy exposes its functionality through a bunch of extensions. The server ships with four core extensions that are enabled by default.

The 'Local' extension is used to play music from a locally connected drive. To point it to your drive, open up the configuration file in a text editor . Under the [Local] section, comment out the lines by removing the # in front of them. Also, remember to point the media_dir parameter to your music directory, such as **media_dir = /home/bodhi/Music**. Now, save the file and ask Mopidy to scan all of the tracks under the directory you've pointed to in the configuration file by typing in the **mopidy local scan** command. Issue this command whenever you add new tracks to this directory, otherwise the Mopidy server will be unable to play them.

You also need to enable some other extensions to be able to control your music server from remote computers and devices. Mopidy uses its own implementation of the popular MPD server – thanks to this, you are able to control Mopidy with any MPD client.

To enable the MPD clients to connect to Mopidy, uncomment the lines in the [mpd] section. The hostname variable should point to the IP address from which the server will accept connections. Because we want our music server to allow connections from any device that is on our local network, replace any address with two colons, so hostname will become ::. You should also enable the HTTP extension, which allows you to control Mopidy from any web browser. Again, uncomment any lines in the [HTTP] section and make sure that the hostname listens to all addresses from your local network. You can use the **static_dir** variable to point to the location of a web-based client, as explained in the walkthrough over the page.

That's it. Now just start the server with the **mopidy** command. When you enter the IP address of the server in a web browser on any computer on the network, you'll see the default web page of the Mopidy HTTP server.

TOP TIPS
LINUX NEWBIES

If you're not that confident with using Linux, have a look at online forums as there is a very helpful open source community who are always keen to assist.

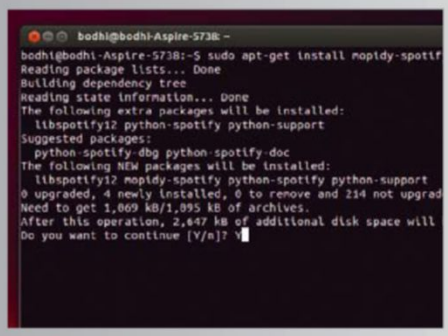
Pump up the volume

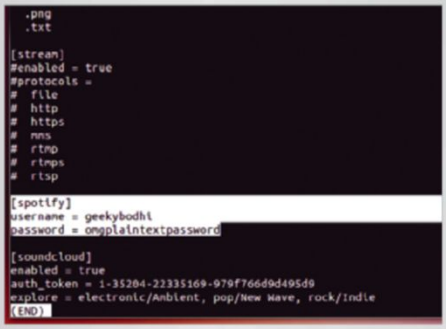
The server is now all set, but you'll have to flesh it out by installing other components and extensions to control it remotely and be able to play music from online sources. You'll need to install a web client on the server before you can access it from a remote machine. You'll also want to install a MPD client on a remote machine or on Android to control the music on the server.

Once it's all set up, your music server will be all ready to pump out music from the local disk or stream tracks from Spotify, and you will be able to control it with your smartphone from any room in the house. Neat!

Stream from Spotify

Hook up your media server with the music streaming service





1 Install

If you have added the Mopidy repositories, you can install the Spotify extension by typing in the **sudo apt-get mopidy-spotify** command. But ensure you have a Premium account with Spotify – the extension doesn't work with free accounts.

2 Configure Mopidy

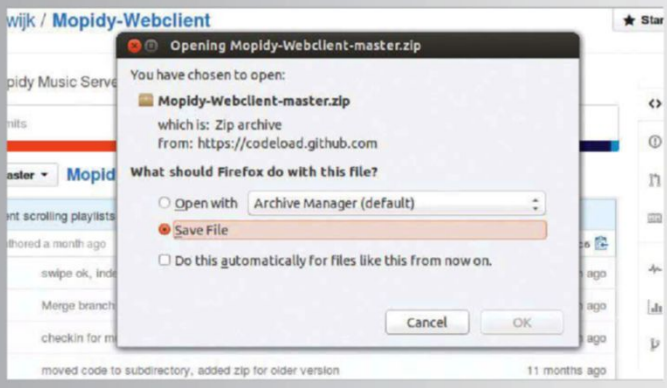
If you have a Facebook Spotify account, get a device password from www.spotify.com/account/set-device-password. Stop the Mopidy server if it's running and open the Mopidy configuration in a text editor. Create a [spotify] section and enter your Spotify login.

3 Stream!

Start the server. To stream music from the Spotify server, connect to your Mopidy server with a client such as the MPDroid Android app. To use a browser, install the Mopify client (http://github.com/dirkgroenen/Mopify).

Add clients

Control your music server from the web, desktop and smartphone

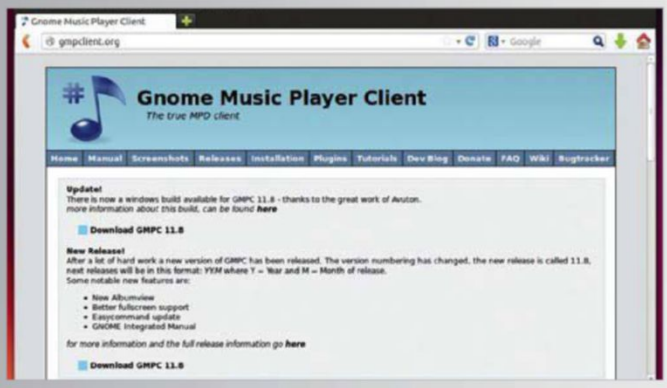


1 Get web client

With a Mopidy web client, you can control the server from any web browser on the network. There are several, but we prefer the mopidy-webclient from http://github.com/woutervanwijk/Mopidy-Webclient. After downloading it, extract it and move the webclient/ directory from the extract contents to the /opt directory.

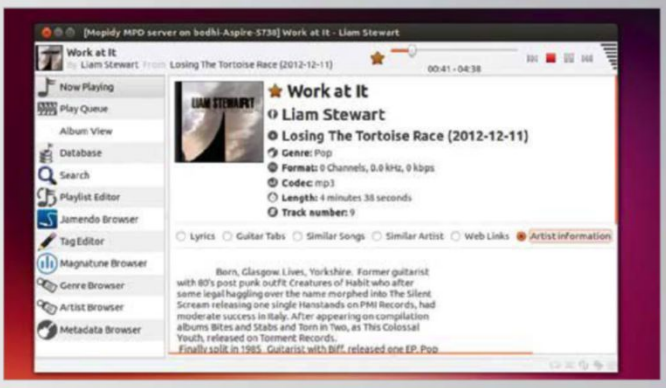
2 Control from browser

Open the Mopidy configuration file, scroll to the [http] section, and point the static_dir parameter to the webclient directory under /opt. Start the Mopidy server and enter its IP address on any web browser on your network. Instead of the default Mopidy web server page, you get the Mopidy web client interface to control playback.



3 Get desktop client

There are several desktop clients to control Mopidy from the desktop. We like the Gnome Music Player Client (GMPC). It's available on Windows and Mac OS X, too. To install GMPC, install its repository by typing in **sudo add-apt-repository ppa:gmpc-trunk/gmpc-stable** then refresh the package manager with **sudo apt-get update**.

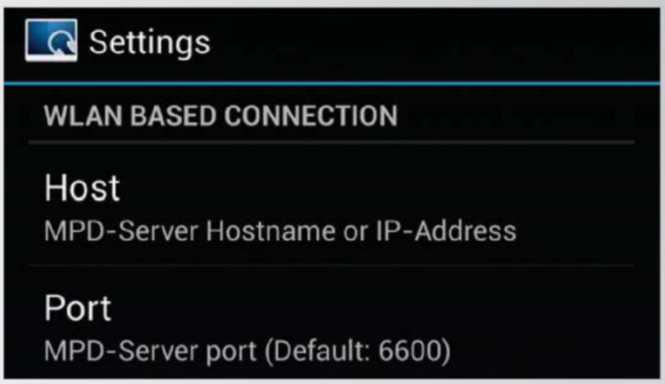


4 Control from desktop

Install GMPC and its plug-ins with **sudo apt-get install gmpc gmpc-plugins**. When you first launch the app, it starts a wizard to connect to Mopidy. Thanks to Zeroconf, your server is detected automatically (make sure it's running before launching GMPC) – all you need to do is select it from the 'Profile' list and click 'Connect'.

5 Get Android client

To control the Mopidy server from an Android device, you need an MPD client. The Google Play Store lists a bunch of MPD clients, but we like MPDroid. The app is available for free and has user interfaces for phones and tablets. Using MPDroid, you can search your music collection and sort it by artist, album, genre and so on.

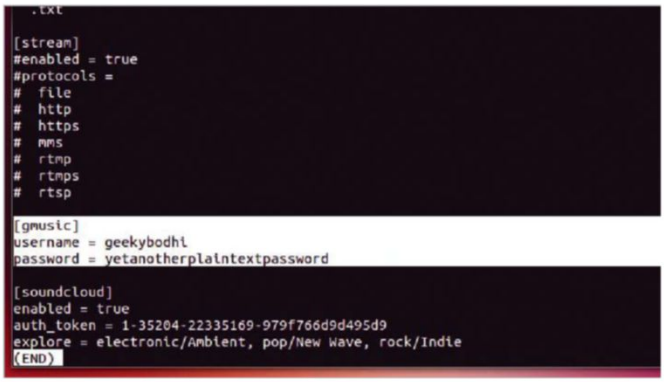


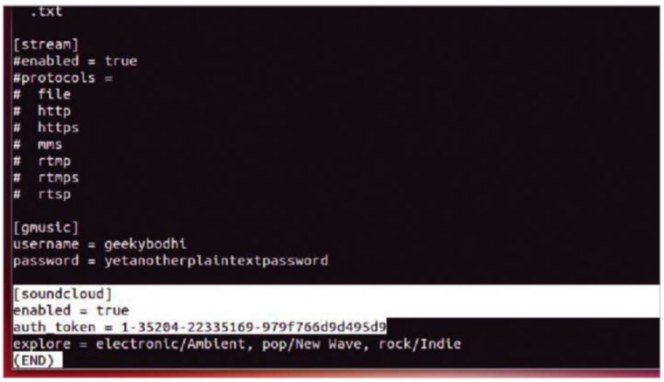
6 Control from mobile

When you launch the app for the first time, you're asked to set it up. First select a preferred WLAN connection and your wireless network. Then tap on the 'Host' parameter and enter the IP address of the Mopidy server. Now head back to the main screen from where you can browse and control the music on your remote music server.

Must-have Mopidy extensions

Make your music server do more!



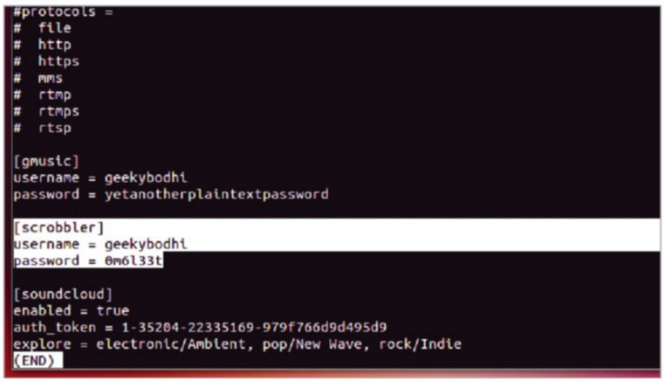


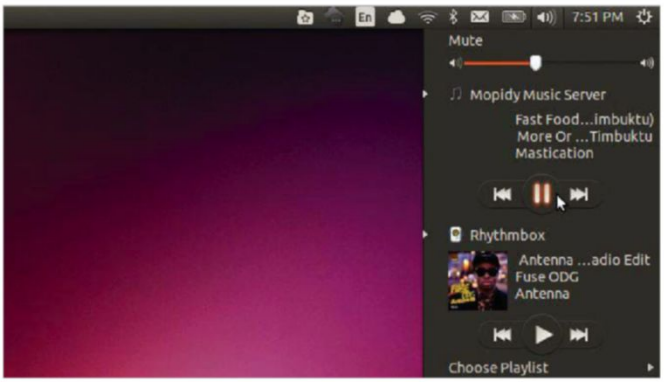
1 Google Play Music

Mopidy can stream music from Google Play Music. Install the Pip Python package management system with **sudo apt-get install python-pip** then use it to install the extension with **sudo pip install mopidy-gmusic**. Stop the Mopidy server, and edit its configuration file by adding a [gmusic] section with your Google Play login.

2 SoundCloud

Mopidy can fetch tracks from SoundCloud. Install the extension using the Pip package management system with **sudo pip install mopidy-soundcloud**. Then head to www.mopidy.com/authenticate and get a SoundCloud authentication token. Add it with the auth_token parameter to the [soundcloud] section in Mopidy's config file.





3 Last.fm scrobbler

You can use a scrobbling service to keep track of what you listen to. Mopidy can scrobble all played music to Last.fm. Download the extension by keying in **sudo pip install mopidy-scrobbler**. You need to register a free account with the service, then edit Mopidy's config file and add a [scrobbler] section with your Last.fm login.

4 Ubuntu integration

If you use Ubuntu, you can control the Mopidy server from Ubuntu's Sound menu. Just install the Mopidy extension for controlling the server through the MPRIS D-BUS interface with **sudo pip install mopidy-mpris**. Unlike other extensions, this one doesn't require any configuration changes to Mopidy.

Mopidy on a Raspberry Pi

You can easily use a Raspberry Pi as your music server. Mopidy runs on both hard-float and soft-float ARM architectures, and can be installed from within the Raspbian distribution.

Before you can install Mopidy onto your Pi, you need to load the IPv6 module into the kernel with **sudo modprobe ipv6, followed by echo ipv6 | sudo tee -a /etc/modules** which makes sure the module is loaded on subsequent boots. By default, Mopidy will output the audio from the HDMI port on the Pi. But if you've connected up some speakers to the AUX port, you must ask it to use the analogue out with **sudo amixer cset numid=3 1**.

Test the output with the command **aplay /usr/share/sounds/alsa/Front_Center.wav**. If you can hear sound from the speakers, add the **amixer cset numid=3 1** command to the /etc/rc.local file to make the change permanent. Your Pi is now set. Follow the tutorial to install the Mopidy server. ■

If you don't want to manually set up Mopidy, you can get the Pi MusicBox distro for the Raspberry Pi

Build your own platform game

2 HOURS

Mayank Sharma helps you make your own fun with *Minecraft* and a Raspberry Pi

PROJECT GOAL

A platformer

If you've always fancied trying your hand at game development but never had the time, this is the perfect solution. Everything is made in *Minecraft* using Python.

REQUIRES

Raspberry Pi

If you don't have one of the tiny PCs, visit www.raspberrypi.org/buy for a list of stockists.

***Minecraft* has steadily taken over the world since its release in 2009, and has become a runaway success across many different platforms, including the PC, Xbox 360 and PS3.**

If you've never played *Minecraft* before, the basic premise is to mine various materials with which you can build objects in the game world. Mining is quite easy but it's essential to survive, and you can mine wood, stone, coal and metals. From these mined materials you can make houses, bridges, weapons, tools and even furniture for your home. But the *Minecraft* world isn't that simple, because the game uses a day and night cycle, just like real life, albeit greatly speeded up. During the day, you are quite safe, with glorious sunshine and lush green fields. But at night, the monsters come out to get you, so you need to build a shelter during the day to protect you from the nasties that appear after dark.

There is another side to *Minecraft* though, and this is what we're going to be focusing on in this tutorial. *Minecraft* also has a creative mode, where you are free to build whatever you want, with no

Create your own Minecraft server

Here's how to share your world with friends around the globe. This method relies on either a static IP address for your home network, or the use of a dynamic DNS service. However, if you wish to share the world with your friends on the same network, this isn't necessary. Instead, you can just give your mates the IP address of your Raspberry Pi, which you can find out by running **ifconfig** in a terminal. If you are connected via Ethernet, look for eth0; if connected wirelessly, look for wlan0. Once you've found either of these, the IP address should be visible, and this is what your friends need to join your server.

The full guide can be found on Martin O'Hanlon's website (www.stuffaboutcode.com/2013/09/raspberry-pi-setup-minecraft-server.html), but here's a quick breakdown of the main points. Overclock your Pi to Medium. Change the memory split to 16MB. Reboot your Raspberry Pi. Download and install Java, followed by the *Minecraft* server. Run the *Minecraft* server using a bash script called start.sh. In a terminal, type **nano start.sh**. In nano, type:

```
/opt/jdk1.8.0/bin/java -Xms256M -Xmx496M -jar /home/pi/spigot.jar nogui
```

Martin also goes into considerable detail about how to refine your setup to achieve the best possible results, so if the idea of running a *Minecraft* server featuring your own code is one that appeals to you, head over to his website, grab a coffee and read up on what to do.

Now that you've built your game, you can share it with your friends

monsters or night-time to threaten you. This is the version that has been made available for the Raspberry Pi. In this version of the game, you're free to build anything you want, just like with a large box of Lego. Of course, it could become tedious building everything brick by brick, but fear not, because help is at hand, and it's in the form of the Python programming language.

Python?

Python is a really cool language, and it comes preloaded with every Raspberry Pi. With Python we can build houses, bridges, cities and even space shuttles in *Minecraft*. Learning Python isn't difficult, and once you get to grips with the syntax (how the language is used), you'll be writing code and building your very own platform game. Here we'll use programming concepts such as loops, which repeat an action many times, and we can even create an infinite loop that will continue for ever. The team behind *Minecraft* has produced a fantastic set of tools that enable us to use Python to create wonderful content in our game world.

During this tutorial, we'll build a platformer, similar to the *Mario* games, and we will use a timer to make it a challenge to get the end of the course. All of the content will be created using Python, and during the course of the tutorial you will come to use and learn the basic concepts of coding and make a really good platform game.

Minecraft is a three-dimensional game and, as such, objects in the game world have an *x y z* position to identify their location. The world is full of cubes or blocks, all with a relative size of 1m x 1m x 1m, and every block has a position in the world of *xyz*, with *x* and *z* being the horizontal positions and *y* being the vertical.

TOP TIPS

CHOOSE YOUR PI

The Raspberry Pi is now available in two versions– the original model A and the newer model B. The latter costs a little more, but is a more powerful device.

Basic programming concepts

In Python, we have a plethora of ways to solve any problem, and typically each coder tackles a problem in their own way. What remains the same for every coder are the fundamental building blocks of programming logic. Let's take a look at a few of these now and discover how we can use them in our game.

Sequence

A sequence is the collective term that identifies the steps taken to complete a task. Our platform game is one big sequence; it has a start and an end, and in between these we have the steps necessary to build objects in our game.

Loops

As mentioned earlier, we can choose to loop certain parts of our code to repeat the same process over and over again. We can use an infinite loop, which in Python is known as a 'while True' loop, and here is an example that prints 'Hello' until we tell it to stop:

```
while True:
  print "Hello"
```

Or we could use a 'for' loop to repeat the loop a set number of times, which would be very handy to create a certain number of platforms or blocks for our game. Here is an example of a 'for' loop that prints the value of i each time the loop is run.

```
for i in range(1,6):
  print (i)
```

Variables

We love variables – they are the unsung heroes of code. We use them to store things, just like a big empty box. In our game, we can store our player's position, the number of platforms that we need, and anything that we would like to use again and again.

Events

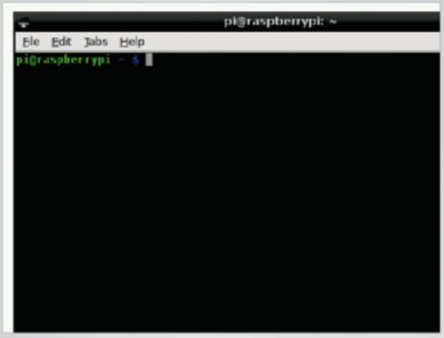
An event can be seen as akind of trigger that kick-starts a sequence of code. For example, in our game, we could use it to trigger a platform to disappear – sneaky!

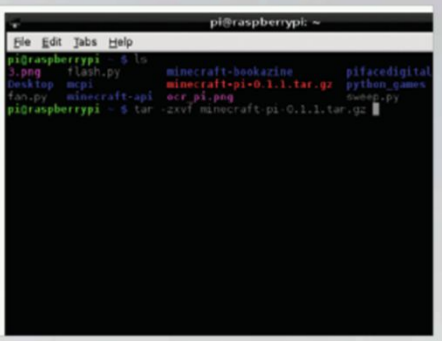
Operators

These are used to compare pieces of code and use a form of logic called Boolean (after George Boole, the mathematician who invented the concept). Boolean logic is True or False, otherwise known as 1 or 0. We can compare our player's *xyz* position against what is stored in a variable, and if the two match (True), then we can run some special code which, for example, throws the player up in the air.

Get started with Minecraft

Set up your Raspberry Pi with all the necessary tools





1 Download the archive

To get *Minecraft*, go to https://github.com/lesp/Minecraft_Bookazine/blob/master/minecraft-pi-0.1.1.tar.gz and download the archive to your Raspberry Pi. Make sure you remember where you saved it, because you will need to use it in the next step.

2 Open the terminal

Extract the archive contents to your Pi via the terminal. On the desktop, double-click on the LXTerminal icon, then navigate to the place where you downloaded the archive. To do this, use the **cd** command to change the directory – for example, **cd /home/pi/**.

3 Stream!

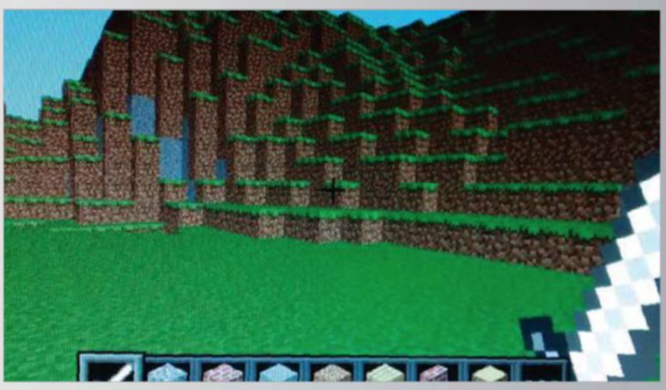
Use the terminal to extract the archive:

```
tar -zxvf minecraft-pi-0.1.1.tar.gz
```

Press [Enter] and you'll see lots of text whizz along the screen. This is the command's way of telling us that it is working. Once complete, the command returns you to a prompt.

Build a better place

Create your own custom *Minecraft* world

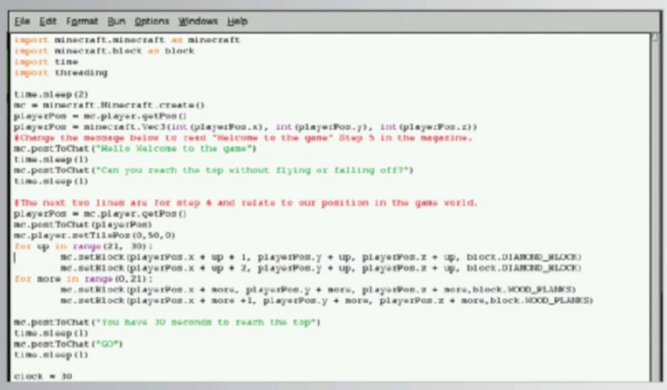


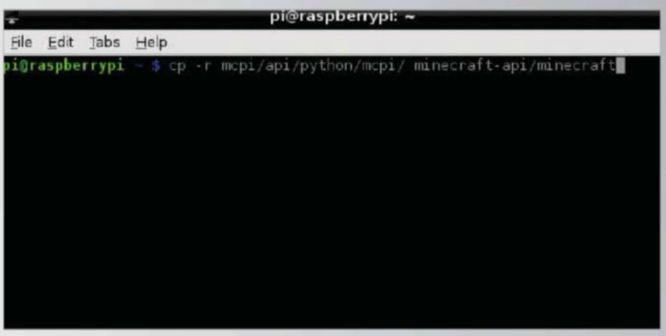
1 Run Minecraft

During the extraction of the archive, a new folder called mcpi was created (as you can probably guess, this is short for *Minecraft* Pi). We need to change our directory to mcpi, so use the **cd** command again. Once done, use a command called ls to list the contents of the directory. Look for minecraft-pi – this is the *Minecraft* application. Now you're ready to get stuck in and create your first world.

2 Play around

To launch *Minecraft*, enter the following command into a terminal: **./minecraft-pi**. Now take a moment to have a play with *Minecraft* and get used to how it works. Create a new world, and when it's ready, use the [W], [A], [S] and [D] keys to move around and explore. The mouse changes where you look, and the left mouse button destroys blocks, whereas the right one places a block.





3 Get the desktop client

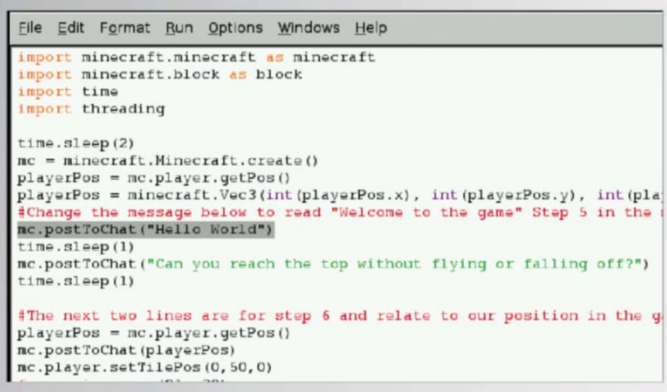
If you want to create objects when you're playing *Minecraft*, you must build them brick by brick. But if we use Python, we can make lots of things quickly. We need to use the minecraft-api.py file from https://github.com/lesp/Minecraft_Bookazine/blob/master/minecraft-api.py and an application called IDLE. A link to IDLE can be found via the icon on the desktop.

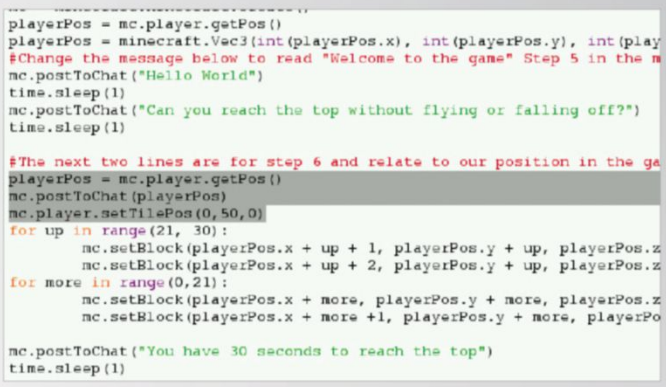
4 Control from your desktop

Once that's done, you need to make a directory called minecraft-api in your home directory and copy the entire contents of /home/pi/mcpi/api/python/mcpi (including any folders) to minecraft-api. The easiest way is to use LXTerminal and type:

```
cp -r ~/mcpi/api/python/mcpi ~/minecraft-api/minecraft
```

The **cp** command means to copy the files and the **-r** switch instructs the copy to include any subdirectories. Also copy the downloaded tutorial file into this directory, ready for the next step.





5 Add a welcome message

Open the minecraft-api.py file in the IDLE editor and take a look at the code. First, let's change the code that says mc.postToChat ("Hello World") to say "Welcome to the game". Save your work, start a new *Minecraft* session using any world, then in IDLE click on 'run', which is in the Run menu. You should see your text on the screen.

6 Drop in your player

Our player has a position, controlled via *xyz* coordinates. We can check where our player is by using mc.player.getPos() and saving the output to a variable called playerPos, ready for use later. Another idea is to use **mc.player.SetTilePos(x,y,z)** to drop your player into the game. We changed *y* to 50, and the player drops into the world.

Raise the bar

It can't be a platform game without any platforms…

```
time.sleep(1)

#The next two lines are for step 6 and relate to our position in the game world.
playerPos = mc.player.getPos()
mc.postToChat(playerPos)
mc.player.setTilePos(0, 50, 0)
for more in range(0,21):
        mc.setBlock(playerPos.x + more, playerPos.y + more, playerPos.z + more,block.
        mc.setBlock(playerPos.x + more +1, playerPos.y + more, playerPos.z + more,blo
for up in range(21, 30):
        mc.setBlock(playerPos.x + up + 1, playerPos.y + up, playerPos.z + up, block.D
        mc.setBlock(playerPos.x + up + 2, playerPos.y + up, playerPos.z + up, block.D


mc.postToChat("You have 30 seconds to reach the top")
time.sleep(1)
mc.postToChat("GO")
time.sleep(1)

clock = 30
while clock > 0:
        mc.postToChat(clock)
```

1 Build the platforms

Now we'll build our platforms. To make things easier, we'll use a 'for' loop, which loops round a set number of times.

```
for more in range(0,21):
```

In this case, it loops round 20 times and repeats this code:

```
mc.setBlock(playerPos.x + more, playerPos.y + more, playerPos.z + more,
block.WOOD_PLANKS)
```

This code uses the player's position as a starting point, then builds blocks of wood, one block ahead, above and to the side each loop, creating a sweeping staircase.

```
        mc.setBlock(playerPos.x + more +1, playerPos.y + more
for up in range(21, 30):
        mc.setBlock(playerPos.x + up + 1, playerPos.y + up, p
        mc.setBlock(playerPos.x + up + 2, playerPos.y + up, p


mc.postToChat("You have 30 seconds to reach the top")
time.sleep(1)
mc.postToChat("GO")
time.sleep(1)

clock = 30
while clock > 0:
        mc.postToChat(clock)
        time.sleep(1)
        clock = clock - 1

mc.postToChat("Time's up!")
```

3 Make a clock

We want our game to be challenging, so let's introduce a countdown clock. To set the clock, we created a variable called clock and gave it the value of 30; this is an integer value. We then created a **while** loop that has the condition of:

```
while clock > 0:
```

This compares the value of clock, and if that value is greater than 0, it runs a piece of code.

```
block.py
File  Edit  Search  Options  Help

AIR                 = Block(0)
STONE               = Block(1)
GRASS               = Block(2)
DIRT                = Block(3)
COBBLESTONE         = Block(4)
WOOD_PLANKS         = Block(5)
SAPLING             = Block(6)
BEDROCK             = Block(7)
WATER_FLOWING       = Block(8)
WATER               = WATER_FLOWING
WATER_STATIONARY    = Block(9)
LAVA_FLOWING        = Block(10)
LAVA                = LAVA_FLOWING
LAVA_STATIONARY     = Block(11)
SAND                = Block(12)
GRAVEL              = Block(13)
GOLD_ORE            = Block(14)
IRON_ORE            = Block(15)
```

2 Choose your material

After the blocks of wood have been built, we want to use a different type of block. Here we've opted for diamond, but there are lots of others to choose from. Open a terminal and go to /home/pi/minecraft-api/minecraft, where you will find block.py. Open this in a text editor and you see all the blocks you can use. Why not change block.DIAMOND_BLOCK to deadly LAVA?

```
mc.postToChat("You have 30 seconds to reach the top")
time.sleep(1)
mc.postToChat("GO")
time.sleep(1)

clock = 30
while clock > 0:
        mc.postToChat(clock)
        time.sleep(1)
        clock = clock - 1

mc.postToChat("Time's up!")
```

4 Ubuntu integration

The piece of code that it runs is only three lines long, but it repeats until clock is equal to 0:

```
mc.posttoChat(clock)
time.sleep(1)
clock = clock – 1
```

Firstly, it posts the contents of the variable clock on the screen, then waits for one second. If we didn't do this, the countdown would be really fast. Lastly, we change the value of our variable clock by instructing it to take the current value of the variable and then subtract 1 from it.

Further reading

There are lots of great *Minecraft* resources to take your game to the next level. Here are a couple that we particularly recommend.

www.stuffaboutcode.com
Martin O'Hanlon is a great advocate of learning through play, and has created a series of guides and blog posts that take you by the hand and show you how to do some cool things. Martin has recreated the Manhattan skyline, for instance, and and has used Ordnance Survey data to create *Minecraft* worlds that are based on genuine locations.

http://arghbox.wordpress.com
Craig Richardson has produced a fabulous set of resources that teach Python coding via CodeAcademy's set lessons, but his slant is to reinforce these lessons with the same concept created in *Minecraft*. His book is available to download as a free PDF and comes in two versions: one for students learning in class; and one for teachers, elaborating on the concepts and code ■

Stream your games with Raptr

If you own an AMD graphics card, showing off your gaming skills is easy, says Alan Dexter

PROJECT GOAL

Stream to Twitch

Use Raptr to stream any game you're playing straight to Twitch with the minimum of fuss.

REQUIRES

AMD graphics card

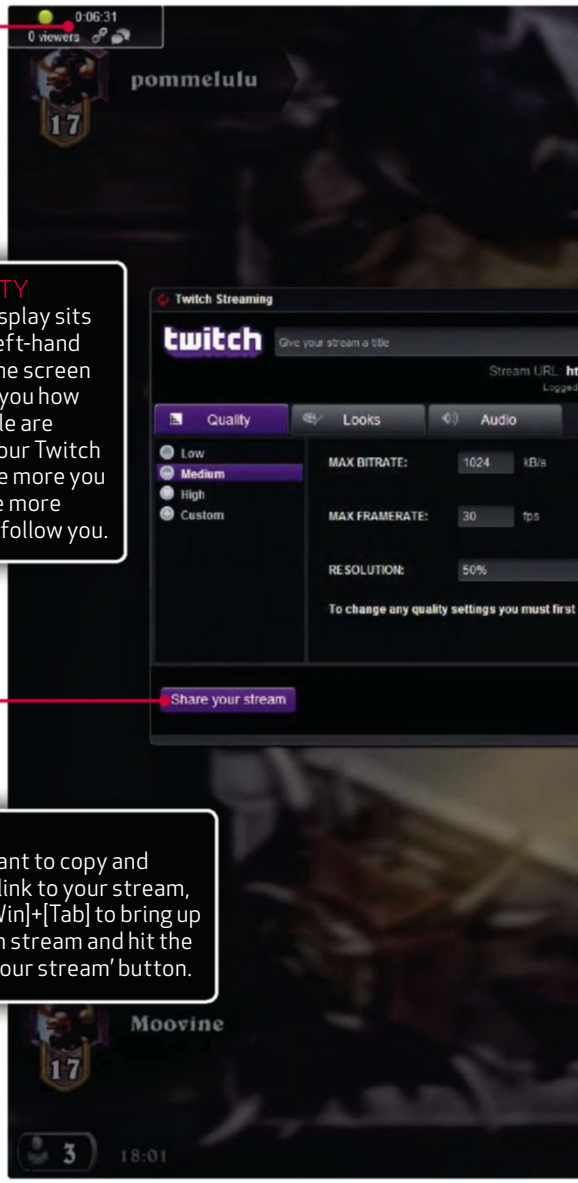
The version of Raptr that ships with AMD's drivers has everything you need to stream.

15 MINUTES

At the time of writing, rumours are circulating that Google is looking to bolster YouTube with the game-streaming site Twitch.TV. The deal is apparently worth a cool $1bn, which not only shows how much money Google has to throw around right now, but also highlights how important game-streaming has become.

It certainly isn't small fry any more – something aptly demonstrated by the fact that PewDiePie is YouTube's biggest success in the last 12 months. In case you didn't know, PewDiePie's channel is all about gaming, and he makes a decent wage out of it.

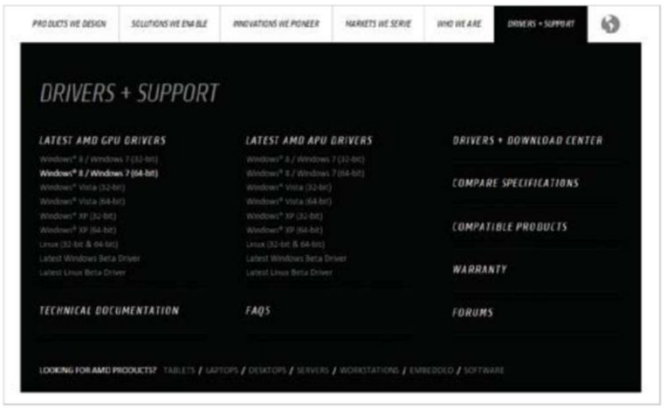
Getting in on this action yourself is traditionally quite tricky, with the likes of XSplit and OBS taking a serious amount of fiddling to get up and running exactly as you want. There's another option now though, and that's to use the version of Raptr that ships with AMD's graphics drivers. Here's how to get a piece of the streaming action.



POPULARITY
This tiny display sits in the top left-hand corner of the screen and shows you how many people are watching your Twitch stream. The more you stream, the more people will follow you.

SHARE
If you want to copy and paste a link to your stream, press [Win]+[Tab] to bring up the main stream and hit the 'Share your stream' button.

Step-by-step: Stream to Twitch

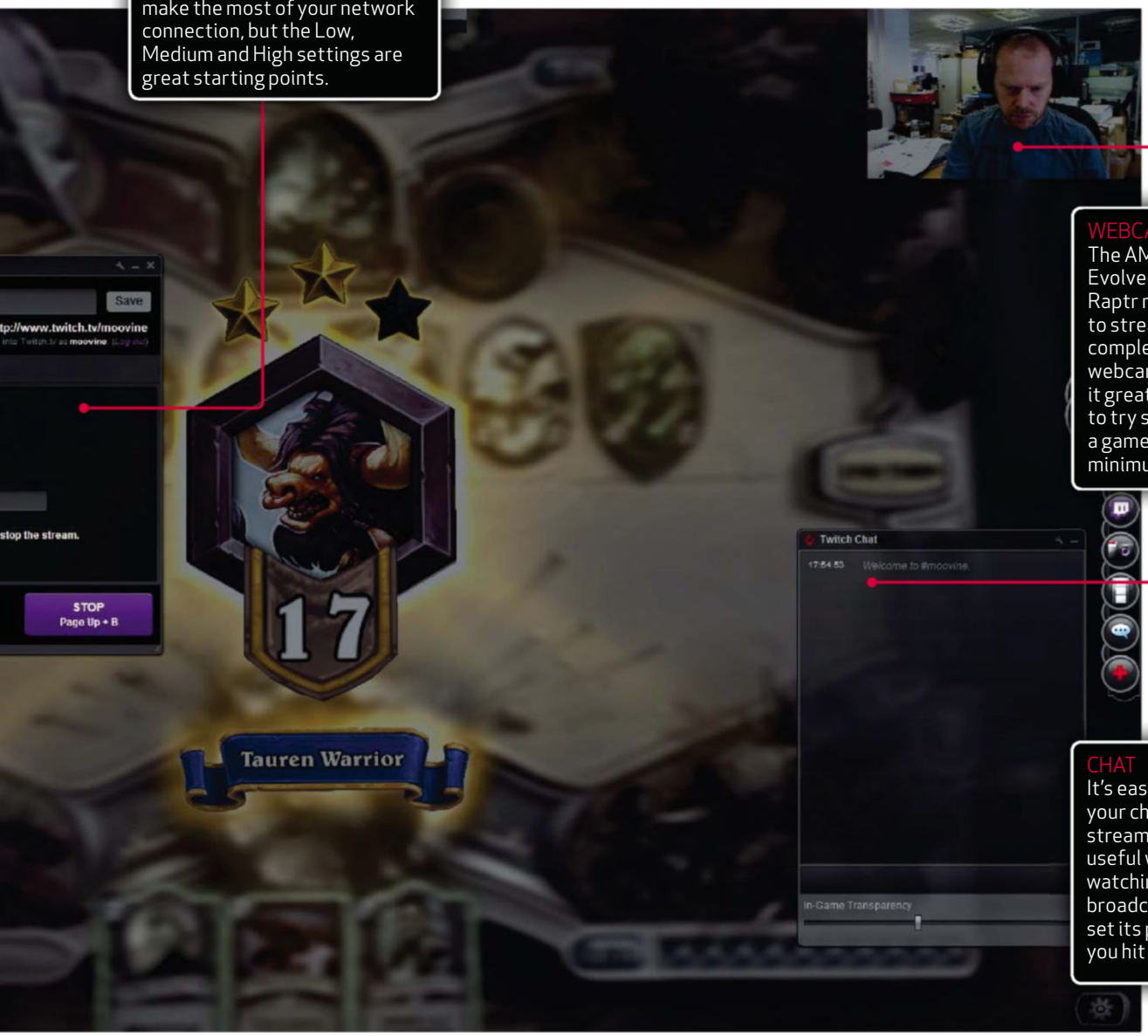


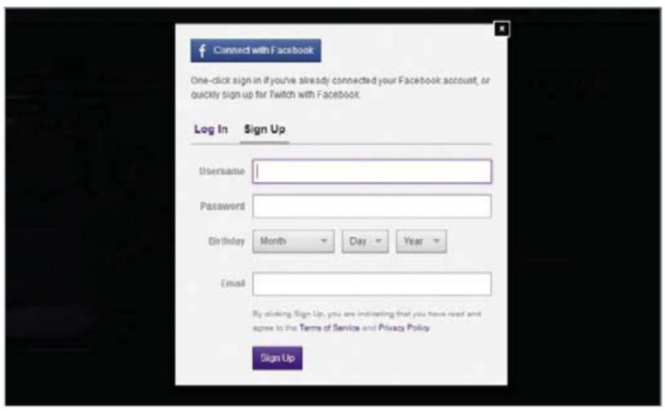
1 Grab a Raptr

"Keep your graphics card drivers up to date" is a standard mantra for us here on *PC Format*, and should be for any gamer, but it always amazes us how many readers don't pay heed. AMD has started packaging a version of Raptr with its drivers, and among other things, it highlights when there is a new driver release, so it's worth grabbing for that reason alone. Get the latest versions from www.amd.com.

2 Optimise your games

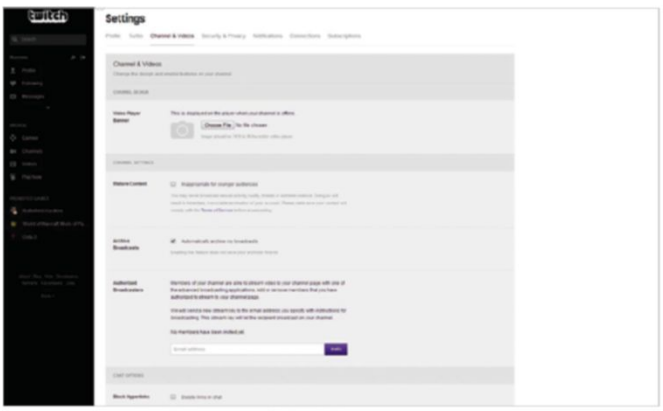
One of the main reasons why AMD has bundled Raptr with its drivers is to give you a simple way to optimise your games so that they run smoothly and still look good (something that Nvidia offered first with its GeForce Experience). Streaming can be something of a resource hog, so start by optimising the game you intend to play. Pick the performance preference for your game and then hit 'Optimise'.





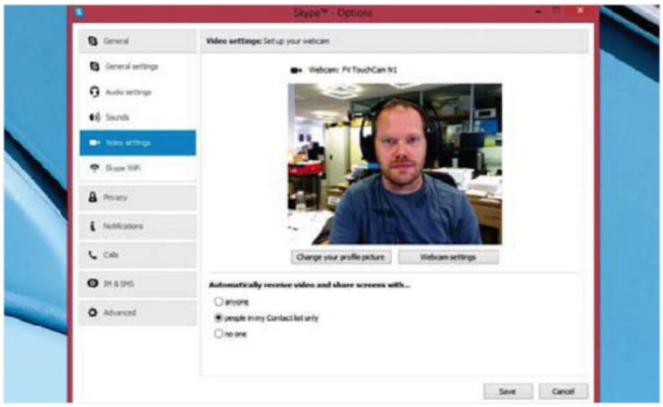
3 Get your Twitch on

In order to stream your gaming prowess, you're going to need a Twitch account. Thankfully it will cost you absolutely nothing to sign up to Twitch, so there's no reason not to. Head over to www.twitch.tv and hit 'Sign up' in the top right-hand corner. You can sign in with your Facebook account if you want. Alternatively, pick a username and password, then enter your date of birth and your email address.



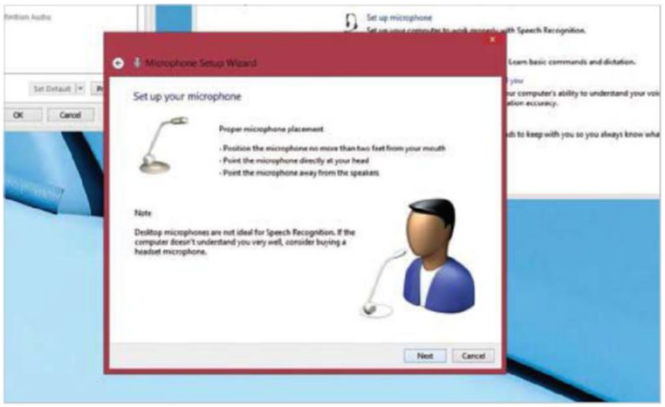
4 Record for prosperity

Twitch can automatically archive your broadcasts so that they can be watched later. Not only is this good for letting people view your streams at a more suitable time for them, it enables you to check that your stream is working as you intended. In order to turn archives on, you need to pop into your settings screen, select 'Channel & videos', then check the box titled 'Archive Broadcasts'.



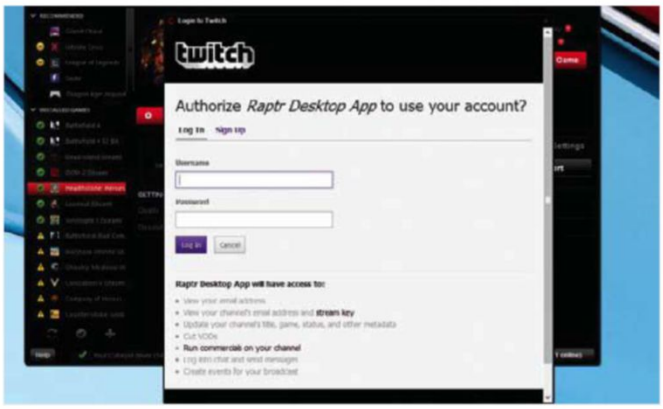
5 Configure your webcam

The basic interface for Raptr's Twitch streaming lets you define which corner of the screen your webcam video should appear in, but that's it. This is why you need to configure your webcam separately first – ideally using the software that came with it, or failing that, a generic tool (such as Skype), to ensure that the white levels are right and that you can, you know, see yourself properly.



6 Get your sound right

Just as you have to get your webcam settings right before you start streaming, it's important to get your microphone to decent levels as well. Open the Control Panel and select 'Sound'. Click on the 'Recording' tab, highlight your microphone and hit the 'Configure' button. Run the 'Set up microphone' wizard to get it up and running. If you want to double-check, use the test call in Skype.

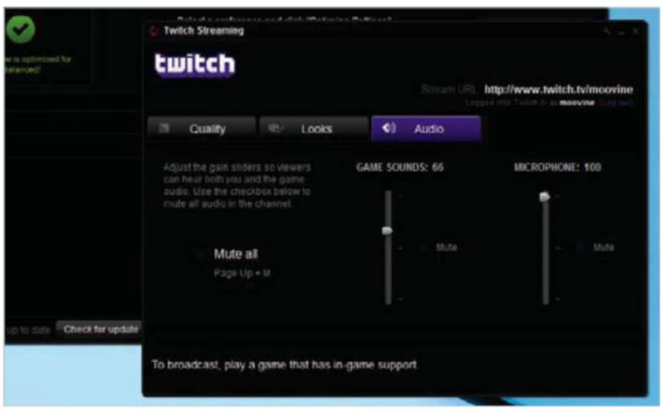


7 Twitch up your Raptr

Open the main AMD Gaming Evolved Control Centre screen and you'll notice a tiny Twitch icon in the bottom right corner of the screen, to the left of the 'Friends online' button. Click on this icon to enter your Twitch login details – just click the 'Log in to Twitch' button at the top of this window and enter the username and password you created in step 3 of this walkthrough.

8 Configure Twitch

Once you're signed in, you should click on that little Twitch icon again. Here you can configure the streaming quality of your game. The quality of your stream is defined by the power of your PC and the upload bandwidth of your internet connection. Getting the quality settings right takes some trial and error, but we recommend trying the Medium quality setting and seeing what the output is like.



9 Webcam and chat

Click the 'Looks' tab to overlay the Twitch chat over your stream. This is also where you'll find the webcam overlay options. Check the tickbox next to 'Enable webcam' and set where you webcam image should go. Different locations work best for different games, but top right is most common. The 'Audio' tab is where you'll find options for balancing the game sound against your microphone levels.

10 Start streaming

You're now ready to start streaming. Launch the game of your choice and once it's up and running press [Ctrl]+[Tab] to bring up the Gaming Evolved screen. You can hit the button to start streaming or use [Page Up]+[B] to start streaming as well. Stream for a minute or so to make sure it's working, then watch the replay to make sure your sound levels are right and the quality settings are smooth. ■

15 MINUTES

Make your screenshots look awesome

Use the ever-powerful GIMP to take screenshots to the next level, says Alan Dexter

PROJECT GOAL

Great screenshots
Use GIMP to make your screenshots pop.

REQUIRES

GIMP
The free, yet powerful, GNU Image Manipulation Program.

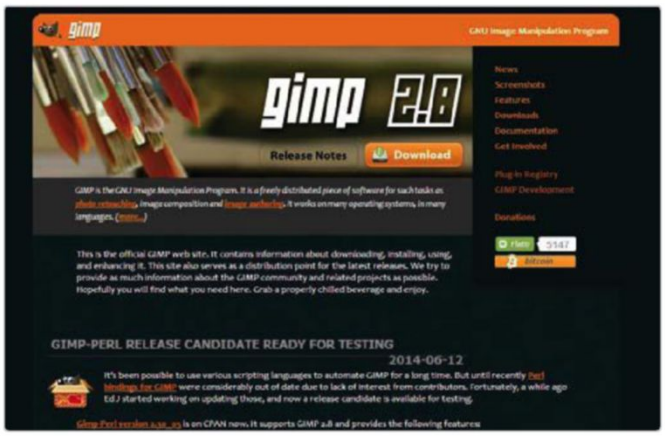
We've all excitedly grabbed a screenshot of that cool moment in a computer game, only to look at it afterwards to discover that the colours are all washed out, it's off-centre and generally looks pretty rubbish.

This means that the screenshot either languishes forever on your computer, never to be seen by the outside world, or you post it up and it's ignored by all and sundry because it just doesn't look particularly exciting.

That's where this tutorial comes in. Over these two pages we're going to show you the techniques you need to turn any screenshot (within reason) into something you can be proud of, that you'll be able to blog about and post onto Steam community pages – or just enjoy at home.

Step-by-step: Step-by-step: Improve shots

Make your gaming snapshots something worth shouting about

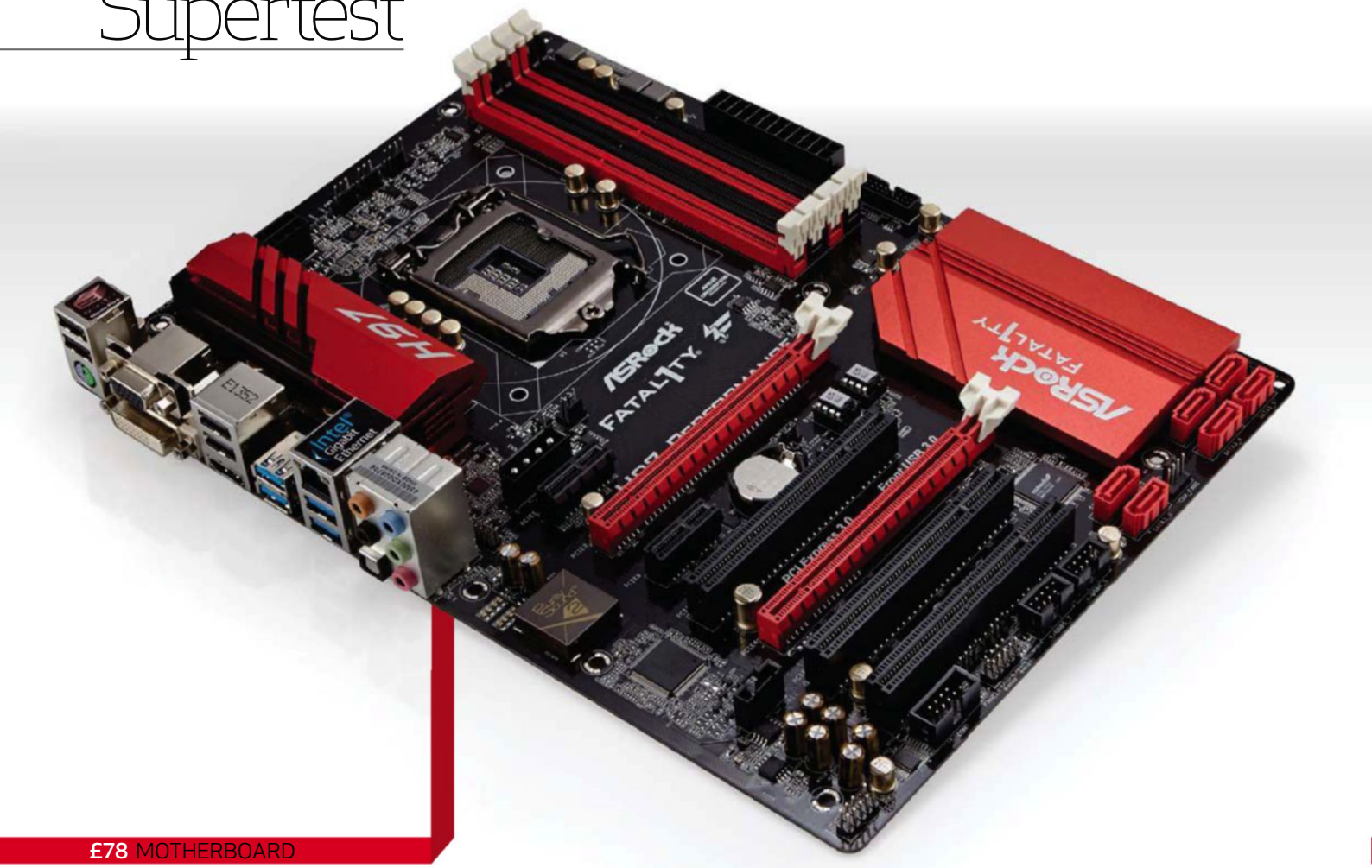


1 Grab your screenshot

If you haven't taken your shot yet, there are a few things you can do to make sure you've got a great starting point to work from. Ensure visual settings are as high as they will go, and max out your resolution too. You should hide the game's interface if at all possible, unless the screenshot is trying to highlight something within it.

2 Install GIMP

There are plenty of good free image editing packages out there, but the GNU Image Manipulation Program (or GIMP for short), packs an incredible amount of power under its hood. You can grab the latest version from www.gimp.org and install it with the minimum of fuss on a variety of OSes. Once installed, open your file up in the program.



£78 MOTHERBOARD

ASROCK FATAL1TY H97

VITAL STATISTICS

Price £78
Manufacturer Asrock
Web www.asrock.com
Chipset Intel H97
Form factor ATX (non-standard)
Sockets LGA1150
Storage 6x SATA
Multi-GPU AMD CrossfireX
Video-out DVI, HDMI, VGA

Profits are a problem. Not so much for motherboard makers. But for you and, yes indeed, we. That's because there is more money to be made from higher-end boards than mere everyday mainstream tackle.

And that's why all the usual suspects are pushing their new Intel Z97 boards hard, and why getting a sniff of anything with an H97 sticker is tricky. But thank goodness for Asrock. It's always done things a bit differently and it's the only board maker to come up with an H97 for us to prod and poke.

Actually, the Fatal1ty H97 Performance conforms to quite a few Asrock norms. Not all of them are good. The PCB is thin (read: cheap) and the form factor is pretty oddball. It's full ATX in width but slightly shallower.

So what, you say? Well, the slight shortening means the board doesn't reach the third set of ATX mounting points but overhangs the middle mounts by some margin. On the wrong side of this divide are the memory DIMM slots.

Factor in the thin PCB and that makes for quite a lot of flex when you push in the memory sticks. Not exactly the end of the world, but it does have us slightly worried about long-term reliability. Ditto the prospect of the board bending and distorting due to heat cycling over time.

Of course, at this kind of price point something has to give. You simply can't expect a luxuriously thick multi-layer PCB. That said, it's a pretty snazzy looking item superficially speaking, what with the red-and-black Fatal1ty livery. And you could hardly accuse Asrock of skimping on the chipset cooling as you get a couple a hefty lumps of alloy to keep things chilly. But we would prefer to see the board mounted more securely.

Whatever, the main attraction here is the question of whether manufacturer Asrock has indeed given Intel the metaphorical finger and enabled CPU overclocking access for this H97 chipset. Straight into the BIOS then and, hurrah, all of the options – including the all-important CPU ratios – are there.

Dial in 45 on the CPU ratio, reboot and hey presto we're in Windows at 4.5GHz. Except something's not quite right. CPUZ reports the ratio is set to 45, but the clockspeed hasn't budged from our 4770K test chip's standard frequencies. Hmm.

We take a few more trips into the BIOS and have a quick check of the CPU cooler mounting and thermal paste, but there's no getting round it – something's not right. No doubt it's just an early glitch that will be ironed out with a BIOS update, but as it stands, overclocking doesn't work.

That's a real pity because the stock-clocked numbers we ran prior to overclocking looked exceptionally good. It's fastest in Cinebench, both single and multi-threaded. Ditto *Rome: Total War*. The storage performance numbers look decent, too, though the lack of SATA Express and M.2 is off putting.

As it happens, Asrock says the Fatal1ty H97 Performance also supports AMD's CrossfireX multi-GPU tech, which is another feature that's not part of the standard H97 package. So, there's plenty to like. But with the broken overclocking it just feels like it's a little bit unfinished. ■

PCFormat Verdict

Features ★★★½☆
Performance ★★★½☆
Value ★★★★☆

A valiant and welcome attempt to undercut the Z97 horde, but this motherboard is currently lacking a little bit of polish.

★★★½☆

TOP TIPS

ADD FLARE

If your screenshot is of a daytime view, then adding a little lens flare can add a little shine to it. Don't overdo it though, unless you want to be the next JJ Abrams.

3 Crop to the action

Firstly, you need to frame your action. GIMP supports overlaying a 'rule of thirds' grid when using the selection tool. Click the selection tool (top-left) and select 'Rule of thirds' from the Guides drop-down menu. Drag a box over the most interesting area, right-click it and select 'Crop to selection' from the drop-down Image menu.

4 Lighten up

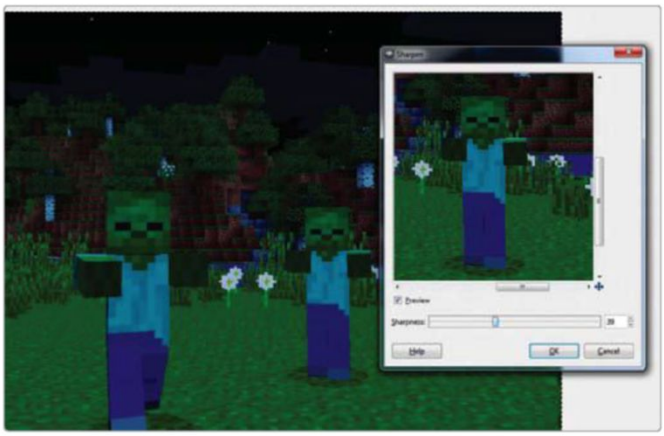
A lot of screenshots are too dark. That moment may have been great when you were fighting for survival, but not so brilliant when you look at a murky image afterwards. To lighten, select 'Levels' from the Colors menu and drag the small white arrow under the right-hand side of the graph to the left. Do the same with the 'Mid-range' arrow.

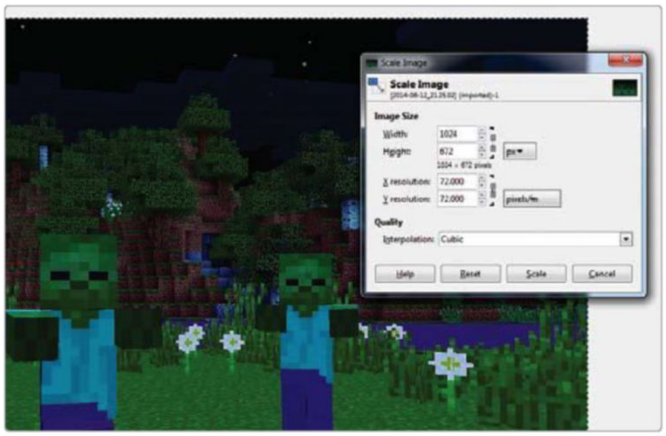
5 Balance your colours

Now to sort out the colours. Games tend to set a mood by restricting the palette, but nudging the colours can give a much more tonally-pleasing image. Select 'Color balance' from the Colors menu and use the sliders to make the tones more natural (or not, depending on your scene). Experiment until you're happy with the results.

6 Boost the saturation

One thing that can improve the look of an image is increasing the saturation so the colours really pop out. Saturation controls are under the Colors menu. Try increasing the saturation by 20-40 per cent or so. Over-saturating can give a cartoony feel, so show a little restraint, but careful use can make your images look more vibrant.





7 Sharpen your view

Now, sharpen up your image to add a little more impact. Select the Filters menu, expand the Enhance section and click 'Sharpen'. Again, something in the order of 20-40 per cent should be enough to add detail without turning it into a freaky modern art experiment. If it's more your style, use the Gaussian Blur tool from the Blur section.

8 Resize and save

You're pretty much done now, beyond tweaking the image a little more. It takes a bit of practice to get right, but after a while you'll be improving all of your screenshots in a matter of seconds. All that's left now is to resize your image for your intended platform and then save it in a format that works best – often JPGs for websites. Job done. ■

Ask Luis

All the stuff **you** didn't know

Luis Villazon is the opposite of the Spanish Inquisition: instead of extracting confessions, he dispenses advice. With only a little torture

RATH

MY KEYBOARD WORKS EXCEPT WHEN IT DOESN'T

I have a Gigabyte Osmium keyboard with which I have encountered a problem. Two specifically, although they may well be related. It works without fault unless one of two things happens: I switch user, or the PC goes to sleep and I wake it up by pressing a key. With either, the keyboard becomes unresponsive.

When switching user, the keyboard backlight remains on. To continue using the PC I can either restart, or unplug and plug in the keyboard to enter the user password, but I need to repeat the action once logged in to get the PC to continue to accept keyboard input. When waking up the PC with a key strike, the backlight does not turn on but the 'breathing' Aivia logo at the top right is lit, as is the Num Lock indicator. I can then re-plug the keyboard as before to get things working and don't need to repeat this once logged in as I do with the 'switch user' issue. Once the PC goes to sleep, I'm able to wake it up with a mouse button press and use the keyboard as normal. When I've tried to prevent the computer waking up via keyboard, using the power management settings, it still does.

Zac O'Neil

This *looks* like it might be a driver problem. Gaming keyboards often have non-standard driver interfaces, and the way that hot plugging temporarily revives it definitely feels like driver-y behaviour. But I'm going to use my level 90 Tech Shaman ability 'Deduce Root Cause' and say that this is a hardware fault. Don't ask me why, you couldn't possibly hope to understand. At my level, I can sift through the user reviews on Amazon and immediately discern when a device has reliability issues. Yes, it's a hunch. But it's a *correct* hunch, and that's all that really matters.

You can verify this by trying the keyboard on another PC, but you'll just be wasting time. What you need to be doing is getting a replacement. If you've had it less than six months, you can claim on the warranty (from the retailer – don't let them fob you off by saying you need to claim from the manufacturer). If it's been more than six months, the onus is on you to prove that the fault was present at the time you bought the keyboard. Good luck with that. Once you've wrangled your way to a refund or store credit or whatever, I recommend you go with a Logitech G710+. Much more reliable.

If you're having input problems, I feel bad for you son. I got 99 problems, but my keyboard ain't one

RATH

WHERE DO I EVEN START?

I have an AMD-based PC – Phenom II quad-core CPU, Nvidia GTX 550Ti graphics card, an SSD for the OS and a couple of HDDs for storage. The PSU is a Corsair 400W. For some time now, randomly, I've been getting complete system lockups, where nothing works at all, not even the mouse. The only way to get out of it is with a hard reset. This typically, but not always, happens 5-10 mins after I switch on the PC. After the reset, I don't normally have any more problems for the rest of the session. I've tried booting into the BIOS and leaving it, but had no lock up after a couple of hours. Can you suggest a way to narrow down the problem please?

Tony

Intriguing. Not overheating then, since it only occurs at the start, and probably not a PSU problem either, since you are past the point of peak power draw when it locks. You don't mention how much RAM you have installed. If you have more than 4GB installed, try removing the top bank and see what happens. If it still locks up, switch the lower bank with the RAM from the top bank (but still run with just one bank). If it doesn't lock in either of these configurations but goes back to locking when you put both banks in, then the bank you have just put back has a bad bit somewhere that is stuck as a permanent 0 or 1. Although bad RAM is always bad, the fault looks random because Windows doesn't always write to the same memory

Free technical support

Email Luis for guaranteed insults and possibly even some technical help as well.

pcfhelpline@futurenet.com
PCF Helpline, 30 Monmouth Street
Bath, BA1 2BW

The six categories of all human misery

IUTWANID: It Used To Work And Now It Doesn't.

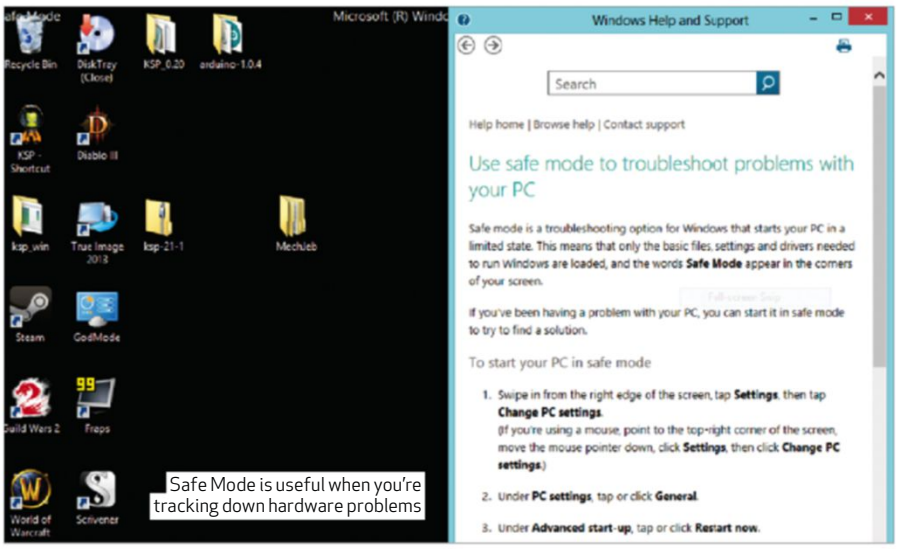
IGAEM: I Get An Error Message.

IMRTIUTB: It's More Rubbish Than It Used To Be.

RATH: Randomly, A Thing Happens.

ICDNT: I Can't Do the New Thing.

IKBTL: I Know Better Than Luis.



Safe Mode is useful when you're tracking down hardware problems

location. And even when it tries to write over the bad bit, the value stored there will only be wrong 50 per cent of the time.

Don't get your hopes up; it's probably not bad RAM, but we have to eliminate it before we can test the next and more likely culprit. Try booting in Safe Mode. With networking, initially, and then if it still locks up, without. If either of these modes stay running for a convincing length of time, then what you have is a driver problem. Now, I could blithely advise you to systematically uninstall things or update things until it goes away, or I could tell you to hunt through the Event View logs to see if you can consistently tie a particular error message to the time that Windows locks up. But we both know you're not going to do that. A less effective, but more realistic, compromise is to do a full reinstall of Windows.

Oh, and if your computer locks up even in Safe Mode, you have a motherboard fault. Time for a new one.

"YOUR GRAPHICS CARD IS WEAKER THAN A LETTUCE LEAF ON A SUNNY WINDOWSILL"

ICDNT

THE CHEAPEST SELF-BUILD

My dad is looking for a cheap PC – sub £300. Unfortunately, I don't have time to build one for him, but I was wondering if you had any pointers, as any custom build I try to configure ends up bloody expensive. He's been looking at restored ones on eBay, in particular one for £160, which looks fairly decent, yet the company selling it is claiming the dual-core will run at 6GHz (two cores, both at 3GHz it says), which I keep explaining is purely a marketing gimmick, as I can't find any processors that are that great! Is buying the restored PC a wise idea? I mean, the seller has positive feedback, it just seems too good. Are there any decent websites around that can build a nice cheap PC?
Harry Baker

Claiming that two cores at 3GHz is the same as one at 6GHz isn't a marketing gimmick, it's fraudulent misrepresentation. The eBay feedback system won't protect you from that sort of thing, because you can only leave feedback on a seller you have bought from. And if you are dumb enough to fall for that kind of ad copy, you probably aren't going to notice how fast your PC runs or doesn't run. Whether you buy refurbished on eBay or new from a reputable box-shifter company like www.meshcomputers.com, £300 buys you roughly the same hardware. Something with an AMD A6-6400K, integrated graphics, 4GB RAM and a 1TB drive is fairly typical. You'll get Windows 8.1 included with that, but no monitor, mouse, keyboard and often not even Wi-Fi. Good enough for basic web/email/word processing, but not much more. And if that's all your dad wants, why not just get a £300 Asus laptop?

On the other hand, if he wants to play games or do anything else that's going to need some welly, he's better off with a second-hand system. There are i5 systems on eBay that go for around £300 with much better specs.

ICDNT

WHAT'S THE DEAL WITH DUAL-BOOTING?

How do you install two operating systems on one computer and choose when booting which one to boot with? I know this is a simple and easy question for IT

YOU ASKED!

FAQ

Nest-building robots

Why do robots need nests?
They don't. These are robots that build structures using techniques inspired by the nests that some cliff birds build from their own saliva.

How does it work?
The Micro Aerial Vehicle is basically a cross between a 3D printer and a quad-copter. The quad-copter carries two different chemicals that combine to form polyurethane foam when mixed. It flies in a precise pattern, using GPS and image recognition from its cameras, and squirts down quick-curing foam from above.

What are the advantages?
It can theoretically build almost anywhere, including remote or dangerous locations. Imagine repairing damaged cable insulation at the top of a radio mast or building a containment shell in a damaged nuclear reactor. The polyurethane foam is also sticky until it has fully cured, so it can be used to pick things up. Bomb disposal robots could encase a suspect device in foam, then fly it somewhere safe.

Any drawbacks?
It only prints in polyurethane foam right now. Traditional 3D printer plastic is stronger but needs a heating element, which requires more electricity than the batteries on a quad-copter can supply. The current prototypes also need external cameras feeding image information to a laptop that handles the guidance. The next step will be to put the cameras on the quad-copters themselves so that they can be fully autonomous. Swarms of build-and-repair bots could be deployed to disaster areas like SCVs in *StarCraft*.

Who's behind all this?
The nest-building robot prototypes have been developed by researchers at Imperial College London.

Read more at:
http://bit.ly/1ntLyxV

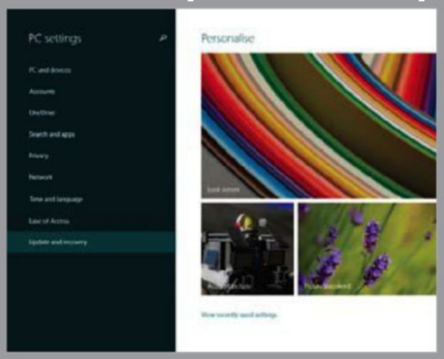
geniuses such as yourself. Feel free to insult me. If it matters I have an Intel i5-3330, a Gigabyte H77M-D3H motherboard and a 1TB Seagate Barracuda hard drive.
Jeanré du Plessis

This is, as you say, both simple and easy. The exact process depends on which two operating systems you want to dual-boot and whether you have already installed one of them or you're starting with an empty drive. In broad brush strokes, it goes like this: install Windows first (or the oldest version of Windows, if you want to dual-boot between two versions), then use Disk Management Tool to shrink the Windows partition down and create a new empty partition on the same drive. Then install the second one into this. Choose the 'Advanced' option in the installer that lets you specify the target partition manually and the installer will automatically set up a boot menu for you so that when you start up the computer, you can pick the OS that you want to load.

Now, I'm painfully aware that these are pretty sketchy instructions. This is not my fault. It is yours for asking such a vague question. If you ask "How do I play an instrument," all I can really tell you is "Blow through the narrowest hole, press down on any hinged levers and pluck or scrape whatever strings you find." I'm an IT genius, not a mind-reader.

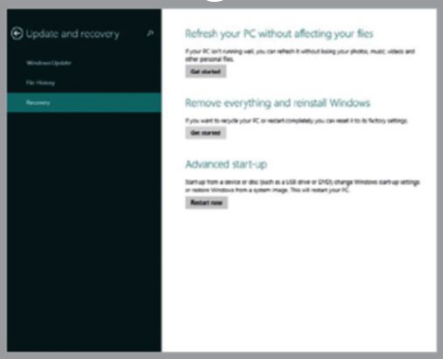
"THE SARCASM IS FREE, JUST LIKE THE PARMESAN IN A CHEAP ITALIAN RESTAURANT"

Four things I get asked all the time
Convince your friends you're a tech guru!



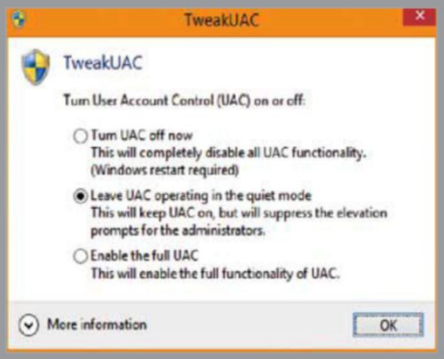
1 Start in Safe Mode

Windows 8 starts too fast for the 'mash [F8] while loading' method. To enter Safe Mode, go to the Charms bar and click 'Settings > Change PC settings > Update and Recovery > Recovery > Restart now > Troubleshoot > Advanced options > Start-up settings > Restart'.



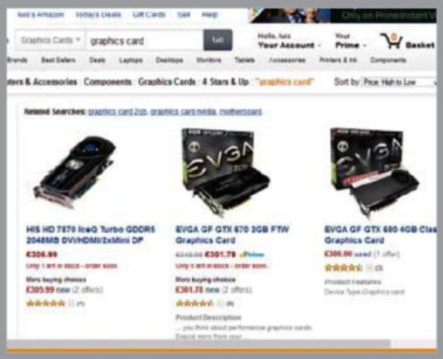
2 Reinstall Win8

Luckily, the options to refresh or reinstall the Windows 8 operating system can be found in the same place, so it's worth getting familiar with this little corner. On the Recovery menu from step 1, find the option to 'Remove everything and reinstall Windows' and then click on 'Get Started'.



3 Disable UAC

Download TweakUAC from http://cnet.co/1vzZHvB (making sure you don't click any of the fake download buttons that install junkware). Quiet mode is better than turning User Account Control off completely. Non-admin users will still get warned, but you'll be spared.



4 Choose a graphics card

Go to Amazon, search for graphics cards in 'Computers & Accessories', filter by four-star reviews and up and sort by price from high to low. Scroll down through the list until you come to your price bracket – £300 for top-end gaming, £200 for reasonable gaming, £100 for a basic system.

IMRTIUTB

I BUILT IT AND IT'S SLOW

I recently built a custom PC and now it is really slow and frustrating. It takes about five minutes just to boot up. I have a GeForce GT630 graphics card, Gigabyte H61M-S2P motherboard, Intel Pentium G630 processor and a 500W power supply. I also tried reinstalling Windows 7 Home Premium but it had no effect. What can I do to improve overall PC performance as well as gaming performance? My budget is about £300.
Herman Stapelberg

Five minutes to boot up is ridiculous. That's way slower that could be accounted for by any number of drivers or system tray apps. Unless you are booting from magnetic tape, this sort of delay can only be caused by some peripheral or network service that isn't responding and yet for some reason doesn't time out either. In *PCF292* I explained how you can use the Windows Event Viewer to track down processes that are stalling your boot and I'm not going to go through it all again. Type **event viewer mainpathboottime** into a Google search for some quite good guides that will at least point you in the right direction.

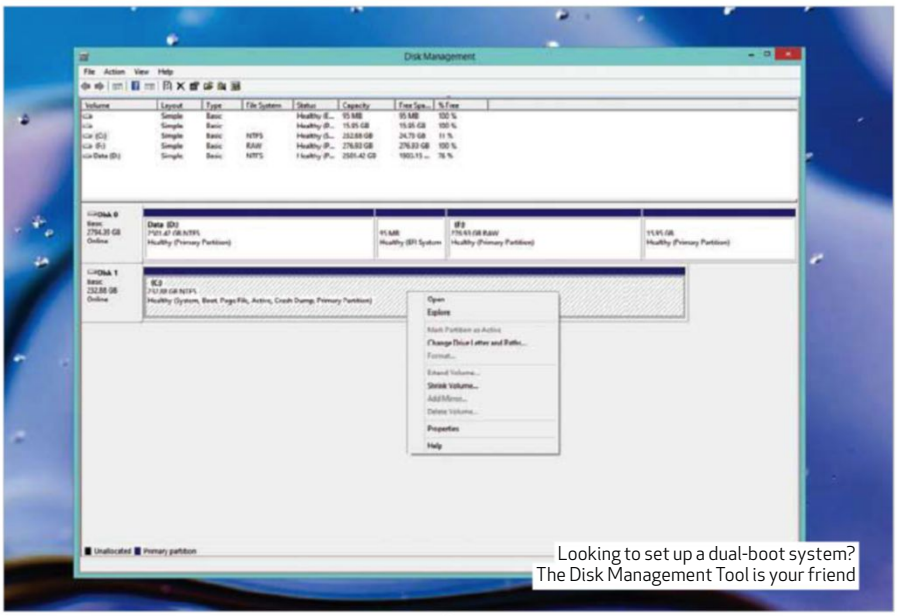
Once you've got your boot time down below the pathological level – let's say under two minutes – there are some other easy things you can do to reduce it even further. By far the easiest is not to shut down in the first place. Resuming from sleep is way faster than cold booting. You'll still need to reboot periodically to install updates and so on, though. You could also throw money at the problem and swap your hard disk for an SSD. But if you want better gaming performance as well, I really wouldn't start from here.

The dual-core G630 only has about 35 per cent of the performance of a Core i5 and your graphics card is weaker than a lettuce leaf on a sunny windowsill. That's harsh, I know. You built this system yourself and you've invested a part of yourself in it. But you know who cares about that? Big fat nobody. If you are concerned about gaming performance, a much better use of your money is to sell this PC for a couple of hundred and then buy (or build) a Core i5 based system with maybe a GTX680 for graphics.

ICDNT

3D OR NOT 3D?

I want to buy an MSI GTX 760 with the Twinfrozr cooler, along with a full HD 3D



Looking to set up a dual-boot system? The Disk Management Tool is your friend

screen. I could not figure out if this graphics card supports 3D. The info page says it does but the page on 3D Vision says only the GTX 6xx cards support it. If it helps I might SLI.
Willie Rossouw

It doesn't help in the slightest. The GTX 760 certainly supports 3D though. The 3D Vision page at www.nvidia.co.uk/object/buy-3d-graphics-cards-uk.html doesn't mention this simply because Nvidia hasn't updated it recently. This is possibly because 3D gaming hasn't really taken off as fast as we were promised. A sure sign that I am getting old is that I think 3D TV is dumb and pointless. Now get off my lawn!

IUTWANID

Q START UP – SHUT DOWN

I'm having trouble starting up my computer. I have a Packard Bell Easy Note TS, and one night my laptop had some Windows updates it needed to finish installing. After it had restarted, it asked me for a disk drive checkup or maintenance check, but I decided to skip it 'cause I was impatient. Then the following morning it showed me the Packard Bell logo (as usual when it starts up), then it showed the command line for a split second and then my laptop shut down. Then it started up and did the same thing and shut down. It doesn't even show me Windows startup or Windows BIOS, or startup command, nothing.
Timothy Rose

The maintenance check you were impatient about is triggered when Windows doesn't shut down correctly. On a normal shut down, the last thing Windows does is write a line in a log file to confirm that Elvis has left the building.

Are people still excited about 3D TV? Don't they know it's 2014!

NO NEED TO READ

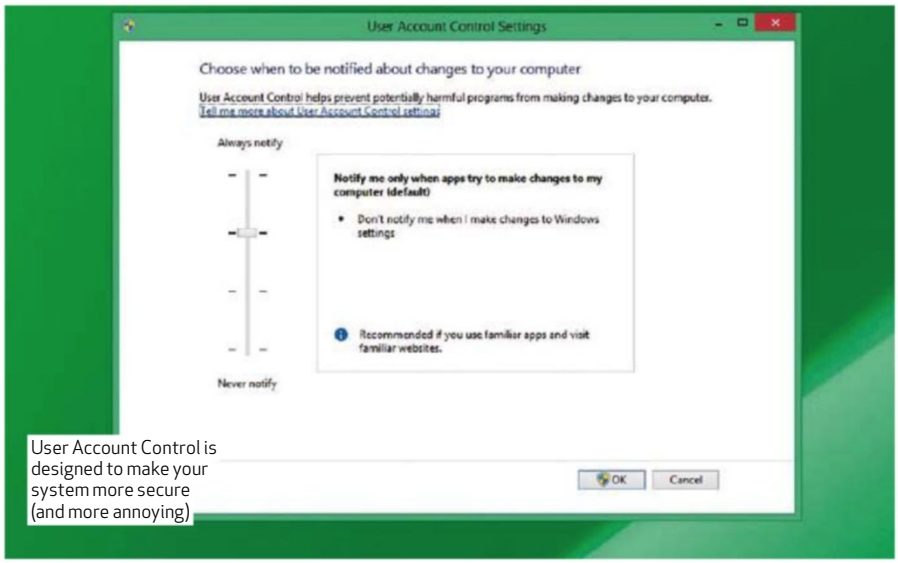
Job Reconnaissance Using Hacking Skills to Win the Job Hunt Game by Josh More

Price £18.99
Publisher Syngress
ISBN 978-0-12-416601-1

This book is the equivalent of the "Men – are you skinny? Do you get sand kicked in your face?" adverts that graced the back pages of 1970s superhero comics. Those adverts appealed to socially awkward nerds by promising you fast muscles. This book targets exactly the same demographic, but instead dangles the carrot of a high-paying job. In both cases the advice boils down to "train really hard". Unsurprisingly, there are no secret weapons here.

"Using hacking skills" turns out to mean "using social media to keep yourself networked" and "using search engines to research your prospective employer". It swings from the hopelessly vague (plant hooks in your stories to make an interviewer more interested) to the risibly specific (if your interviewer is interested in baseball, spend five evenings researching the sport on ESPN so that you can use baseball metaphors in your conversation).

And the baseball is a bit of a giveaway. This is an incredibly US-centric book. Self-effacing Brits will squirm as they are told how to leave a confident voicemail message that doesn't take no for an answer. It's not that the advice in this book is *bad*, exactly, it's just that you can't teach someone to fly by explaining how good birds are at it. Like the people who write books full of dating advice, Josh More is already confident, eloquent and successful, and he more or less assumes you could be too if only you just tried harder. He may well be right, but hacking doesn't have anything to do with it.



User Account Control is designed to make your system more secure (and more annoying)

When Windows next starts, it looks for this line and if it isn't there, it assumes that somebody yanked a power cable out during the previous session. This can corrupt files and folders on the hard disk if there were buffered writes pending at the time, so it prompts you to run Scandisk.

Since you don't mention anything about an unexpectedly abrupt shutdown, it follows that something else must have stopped the Elvis message from being written. The most likely culprit is a failing hard disk, which is consistent with the other symptoms that you have been experiencing. Replacing the hard disk isn't trivial on a Packard Bell laptop, but it's perfectly doable.

IMRTIUTB

EVER INCREASING NETWORKS

I have a wireless telephone that I use to load airtime, then convert the airtime into data bundles for web browsing. Every time I connect my computer to the phone, the network name increments by one. It started off as Telkom.Telkom and now it is Telkom.Telkom 14. Is this okay, and is there a way to get it to keep one name, as I keep having to select 'Home network'?
Wisani Maluleke

When you tether your PC to the network connection on your phone, you're running an app that makes the phone look like a broadband gateway to Windows. Windows uses the unique MAC (Media Access Control) address to tell which network it's connected to. If the MAC address changes, it assumes that you're on a new network and creates a new connection with a new name. Your phone has a MAC address (every network device does). If the tethering app used that address for the gateway then you would keep the same network each time you connected, but when the tethering app is supplied by your ISP, it often takes the MAC address of whatever remote gateway you end up connected to. And there can be a lot of those. Switching to a third-party tethering app like android-wifi-tether (http://bit.ly/1obiusG) will give you a constant network name, but it can make it hard for your ISP to record your data usage, so it's sometimes against their terms of service and might be actively blocked.

IGAEM

I TRIED THAT, NOW WHAT?

I would like to thank you for your reply regarding the small matter of motherboard utility messages when family members are not administrators [see *PCF290*]. Unfortunately, I had already tried your suggestion of temporarily making them administrators (and not so temporarily) but the utility messages do not appear until I 'bust them back down to private'. I know, I should have made this clearer in my original cry for help – I can only apologise for wasting your time. Please, what do you suggest next? So that I can maintain my technical-dom, assist you with your answer and maintain a shred of my dignity, I would like to amend the insult/sarcasm/help ratios to 30/30/40.
Chris Barry

You don't get to make that call! It says '*Ask* Luis' at the top of the page, not '*Haggle with* Luis'. The ratio of insult to help is determined by my whim and the number of grammatical errors in your letter and by nothing else! (The sarcasm is free, just like the Parmesan in a cheap Italian restaurant.) Those messages of yours are part of the User Account Control system that is intended to protect you from programs that try to silently make administrator-level changes to Windows. In your case, it's the tweaking and monitoring tools that come with your Asus motherboard. You should consider yourself lucky – there are plenty of apps that will trigger UAC warnings *even when you are administrator*. You can silence them with the TweakUAC utility (see this month's step-by-step guide) but this isn't a viable option for you because it only mutes messages for administrator logins.

So basically, you have two options. You can give the less technical members of your family full admin rights, you can disable UAC, or you can stop the Asus AI Suite II from loading at startup. Okay, three options. Or you could just give up altogether. Four! You have *four* options. You can disable UAC quite easily from 'Control Panel > User Accounts and Family Safety > User Accounts > Change User Account Control Settings'. Stopping AI Suite II from loading is only fractionally more complicated. You need to open Task Scheduler and select 'ASUS' from the Task Scheduler Library. Right-click 'ASUS AI Suite II Execute' and 'ASUS DigiVRM Help' and choose 'Disable'.

But personally, I wouldn't do any of these things. I used to keep my kids on a non-admin login but I found that all that happened was I was summoned to fix minor things or supply an admin password every 20 minutes. Eventually I cracked and upgraded them permanently to admin. And to my surprise, nobody died. ■

STATS KNOW-IT-ALL?

Quiz

1. When was Blu-ray invented?
a) 1985
b) 1997
c) 2000
d) 2003

2. By 2004, what proportion of movie discs were still DVD?
a) 4%
b) 62%
c) 84%
d) 96%

3. How many Blu-ray discs were sold in the US in 2013?
a) 16 million
b) 124 million
c) 630 million
d) 2.4 billion

4. How is DVD and Blu-Ray revenue expected to change by 2018?
a) 38% increase
b) 3.8% increase
c) 3.8% decline
d) 38% decline

5. How many Blu-ray discs does Facebook use in its new prototype storage system?
a) 1,000
b) 10,000
c) 100,000
d) none

Answers: 1C 2D 3B 4D 5B

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Printed in the UK by William Gibbons and Sons Ltd on behalf of Future.
Distributed in the UK by Seymour Distribution Ltd, 2 East Poultry Avenue, London EC1A 9PT. Tel: 0207 429 4000

Next issue on sale 31 July 2014

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THE MONTH IN NUMBERS

$2 billion

The amount paid by former Microsoft CEO Steve Ballmer for basketball team the LA Clippers. Apparently, he plans to make the team more touch-friendly, and to replace the hoops with menu screens.

12,000

The number of people who asked to be 'forgotten' by Google on the day it launched its identity-wiping service. The European Court of Justice ruled that results relating to particular people should be removed if requested.

10.5 GBPS

The speed of the Wi-Fi network of the future. Huawei has set the world record for wireless networking, and it wants 802.11ax networking to be an actual real thing by 2018.

5 YEARS

How long Google plans to support its Chromebook laptops, including the CR-48 prototype handed out in 2010. It's a nice idea, but we've yet to meet anyone who can use a Chromebook for more than five minutes.

20,000

How many Microsoft Surface Mini tablets were produced, then canned just before the launch of the Surface Pro 3, according to Neowin. The 8-inch tablets were set to take on the iPad Mini, but Microsoft pulled the plug at the last minute for unknown reasons.

PC Format has a mole. A man wedged inside the games industry's nether regions. A man rendered so hideously paranoid by a life spent playing sub-standard PS2 ports that he won't even let us edit his copy. These are his troubled thoughts…

THE VOICE OF REASON

Indie avalanche

The world of gaming is plummeting to certain doom, according to veteran small-scale developer and general man Jeff Vogel. The reason, according to Vogel, is that every man and his monkey and their dog and their little spider is making an indie game, which is only ever going to result in a catastrophic breakdown of supply and demand. It will be like the 1929 Wall Street crash, or the dot com bubble, or that time I forgot to wear trousers to a job interview.

There is some truth to Vogel's doom-laden thesis. The golden age of indie gaming – which happened about five years ago – was defined by *Minecraft*, *Braid* and *World of Goo*. The developers of those games grew very rich very quickly, and suddenly everyone wanted a piece of the indie action – even the great big publishers. Now there's a crippling number of indie games coming out, and more titles were Greenlit by Steam in the first 20 weeks of this year than there were in the entirety of 2013.

The good quality games are overwhelmed by the bad. For every gem like *Transistor* or *Rust* there are multiple *Minecraft* clones and crappy pixellated platformers churned out. Compilations such as the Humble Indie Bundle once offered a chance for people to try the games they missed the first time round, but the sheer number of these cheapo collections is their own undoing. The pennies they generate for the games' developers amount to little more than a sticking plaster laid over a particularly vicious bisection.

However, there is another entertainment format that exists under a forecast of perpetual doom: the music industry. It has died a thousand deaths in the last few years, with naysayers saying that downloads are killing it (as well as saying nay, as they are wont to do). But, guess what? The music industry is thriving, and you only have to pull your eyes and ears away from all the vomit-slick pop and throat-slittingly dull pseudo folk to realise that it has become more diversified than ever before.

Bands no longer need record deals to put out decent tunes and attract an audience (although it still helps); instead, they can build listeners through sites such as Spotify and Last.fm. They can then make their money – not loads, but enough to keep themselves going – through touring. We've reached a point where there's a genre of music or a band for just about everyone, and you can show your support and admiration for them by paying to see them in the flesh.

What's needed, then, is a way for indie programmers to be able to tour the world and program games live. An entire show could be set up, in which an unusually hairy bedroom developer takes centre stage, sitting in their crusty pants and eating Asda value noodles while they try to solve the parsing error in line 295, occasionally stopping briefly to masturbate or poosock. It's the only way we'll save indie gaming from itself. ■

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UNLOCKED FX PROCESSOR AMD

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