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Alan Dexter, Editor

A DODGY SSD IS HOLDING BACK NASA'S MARS ROVER

NASA'S MARS EXPLORATION rover, Opportunity, holds the off-world record for distance travelled, having traversed 26 miles since landing on the red planet. Despite this marathon, it's still 650 metres away from what could be the most interesting site so far. The problem is, Opportunity has developed 'amnesia' and technology is holding it back. Specifically, its flash memory is holding it back. Its solid-state drive if you will.

One of the banks in the rover's flash module has developed a fault. When it tries writing to it, it gets an error and thus tries rebooting to correct the error. In the meantime, it stores its telemetry in its volatile memory and then promptly loses what it's doing when it restarts. Thus the likening to it suffering from 'amnesia'. In other words, Opportunity is being hampered by a dodgy SSD.

Now chances are that your own non-volatile storage of choice (be that hard drive or SSD) isn't as mission critical as that of a robot exploring an alien world, but it's still a pain in the rump if your main storage fails. Without a team of scientists trying to sort out your problems, this can mean a loss of work, your picture collection disappearing or even worse, the evaporation of your save game files – we've felt that loss, we know how awful it can be. You need to buy well in the first place. You need to make sure that your storage of choice will weather the storm of constant use and not develop a sudden bout of amnesia when you need it most.

This issue we look at the latest solid-state drives to see if they have what it takes to be reliable companions. Check out our findings starting on page 8. This issue we also take to our crystal balls to see if we can work out where PC technology is heading next. By piecing together hints and rumours to see what we can expect to hit our machines in the coming year. We also peer ahead to see what's happening in the gaming space, and have plenty of titles to get you excited about the future of the PC as the definitive platform for entertainment.

It's a great issue, enjoy it.

Alan Dexter, Editor

↘ submit your questions to: alan.dexter@futurenet.com

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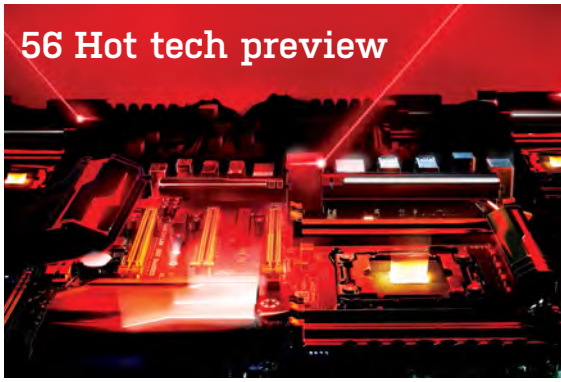

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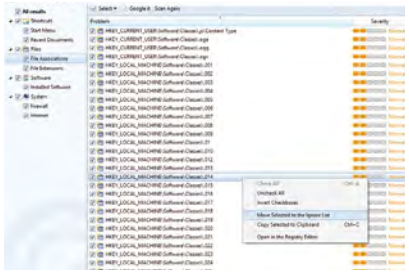

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Solid State Drive

The Future of Solid-State Storage

It's taken a decade, but SSDs are finally delivering

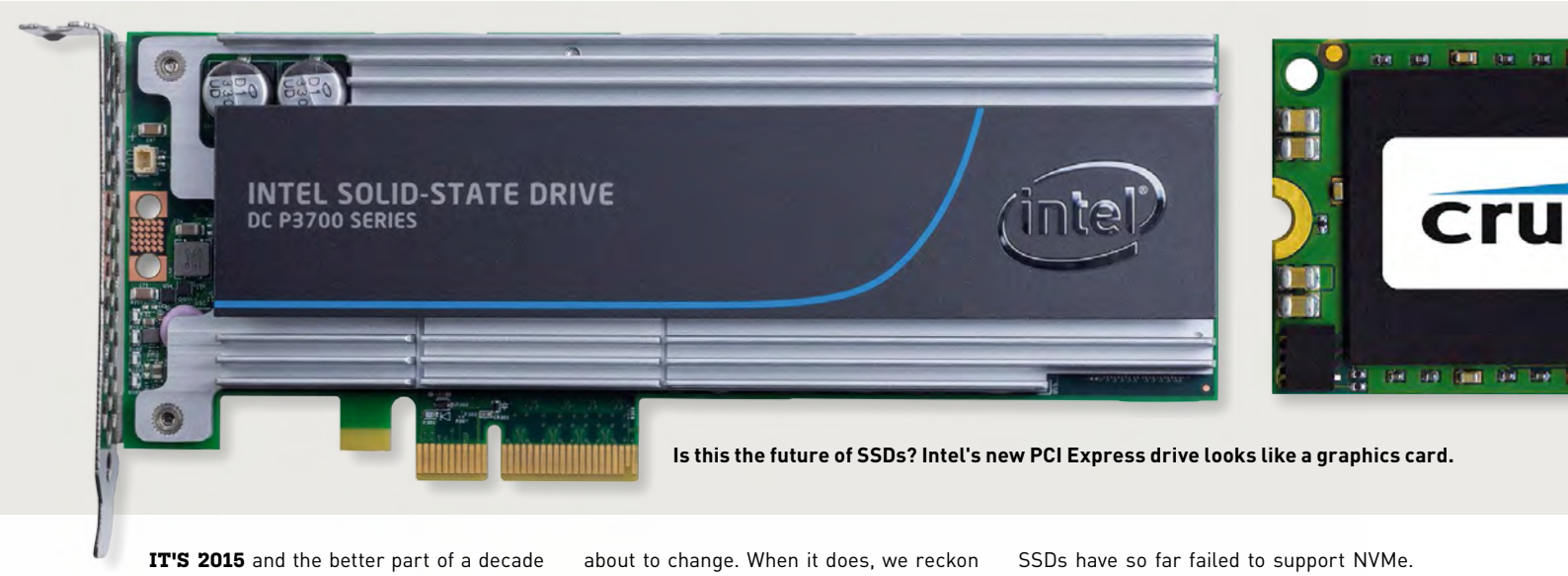
by Jeremy Laird

SOLID-STATE STORAGE was once the final frontier. It's arrival would banish the last remaining mechanised throwback and deliver us into a brave new age of lagless, lightning-quick computing. Back in 2008, when the first affordable SSD rocked up, initial impressions were revelatory, but it quickly became clear solid-state storage wasn't quite the instant fix – it turned out to be the most complex component of all.

Whether it's different data types delivering differing performance, drive survival or performance longevity, the more we learn, the more we recognise the limitations of earlier drives and realise how much potential there is. Fast forward to 2015 and today's SSDs are out-of-sight better than those laggy, stuttery early-adopter drives. If you haven't already jumped to SSDs, we guarantee you'll be delighted when you do. It's now more affordable, too. Decently capacious drives with great performance can be had for under £100.

But we can also see just how much more there is to do. Frustratingly, there are a number of emerging technologies which promise dramatic improvements in SSDs that have either already arrived but not yet delivered on their full promise, or remain tantalisingly out of reach.

What does that mean for you? If you already own a relatively up-to-date SSD, take it easy, you already have it pretty good. There's no hurry. If you haven't made the leap, the choice is trickier. You can either skip passing Go and collecting your £200, by heading straight for our reviews of the best current drives and experience a truly revelatory performance upgrade. Or you might want to find out about the next generation of drives and hold on that little bit longer. The choice is yours.



Is this the future of SSDs? Intel's new PCI Express drive looks like a graphics card.

IT'S 2015 and the better part of a decade since the first mainstream solid-state drives appeared. But somehow, it still feels a little like SSDs haven't quite arrived.

For sure, all PC components just keep getting better, keep getting faster, keep getting cheaper, and SSDs won't ever get to a point where they can no longer improve. But today's SSDs are wonderful things already. It's all too easy to forget just how sluggish magnetic hard drives could make a PC feel. Once you go solid, you don't ever want to go back.

The problem is that the PC as a platform wasn't really ready for solid-state drives when they first arrived. It still isn't fully optimised for them even now. But that's about to change. When it does, we reckon the SSD will truly come good. Unfortunately, that change is pretty complicated and it's probably not going to be cheap. Oh, and it won't be a case of simply picking up a drive with a fancy new feature and plugging it in.

Crucial's MX100 may be a SATA drive, but it's still awesome value for money.

But let's start at the beginning. The problem with SSDs, it turns out, isn't just the SSDs themselves. It's your PC. Or more specifically, the standard storage interface inside your PC, known as SATA. The problem with SATA is twofold. Firstly, it doesn't have enough pure, dumb bandwidth. It's limited to a mere 6Gbps which translates into a real-world 600MB/s maximum.

Arguably just as problematic is that it doesn't know how to talk to SSDs properly. It uses a control protocol known as AHCI which was created for magnetic drives with spinning platters and never designed with SSDs in mind. And that means it introduces wholly unnecessary latencies into the read and write process in the context of SSDs.

PLAYING CATCH-UP

What we need is a new control protocol optimised for SSDs. And that's exactly what we're getting in the shape of the NVMe or Non-Volatile Memory Express. NVMe isn't going to revolutionise the peak throughput you see. But what it should do is dramatically improve the random access performance SSDs can deliver. We're talking about all those little read and writes from your OS and apps, the ones that arguably have more impact on how responsive your PC feels moment to moment than peak sequential read and write performance.

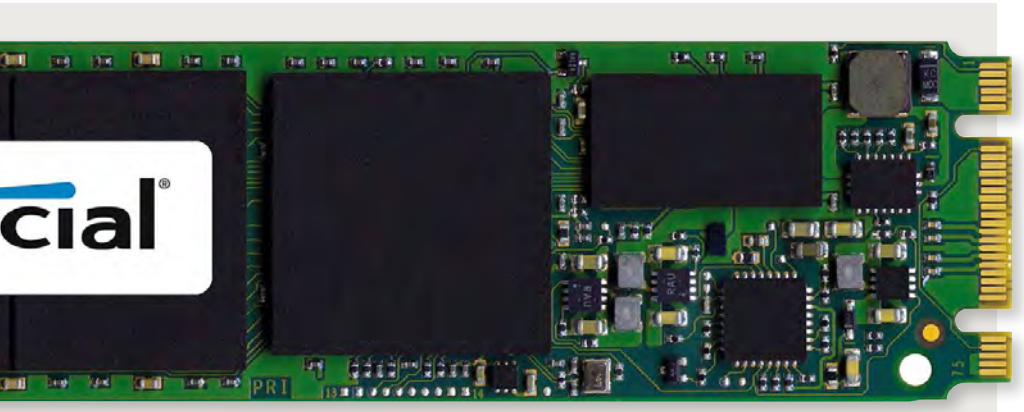
Where things get really complicated, however, is the delivery vehicle for NVMe. You won't be surprised to learn it arrives alongside a new PCI Express-based storage interface, memorably known (not) as M.2. But it is confusing to learn that early M.2 SSDs have so far failed to support NVMe. Making matters even more complicated, there's an alternative new interface for SSDs, again with a PCI Express element, known as SATA Express, that weirdly looks stillborn. There's still the option of going with a straight PCI Express-based SSD too.

At first glance, then, the whole thing looks like a complete mess – a rats' nest of new interfaces, essential protocols not appearing in new drives and technology seemingly dead on arrival. So how is it all going to shake out? What kit will you need and what will the benefits be when it all comes together? The easy bit is that you can ignore SATA Express. Compatible sockets are fairly commonplace on new mobos but SATA Express drives are nowhere to be seen and the SSD makers we've spoken to typically say they've zero plans to produce them. Laters!

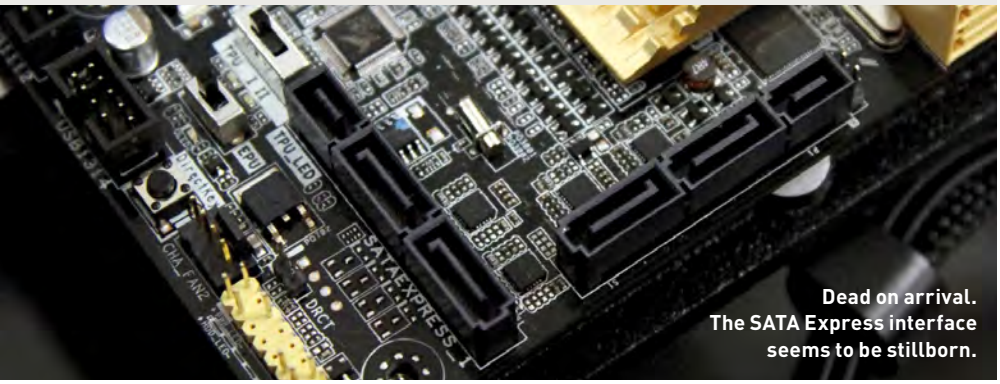
The remaining two are really variations on the theme, that theme being the high bandwidth PCI Express interface. M.2 is a standard that closely resembles the existing mSATA interface for mobile PCs and involves bare circuit boards with exposed memory and controller chips. That's a little odd in the context of neatly boxed SATA drives. And it also means you're only typically getting a single M.2 slot on a new motherboard. But in practice, it does make sense for the medium term as you're likely to only need a single M.2 drive for your OS and apps, leaving legacy SATA ports as more than adequate for mass data storage on bigger, fatter, cheaper drives.

Of course, the motherboard you have right now very probably doesn't have an M.2 slot. That means you'll either need a new mobo or a PCI Express adaptor card. In theory, the latter should allow for M.2 drives on legacy motherboards. In practice your mileage will vary. Some online

> **The problem is that the PC as a platform wasn't really ready for solid-state drives**



M.2 drives are the way to go, just be sure to get one with NVMe support.



Dead on arrival. The SATA Express interface seems to be stillborn.

research regarding your own specific make and model of mobo is the order of the day.

EXPRESS DELIVERY

Assuming that's all sorted, the other major piece of the puzzle is making sure you've an NVMe-capable M.2 drive. We've had a fair few M.2 drives hit our test bench. But so far, none have support for NVMe. That's mostly because it's taking a little longer than anticipated for SSD controller chips with NVMe to hit the market. However, with the new Marvell 88SS1093 controller and others finally coming on stream, that's likely to change very soon. When it does, what can you expect in terms of performance?

Peak numbers will depend somewhat on configuration. Various PCI Express lane setups are possible, with x4 being the most we've seen referenced to so far. Whatever, what we're talking about is bandwidth in the low GB/s, the sort of numbers that were more typical for RAM just a few years ago, not hard drives. For us, however, the really intriguing numbers involve random access. Samsung has a new drive due out that's capable of 750,000 read IOPS. Admittedly this is an enterprise drive that's compatible with yet another interface standard known as SFF-8639 and which won't be coming to desktop PCs. But it hints at what NVMe drives will deliver. It's pretty much 10 times or an order of magnitude better than most of today's AHCI SATA drives. Yes, really.

While all this is going on, of course, the cost per GB of SSDs will keep dropping. Already, decent drives at what we think is the minimum desirable capacity – 240 to 256GB – can be had for well under £100. Admittedly, the unstoppable march that is Moore's Law and the process of shrinking transistors seems to have slowed. However, new approaches, including 3D NAND or stacked memory chips (see "What's a 3D SSD?", right) should keep prices tumbling and capacities increasing for several years to come. It's all good. ■

when they first arrived.

What's a 3D SSD?

YOU'VE HEARD OF 3D GRAPHICS. But 3D SSDs? Oh, yes, they're a thing and they're coming. Actually, they're already here. Both Samsung's 850 Pro and 850 Evo drives use 3D NAND memory. But what does it mean?

It means building chips in layers or 3D stacks of transistors rather than just a 2D plane, so you end up with loads more transistors per square millimetre. And that means greater memory density.

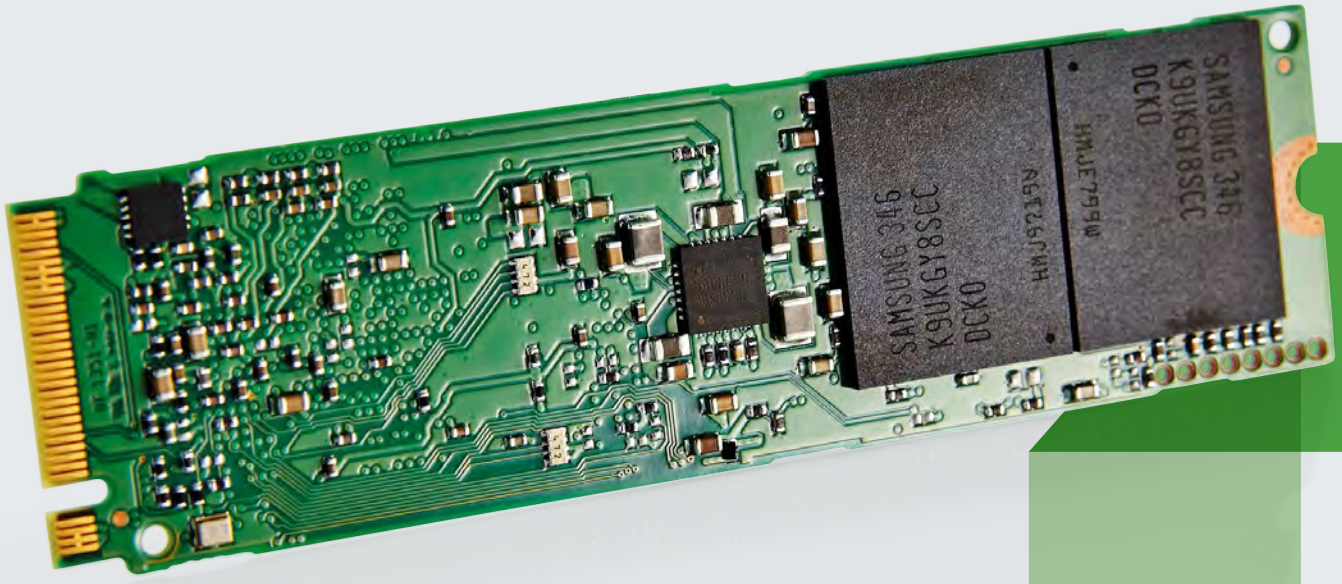
That's handy given chip makers are finding it ever harder to reduce the size of individual transistors, which is the traditional route to greater density and lower costs. The upshot is that Samsung is using some pretty old-school 40nm production technology for its 3D memory where 2D chips need to be sub-20nm for remotely comparable density.

What's more, there are further benefits. With each successive process shrink, NAND memory cells tend to be less robust. In other words, they can sustain fewer read/write cycles before dropping dead. So the brilliance of 3D NAND is that it reboots that vicious cycle somewhat.

Finally, 3D can also have performance benefits. In simple terms, you can have both horizontal and vertical interconnects and that creates more options. We're struggling to see a downside with 3D NAND memory, let's put it that way.

As ever, the full benefits haven't quite kicked in. Samsung's 3D NAND offerings aren't yet really any cheaper or much faster than the 2D alternatives. But 3D remains a critical enabler of both future performance increases and cost reductions. All the major NAND memory chip makers have plans to start cranking out 3D chips. Within a couple of years, it's likely most if not all SSDs will be 3D.

Samsung's 850 Pro is the first SSD with 3D memory chips.



SAMSUNG XP941 512GB

Welcome to the wonderful world of M.2

TO PARAPHRASE DR EVIL, is it too much to ask for an M.2 drive with frickin' laser beams, sorry NVMe support, attached to its head? No idea what we're talking about? Let's start at the beginning.

Solid-state drives were the final piece of the PC performance puzzle. Before they arrived, everything else was achieved with solid-state circuits. Central processing, system memory, graphics, the whole nine yards. But not mass storage of data.

No, that was still done using arcane magnetic platters rotating about a spindle and interrogated by read heads floating precariously above the platter surfaces. That made for slow going during certain tasks, most obviously collecting random bits of data from distant sections of the platters. It also makes conventional hard drives prone to failure due to the delicate moving components.

Of course in many ways those drives were, and remain, marvels of engineering. They were fundamentally a stop-gap idea waiting for a solution. That solution is solid-state storage where memory chips replace the magnetic platters. Suddenly, it doesn't matter where the data is stored on the drive, it's all equally accessible and, in the absence of moving parts with tight physical tolerances, you can knock things about to no ill effect. However, the arrival of the very first solid-state drives wasn't quite the technical triumph we'd been expecting. Early drives suffered from some pretty epic performance inconsistencies and it quickly became apparent there was much work to be done before SSDs fully delivered on the theoretical promise of solid-state storage.

Nearly a decade later and the waiting isn't quite over. Unfortunately, the new Samsung XP941 doesn't change that. Surprised? After all, this is one of the very first SSDs to be based on the new M.2 storage interface. M.2, of course, makes use of the PCI Express interconnect and that means masses of beautiful bandwidth. Where existing SATA drives are limited to 6Gbps theoretical, which translates into about 550MB/s of real-world bandwidth, M.2's PCI Express tech means whole gigabytes per second are possible. The specifics vary according to how many PCI Express lanes are commandeered for storage, but however you slice it, we're talking about a huge leap forward.

For this particular drive, Samsung has configured four PCI Express lanes in 2.0 specification. On paper, PCI Express is good for 500MB/s per lane, so we're looking at a ceiling of around 2GB/s for a four-lane drive or roughly four times faster than SATA 6Gbps. Of course, these are theoreticals and real-world performance will inevitably be lower. But it's not bad from a single generational leap, eh?

STORAGE HUNTER

In fact, it's so good that you're probably wondering what on earth could be stopping this slick little memory stick from achieving storage nirvana. To find out, we have to dig down into the technical details a little.

The XP941 is an 80mm M.2 drive, making it the second longest in a four-strong range

Samsung's XP941 lacks NVMe support, meaning many of M.2's benefits remain out of reach.

of standard M.2 form factors which also includes 42mm, 60mm and 110mm. This isn't hugely significant for desktop PCs, as any motherboard with M.2 support should be able to cater for this drive physically. It's worth noting for laptop PCs, however, where limitations may exist.

Anyway, the 80mm form factor is significant in allowing for up to eight NAND memory packages and that, in turn, is what allows the XP941 to hit the 512GB capacity tested here. For the record, Samsung is using its own 64Gb 19nm Toggle-Mode 2.0 MLC NAND. Still, it remains a very dinky little thing and, as jaded as we tend to be by even the most advanced kit, you have to marvel at the sheer storage capacity in such a small device. It's quite magical.

Whatever, the XP941 uses Samsung's first PCI Express SSD controller, the S4LN053X01. If that doesn't exactly trip off the tongue, there's not much of a story to help you remember it either. Details are hard to come by which is probably a function of the XP941's official status as an OEM product. In other words, it's mainly intended for PC manufacturers to put in prebuilt systems rather than aimed at inquisitive punters doing DIY configs.

The best we can do is guestimate based on this drive's specs that it's probably a PCI Express version of the MEX controller that Samsung fits to the 840 Evo and other SATA SSDs. As for what those specs specifically are, we're talking 1,170MB/s peak reads and 950MB/s writes. Random access, meanwhile, is rated at 122,000 IOPS for reads and 72,000 for writes.

Immediately, a few things become apparent. Firstly, this drive isn't capable of maxing out its four-lane PCI Express specification. How much that actually matters given that it's still claimed to be roughly twice as fast as any SATA drive is debatable. It's also worth remembering that M.2 ports on Intel H97 and Z97 boards are in any case limited to two lanes. A more unambiguous issue is those random access numbers. They're nothing special. And that, finally, brings us to Dr Evil's head-mounted NVMe problem.

COMPRESSION SESSION

For all its PCI Express prowess, this drive lacks support for the new NVMe storage control protocol. It's an old school AHCI drive. And that means that like all other AHCI drives, it's not truly optimised for solid-state memory. The upshot of all this is fairly predictable. This drive flies in sequential workloads. It puts out about 1GB/s for both reads and writes and tears through our 30GB file transfer test faster than any other drive here by a mile. It also looks pretty clever in the PC Mark consistency stress test, losing out only to the SanDisk Extreme Pro by that metric.

On the other hand, it kicks out some extremely mediocre-looking results in the AS SSD 4K random benchmarks and likewise doesn't look remotely special in file compression workloads. All of which adds up to a pretty complicated way of explaining what was obvious from the get go. Without NVMe support, you're not getting the full M.2 experience.

It's also worth name-checking the caveats that apply to all M.2 drives. You'll need motherboard support and that's not a given. Only very recent mobos have native M.2 support and typically only cater for a single drive. Also, M.2 pinches PCI Express lanes. That can be a problem on the Intel LGA115x sockets with their limited PCI Express lane availability, especially if you're running multiple graphics cards.

That said, most motherboards should support M.2 via a cheap PCI Express adaptor card, so the compatibility hurdle should be surmountable. It just may not be a case of simply hooking up the XP941 to your motherboard and letting rip. Finally, as we mentioned above, this is essentially an OEM product and that means it may not be too easy to find and source.

Ultimately, then, we're a tiny bit frustrated by the XP941. It's a big step forwards in terms of raw bandwidth, but misses out on the bit we're really excited about, namely the big boost in random access performance promised by the new NVMe protocol. And that's something we really want to see on any M.2 drive. It's not like we're demanding sharks with frickin' laser beams on their heads, is it?

VERDICT **7**

Samsung XP941 512GB

XP Speedy sequential performance; consistent; supports PCI Express x4.

MILLENIUM Not cheap; doesn't do NVMe.

£372, www.samsung.co.uk

SAMSUNG 850 EVO 500GB

3D memory goes mainstream

WITHOUT GIVING AWAY TOO MUCH, too soon, you may have noticed that both of our showcase SSDs this issue hail from the same outfit, namely Samsung. Without doubt, the Korean giant dominates the market for solid-state drives. That applies in terms of sheer number and presence, *plus* in terms of technical innovation. And it's the latter that qualifies the 850 Evo for special attention, though that doesn't mean it's doing something absolutely new or that it's necessarily a winner. Still, it's all a bit galling when you consider Samsung is also dominant in the smartphone market. And HDTVs. And just about any other area of consumer electronics you care to mention. Resistance, it seems, is futile.

Not that it's terribly surprising to find big players dominating a technology like solid-state drives. At their core, SSDs depend upon memory chips created courtesy of some of the most advanced technology in the world. For advanced, read expensive. It now costs many billions of dollars to build a factory for memory chips and there are very few companies who can stump up that kind of cash. Consolidation down to a few key players is inevitable.

However, as dominant as Samsung is, it's not actually unchallenged in the SSD market. While only a handful of companies make memory chips, there are a fair few who knock out controller chipsets and even more who put controllers together with memory chips to create drives. That means Samsung's innovations can be largely seen as adding to healthy competition rather than tools of competitive oppression. For now, at least.

Whatever, the big news with the Samsung 850 Evo is its use of 3D memory chips. It's not actually the first time we've seen 3D memory in an SSD, known as V-NAND or vertical NAND in Samsung speak. That distinction goes to its Samsung sibling, the 850 Pro. Yeah, it was always going to be another Samsung drive. But the 850 Evo brings 3D memory to a more mainstream part of the market and signals what looks like being a shift in memory tech that will eventually take over every SSD.

WELCOME TO THE LAYER CAKE

The future, then, is 3D memory. But what does that mean? In simple terms, we're talking about memory chips that go up in layers as well as across in terms of the pattern of the circuit. Say what? Haven't integrated circuits always been built up in layers? That's nothing new, is it?

Actually, yes. Previously, the layers in a chip were all about providing connectivity between the thousands and then millions and latterly billions of transistors. That's such a complex job, it had to be achieved using multiple layers. But the network of the critical component – those transistors – was essentially laid out on a 2D plane. Chips had a single layer of transistors.

The 850 Evo might boast exciting 3D memory, but it's still stuck in the land of the AHCI protocol.

With 3D memory, the big innovation is multiple layers of transistors. As we're talking memory chips, that effectively means multiple layers of memory cells. Immediately, the impact of that is obvious. Two layers of cells gives you twice the memory capacity for any given area of chip, albeit at the cost of increased thickness. But it's easy to see how memory capacity suddenly skyrockets when you start to build up multiple layers of cells. As it happens, Samsung has also upgraded its V-NAND from two bits per cell to three bits per cell for the 850 Evo, thereby upping capacity even further.

That's important for all kinds of reasons. For starters, the chip industry is having increasing problems keeping Moore's Law on track. Moore's Law says the chip industry will squeeze twice the number of transistors into a given area of chip every two years. In other words, it's a doubling of transistor density that results in the exponential growth of transistor counts and therefore processing power and memory capacity over time.

Eventually, we'll arrive at transistors made of one or two atoms and the fun will stop. We're not far off that today, so a new approach is needed if we're to keep increasing memory capacity. The other big upside is also related to the manufacturing processes used to create chips. As transistors and in turn memory cells shrink ever smaller, they become less robust. In other words, they can sustain fewer read and write cycles before they fail.

The same applies to memory cells with the capacity to store multiple bits of data. As you go from single-bit to two-bit and three-bit cells, robustness tends to fall off. All of which means that the endurance of flash memory has been getting worse and worse as capacities have increased.

Introduce 3D memory, however, and you can wind back the clock a bit on that problem. That's exactly what Samsung has done with its own 3D NAND memory. Because it's composed of 32 layers of memory cells, Samsung can achieve excellent memory density without the latest manufacturing tech. The 850 Evo's memory chips are 40nm items but still achieve 128Gbit per chip. That's several generations behind its cutting-edge 19nm 2D chips.

Oh, and as if that wasn't enough, the vertical connections between the layers of memory cells, known in tech speak as through-silicon vias or TSVs, also help boost bandwidth inside the chip and therefore overall memory performance. So that's more storage, increased endurance and better performance. Yup, 3D NAND looks like being all things to all PCs.

NOT FAR ENOUGH

In capacities up to and including this 500GB model, the 850 Evo also gets Samsung's latest MGX SATA SSD controller. So there's an awful lot of newness all round. But does all this theoretical hotness actually make the new 850 Evo any better in the real world? Unfortunately, there's an immediate and very obvious problem. This is a conventional SATA drive suffering the AHCI protocol and a modest 6Gbps bandwidth ceiling. It's not a fancy new M.2 drive with oodles of PCI Express-powered bandwidth and SSD-optimised NVMe gubbins. Oh dear.

It's no surprise, then, to find our test results look largely pedestrian. So, that's 500-odd MB/s for peak sequential performance and healthy but ultimately unremarkable 4K random numbers. The same goes for our file transfer and compression tests. The 850 Evo doesn't do anything terribly special. Nor does it set the world alight for performance consistency. We should also point out that Samsung's RAPID mode feature is pretty useless in the real world. On paper, it uses your system memory as a super-fast drive cache. In practice, it only delivers really tangible results in synthetic tests.

All of which means the upsides of the 850 Evo's fancy pants 3D NAND memory end up feeling a little theoretical. That's not to say the Evo is in any way a bad SSD. Taken in context – as a 500GB SATA drive at this price point – it's definitely still highly competitive. It's just not the game changer we'd been hoping for.

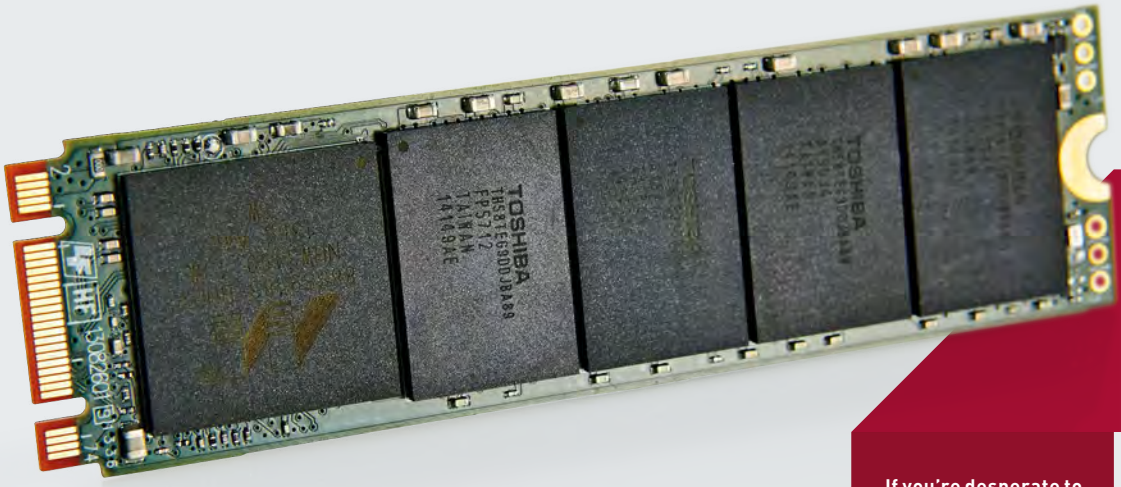
VERDICT **7**

Samsung 850 Evo 500GB

PRO EVO Good all-round spec; longevity bodes well.

ACTUA SOCCER Limited by SATA interface; M.2 drives are faster.

£192, www.samsung.co.uk



If you're desperate to get an early M.2 drive, best avoid this over-priced Plextor.

PLEXTOR M6E 512GB

M.2 done wrong

TO EARLY ADOPT OR NOT. That is the question. At least, it's the question you'd better have in mind when considering the new Plextor M6e. Because it most definitely ain't the finished M.2 article.

All this M.2 and PCI Express stuff is still quite new and certainly a little confusing, so let's recap. M.2 is the new PCI Express-based storage interface that's taking over planet Earth. Well, it's taking over the little bit of planet Earth that is PC data storage. In the process it's replacing the venerable SATA interconnect.

That's overdue for several reasons. Firstly, SATA development has crept along at what you might call a rather stately pace, requiring a new standard for each and every speed boost. Meanwhile, the underlying performance of solid-state drives has grown fast and thumped firmly into the 6Gbps ceiling of SATA. Make PCI Express the basis of your storage connectivity and you can dial up more bandwidth merely by adding more links. Whoopie.

What's more, the control protocol that comes with SATA, known as AHCI, is a clunky old thing designed for ratty old magnetic drives. And it simply isn't any good at talking to sleek, modern SSDs and their zingy NAND memory chips. For that you want NVMe and its low-latency cleverness. Except this M.2 drive from Plextor doesn't have NVMe support, which is where the early adopter angle comes in. As we'll see, there are still benefits of an M.2 drive like this that makes do with AHCI, but it's almost certainly not nearly as good as the NVMe M.2 drives that are due later this year.

ROLLING IN CACHE

We also can't help but notice that the M6e sports a mere two-lane PCI Express interface. Now it just so happens that Intel limited bandwidth to its native M.2 slots for the H97 and Z97 chipsets to two lanes. So you could argue that's academic for most right now. But then you could also use this SSD in a PCI Express adaptor card to sidestep that limitation.

What's more, there's the Marvell 9183 controller onboard, which bodes well enough, and for this 512GB version you also get a full 1GB of DDR cache memory and a decent five-year warranty. Not bad. Nor are the M6e's test results. It is unambiguously, undeniably quicker than any SATA drive in sequential work loads, be that synthetic or real world. On the synthetic side, you're looking at peak data transfer in and around 700MB/s in both directions.

Back in the real world, it zaps our 30GB file transfer test in two minutes and 46 seconds. Most SATA drives take 30 to 40 seconds longer. That, unfortunately, it where the good news ends. No doubt thanks to a controller chipset that doesn't talk the new NVMe lingo, 4K random access performance is pretty poor, even by SATA standards. Likewise, it's dead last in our performance endurance test and returns some seriously nasty looking numbers in the degradation part of that test. Just to add insult to injury, Samsung's M.2 alternative, the XP941, tears the Plextor a new one when it comes to peak sequential performance, cracking the 1GB/s barrier. It also does very well in the performance degradation test. So there's little doubt which drive is the pick of the early M.2 movers.

Of course, the M6e is also a proper retail product, so a little easier to find. But as we go to press it's probably not much, if any, cheaper than the Samsung. If you are absolutely committed to going with a pre-NVMe M.2 drive, it's hard to make the case for the M6e over the Samsung alternative.

VERDICT **6**

Plextor M6e 512GB

+ EARLY BIRD Faster peak performance than SATA drives; five-year warranty.

– EARLY EXIT Unimpressive for an M.2 drive; very expensive.

£335, www.plextor.com

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SANDISK EXTREME PRO 480GB

The price of consistency

The unpretentious Duracell Bunny of SSDs gets our gong for best drive.

KEEP IT SIMPLE, STUPID. Even if that means making everything, well, stupid. That's pretty much how the mass marketing of most consumer goods works. It explains why the processor industry disappeared down the rabbit hole chasing megahertz in the late 1990s. More megahertz must be better. It's a simple and effective sales pitch. Likewise, the burgeoning CPU core counts in smartphones. Never mind that most software and apps on mobile devices aren't multi-threaded, that phone has eight cores. It must be totally awesome.

Apply that same logic to everything from megapixels in cameras to milliseconds in LCD panels and you've got the sales pitch all sown up. In that context, we fear for SanDisk's Extreme Pro. It may not be cynical enough. SanDisk seems to have concentrated on producing a drive that gives a great experience, rather than merely ticking boxes and chasing specs.

For starters, this is a SATA 6Gbps drive, not a fancy new M.2 model with NVMe and PCI Express-powered bandwidth. It's won't turn any heads with claimed read and write performance of 550MB/s and 515MB/s respectively. Okay, the 4K IOPS numbers don't look half bad at around 100,000 each. Until you remember drives with NVMe support are due to hit the million mark.

On paper, then, the Extreme Pro looks routine. Until you clock the 10-year warranty. Then there's the nuanced metric of drive performance that is consistency. Pretty much all SSDs fly out of the box. The rate at which performance falls off with use, however, is much more variable and has a big impact on how good an experience you actually get. But again, it's also an extremely unsexy measure of performance.

PLAYING THE LONG GAME

Anyway, SanDisk claims the Extreme Pro is more consistent than the usual suspects including Samsung's 850 Pro and the Crucial M550. How so? The basic specs don't give much away. There's SanDisk's 19nm MLC NAND memory and a slightly crusty Marvell 88SS9187 controller. Okay, SanDisk has provided a large 32GB slab of spare NAND memory to step in as cells die off and enable that 10-year warranty, albeit at the cost of overall usable capacity. And its nCache tech does some clever things courtesy of using a small section of usable memory in high-performance SLC mode.

But in the end, it's stuff you can't easily point to that makes the difference, namely SanDisk's firmware. A quick glance at our benchmarks wouldn't have you sprinting out to pick up an Extreme Pro. Sure, it puts out very competitive numbers for a 6Gbps SATA drive, but it's also one hell of a lot more expensive. With one critical exception. The Extreme Pro returned the best performance consistency numbers we've ever seen.

This drive just keeps on trucking, no matter how much you throw at it. In the real world, then, the Extreme Pro will be tangibly faster than just about any other SATA 6Gbps SSD you can currently buy. Because it will still be performing near its peak while other drives have lost their edge. Whether that's worth the price is another question, especially in the context of the slightly stingy 480GB usable capacity, not to mention the imminent influx of M.2 NVMe drives. If it weren't for the latter, we'd heartily recommend the Extreme Pro. But they are coming and that makes spending this much on a SATA drive a bit of a stretch.

VERDICT **8**

SanDisk Extreme Pro 480GB

+ MARATHON MAN Exceptional performance consistency; 10-year warranty.

– ONE-HIT WONDER M.2 performance peak higher; not cheap for a SATA drive.

£200, www.sandisk.co.uk

CRUCIAL MX100 512GB

The SSD that just won't die

The MX100 would make a good, cheap stopgap if you're waiting for an M.2 drive with NVMe support.

ONE DAY THE CRUCIAL MX100 will hang up its spurs. It'll retire from the solid-state storage game and get some well deserved rest. But that day hasn't quite come. Incredibly for a drive that has never really been a world beater by any single metric, it remains relevant. Just.

A lot of that is down to cost. For an SSD from one of the really big noises in solid-state storage, this thing is filthy cheap. It's probably not the cheapest drive you can get in the 500GB segment. But it's very appealing given Crucial's reputation for producing decently reliable drives.

It's also worth noting that at this capacity, the MX100's Marvell controller actually comes good. The 256GB and smaller variants of the MX100 drop off when it comes to sequential read performance due to the way the Marvell controller manages its memory channels. But with all the channels populated in this 512GB version, you get peak performance over 500MB/s for both reads and writes.

That's close enough to the best SATA drives that it hardly matters. Its 4K random performance is remarkably non-shabby too, with writes over 100MB/s and tolerable 24MB/s reads. It puts in a very decent effort in our 30GB file transfer test as well, beating even the mighty Samsung 850 Pro.

At this point, you're probably wondering why you'd bother paying more and we couldn't really disagree. The only real catch is some patchy performance in our performance consistency tests. It's not as awful as Plextor's M6e drive. But it's bad enough to remind you that you do, in the end, get what you pay for.

Of course, that's always been true of the MX100 and until M.2 drives with NVMe support finally arrive, you can make a pretty good argument for grabbing one of these on the cheap and waiting for the next really big jump in storage performance to arrive.

VERDICT **8**

Crucial MX100 512GB

HIGHLANDER Silly cheap; decent all-round performance.

HIGHLANDER II Poor consistency; SATA is yesterday's news.

£150, www.crucial.com

CRUCIAL M550 512GB

Big, but not that clever

There's little reason to buy the M550 over its similar, cheaper sibling, the MX100.

WE'VE ALWAYS BEEN BIG FANS of Crucial's MX100. So a similar but upgraded drive from the same brand ought to be a no brainer, right? If only things were so simple.

But let's not get ahead of ourselves. First let's take a look at what separates this range-topping M550 from Crucial's more prosaic MX100. It's not the controller chipset, as both drives tote the Marvell 88SS9189 chip. Of course, that doesn't mean you're getting the same quality of firmware from each drive and we've long known that firmware is at least as important and possibly more so than the controller chip.

As for flash memory, the MX100 uses 16nm chips to the M550's 20nm items, suggesting the latter should last longer. That said, Crucial applies the very same 72TB endurance rating or three-year warranty to both drives. As for performance, that's a wash as well when it comes to peak sequential transfers, with both of the drives hitting a claimed 550MB/s for reads and 500MB/s for writes.

Admittedly, the smaller 256GB MX100 loses write performance compared to the 256GB M550. But that's academic. There's very little in it regards claimed 4K IOPS capability either. And so it proves in our benchmarks with the M550 failing to put clear water between itself and its cheaper sibling by pretty much any metric.

In fact, the MX100 turned out slightly faster for both 4K random reads and writes. Whoops. Critically, the unflattering comparison extends to performance consistency. Both drives are awfully similar. For the MX100, that's fine. It's very cheap. For the pricier M550, it's a cap to the head. We doubt paying extra for the M550 would make any difference to the performance or reliability of your PC. It's a decent enough drive, but that's a damning conclusion.

VERDICT **6**

Crucial M550 512GB

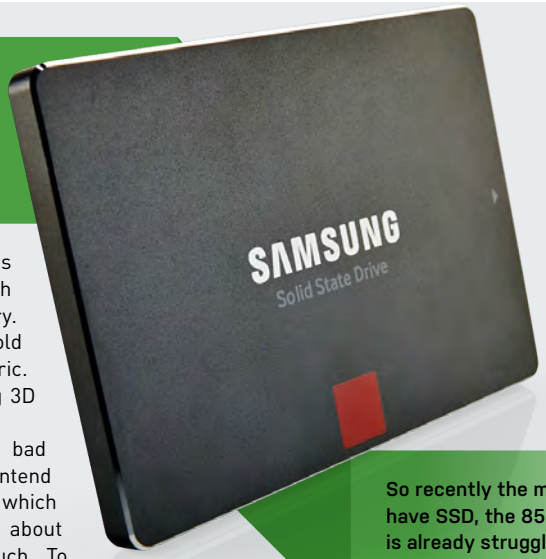
CRUCIAL Tolerable all-rounder performance; decent endurance rating.

POINTLESS Poor performance consistency; expensive against the MX100.

£180, www.crucial.com

SAMSUNG 850 PRO 512GB

The king is dead



So recently the must-have SSD, the 850 Pro is already struggling to keep up with the pace.

AH, HOW QUICKLY the all-conquering tech hotness of yesterday becomes today's object lesson in instant obsolescence. Just a few months ago, Samsung wheeled out its new 850 Pro SSD and all were strewn asunder. With its fancy new 3D NAND memory and world-beating performance, the 850 Pro was the solid-state weapon of choice. This was the SATA SSD you had to buy. Assuming you could afford the price premium, that is.

But suddenly, the 850 Pro is looking a lot less clever. For starters, drives based on the new M.2 interface, including Samsung's very own XP941, are popping up and bringing with them unprecedented levels of PCI Express storage performance. There's no getting round it, they simply annihilate any mere SATA drive like the 850 Pro for peak throughput.

That performance gap is only going to get worse very soon when M.2 drives with NVMe support appear and take 4K random access to all new heights. And while we're talking fratricide, Samsung has also released the 850 Evo with revised TLC 3D NAND memory. So the 850 Pro is looking old hat by pretty much every metric. It's not even unique in having 3D memory chips any longer.

And as if all that wasn't bad enough, the 850 Pro must contend with SanDisk's Extreme Pro, which can teach it a thing or two about performance consistency. Ouch. To be clear, this remains a very rapid drive by SATA SSD standards, but in the battle of the 'Pro' drives, SanDisk wins out.

It's got some pretty hot specifications, including that 40nm 3D NAND memory that promises outstanding long term reliability. Samsung rates this thing at 150TB for overall endurance, which is epic. But things are moving fast. That fact, plus the 850 Pro's lofty, going on debilitating, pricing makes what was recently a very desirable drive surprisingly tricky to recommend.

VERDICT **7**

Samsung 850 Pro 512GB

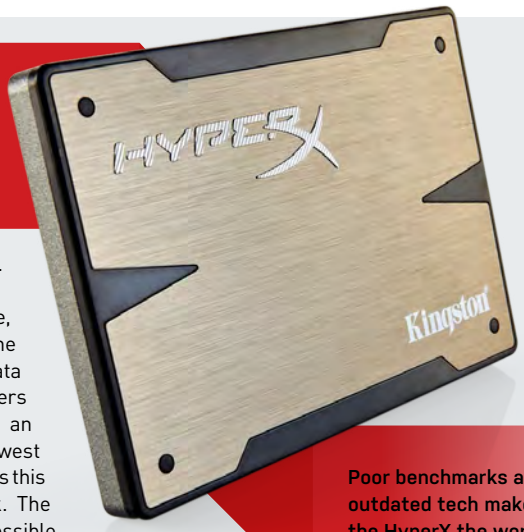
+ LORDIN' IT One of the best SATA drives around; excellent endurance rating.

– PAST IT M.2 drives are much faster; suddenly looks old and expensive.

£260, www.samsung.co.uk

KINGSTON HYPERX 3K 480GB

Left behind by Father Time



Poor benchmarks and outdated tech make the HyperX the worst of our tested SSDs.

TEMPORA MUTANTUR, *nos et mutamur in illis.* Or to put it another way, get with the times, dude! Things are changing fast in the SSD market and drives like Kingston's elderly HyperX 3K are being left behind.

It's not all bad news. The '3K' in Kingston's moniker refers to the number of program/erase, or P/E cycles, its memory cells support. At launch, 3,000 P/E wasn't great. But as memory cells have shrunk, so has their endurance. Today, the 3K rating delivered by the HyperX's 25nm Intel NAND memory isn't too shabby. Drives with mere 1.5K and 1K P/E cycles are on the market.

But elsewhere time hasn't been kind to the HyperX. It's based on the SandForce SF-2281 controller chipset which once ruled the market but is now almost end-of-life. The 2281 now looks odd in that this 480GB drive actually offers worse performance than 120GB and 240GB variants of the HyperX 3K. That's true for both 4K random access and sequential throughput. Usually, smaller drives lag behind.

As for actual tested performance, the 3K doesn't look too hot. The traditional incompressible data limitation that SandForce controllers have suffered from makes an appearance and ensures the slowest sequential bandwidth of all our SSDs this month in the AS SSD benchmark. The 263MB/s for sequential incompressible writes is a very ugly number. The 4K randoms aren't that great, either; 20MB/s for 4K random writes is little more than one quarter of what we now expect.

Then there's performance consistency over time with heavy usage. It's certainly consistent, but unfortunately it's consistently low. All of which makes for a rather unappealing SSD. It's not actually disastrous. It's just been left behind by old Father Time.

VERDICT **5**

Kingston HyperX 3K 480GB

+ SSD It used to be a contender; decent P/E cycles.

– STD Slow out of the box; even slower with sustained use.

£200, www.kingston.com

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Computer Shopper - 5 Stars
Expert Reviews - 5 Stars
PC Format - Gold Award
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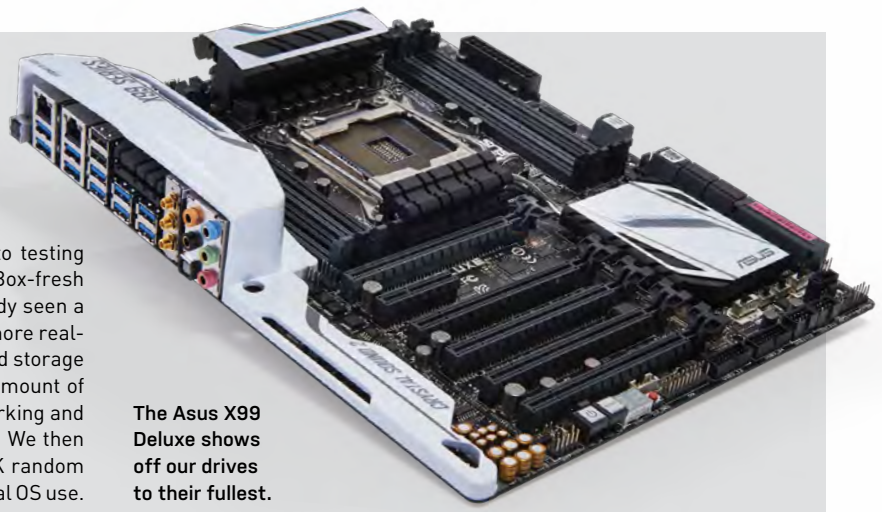
HOW WE TESTED

The most important thing to nail down when it comes to testing SSDs is to ensure you're testing from a level playing field. Box-fresh drives often perform better than drives which have already seen a fair bit of use. To make sure all our drives are tested in a more real-world state we ran each drive through PCMark8's extended storage consistency test. This hammers each drive with a huge amount of data, at once putting them in a reliable state for benchmarking and delivering a snapshot of how they perform under duress. We then ran our real-world and synthetic benchmarks and the 4K random test to emulate the small file transfers that make up general OS use.



The Asus X99 Deluxe shows off our drives to their fullest.

BENCHMARKS

Testing	Samsung XP941 512GB	Samsung 850 EVO 500GB	Plextor M6e 512GB	SanDisk Extreme Pro 480GB	Crucial MX100 512GB	Crucial M550 512GB	Samsung 850 Pro 512GB	Kingston HyperX 3K 480GB
ATTO peak read/write speed (MB/s)	**1,060/997**	553/533	733/690	554/520	553/506	560/510	561/532	542/517
AS SSD average read/write speed (MB/s)	**1,055/885**	494/485	649/645	506/474	499/474	504/463	528/500	484/263
AS SSD 4K read/write speed (MB/s)	23/49	**36/108**	27/76	30/103	24/106	22/92	**37/107**	22/20
5GB file compression (seconds)	73	74	72	**71**	74	79	73	76
30GB Steam folder transfer (seconds)	**132**	208	166	191	191	183	169	205
PCMark 8 consistency (index score)	4,849	4,474	3,921	**4,929**	4,291	4,340	4,751	4,676

Best scores are bolded.

SPECIFICATIONS

	Samsung XP941	Samsung 850 EVO	Plextor M6e	SanDisk Extreme Pro 480GB	Crucial MX100	Crucial M550	Samsung 850 Pro	Kingston HyperX 3K
Manufacturer	Samsung	Samsung	Plextor	SanDisk	Crucial	Crucial	Samsung	Kingston
Price	£372	£192	£335	£200	£150	£180	£260	£200
Website	www.samsung.com	www.samsung.com	www.plextor.com	www.sandisk.co.uk	www.crucial.com	www.crucial.com	www.samsung.com	www.kingston.com
Capacity	512GB	500GB	512GB	480GB	512GB	512GB	512GB	480GB
Memory controller	Samsung S4LN053X01	Samsung MGX	Marvell 9183	Marvell 9187	Marvell 9189	Marvell 9189	Samsung MEX	SandForce SF-2281
Memory	Samsung 19nm MLC	Samsung 40nm 3bit MLC (V-NAND)	Toshiba 19nm MLC	SanDisk 19nm MLC	Micron 16nm MLC	Micron 20nm MLC	Samsung 40nm 2bit MLC (V-NAND)	Intel 25nm MLC
Cache	512MB	512MB	1GB	1GB	512MB	512GB	512GB	N/A
Score (10/10)	7	7	6	8	8	6	7	5

Best on test in blue.

And the winner is...

SANDISK EXTREME PRO 480GB

FIRST THE GOOD NEWS. None of these drives are ambulance-chasing disasters. With prices kicking off as low as £150, a decent 500GB SSD is now affordable. That's important because 500GB allows for a very generous library of installed games and other apps alongside your operating system. The bad news is that the SSD market is currently in transition. So while there are no absolute horrors, nor is there a single drive that totally gives us the hots.

The problem is that the promise of M.2 – the überfast PCI Express-based storage interface – hasn't been fully realised. That won't happen until M.2 drives that also support the new NVMe control protocol arrive. Until then, we can see how good things are *going* to be. And that makes existing drives, be they older SATA drives or early M.2 items, a bit short on appeal.

That said, everything is relative and if you're either still using a magnetic hard drive or suffering a stuttering early SSD, any of these drives will be a great upgrade. So which should you go for? Not the Kingston HyperX 3K. Of all the solid-state drives here, it's the one that feels most dated thanks to its SandForce controller and patchy performance. If it was exceptionally cheap, that would make a difference. But it's not, so it doesn't.

Next through the window of dismissal in unceremonious fashion is, surprisingly, an M.2 drive. Yup, the Plextor M6e with its hot new M.2 interface is a goner. It's quick compared to SATA drives for peak performance, but it's pricey and very disappointing for an M.2 drive. Then there's the Crucial M550. Frankly, it's difficult to know why it still exists. It's really no better than Crucial's own MX100 and yet much more expensive. Goodbye. If those are the drives we'd suggest you avoid, from here on in we're talking about SSDs that really are worth owning.

CHAMPION DRIVES

Samsung's 850 Pro is one hell of a SATA SSD, but it also comes at one hell of a price. So it can't actually win. Samsung's 850 Evo is an appealing effort, too. The 40nm 3D NAND bodes well for long-term reliability and it's quick by most metrics. The price isn't bad, either. Problem is, there's another drive here that's only a little pricier but offers far better performance consistency. Hold that thought.

Now we're into the podium positions and it's as much about picking the right drive for your needs as saying which is the best. But we need a finishing order. The bronze medal therefore goes to our old favourite the MX100. Yes, it suffers from patchy performance consistency, but it's wonderfully affordable for a 500GB SSD. It's a decent drive at a great price.

In second spot is the Samsung XP941. There's an air of early adoption about this OEM M.2 drive. It's super quick in some tests and yet still not as fast as we're expecting from M.2 SSDs in the coming months. It's expensive, too.

All of which means our winner is the SanDisk Extreme Pro. It's a SATA drive, obviously, so won't help if you're looking for an M.2 item. But it's by far the most consistent drive we've ever seen in terms of sustained performance. It's reasonably priced. And it's the SSD we'd most like to have in our PCs today. ■

HARDWARE

PERFORMANCE GEAR, UNCOMPROMISING VERDICTS

What Are You Doing, Dave?

Wrestling with my gaming exoskeleton

"Do I really need all this tech strapped to my body?"

HOW MUCH GAMING IMMERSION do you really want? And what compromises are you willing to make to get to that level? I feel like I'm already reaching a limit and I'm barely trying. But then I'm getting old now and everything feels like a hassle these days. I have to exhale unnecessarily loudly getting out of chairs, I drive exclusively at 30MPH on Sundays and I can't understand a single word teenagers say to each other.

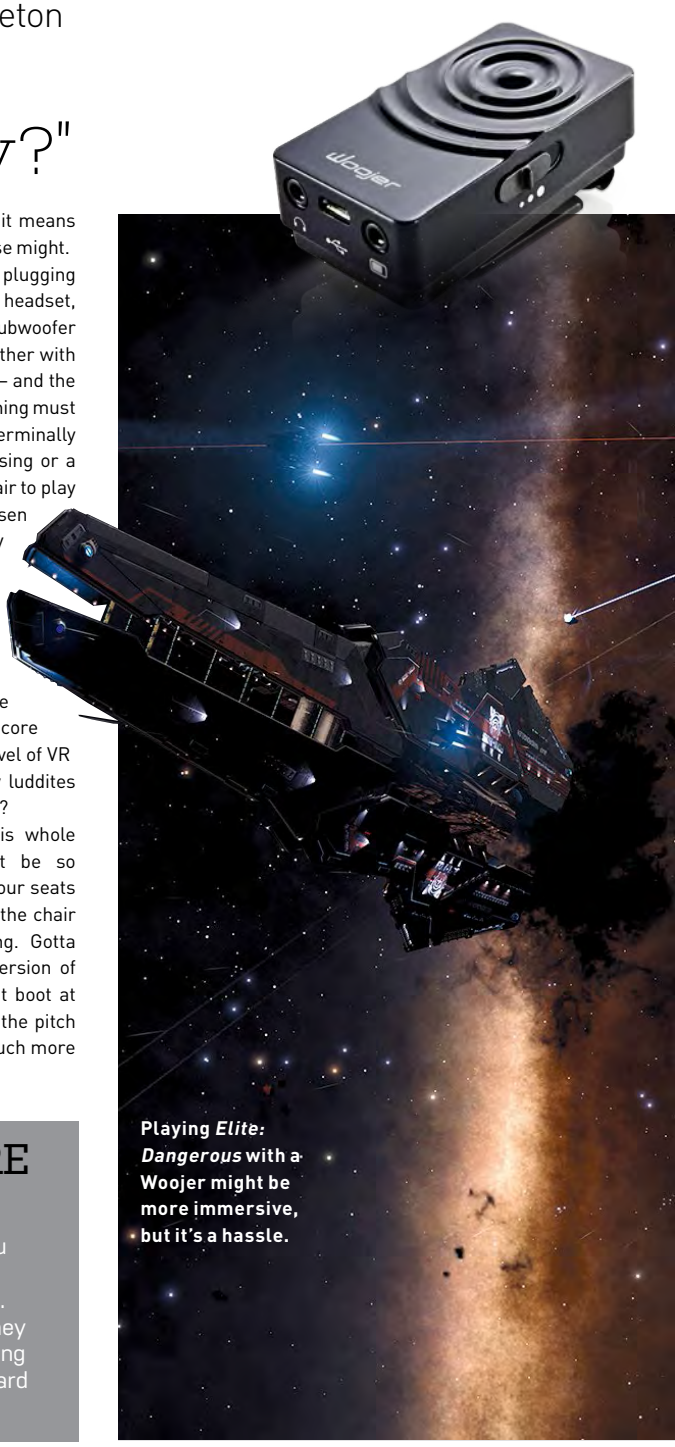
Messing around with the Woojer tit-kicker this month, and having seen all the extraneous virtual reality gubbins that CES vomited out this year, I've started to wonder about how much tech I actually want to strap to my body just to enjoy a little gaming escapism. The reason I'm questioning this is because of *Elite: Dangerous*. To play *ED* with my preferred setup means rejigging my whole desk layout, plugging in a HOTAS array, dragging my screen forwards, attaching the TrackIR onto my headset, then pulling that on. With the Woojer plugged in too I find myself ensconced in a tangled web of cabling from which to extricate myself means Zeta-Jonesing under them, à la *Entrapment*. Now there's a mental image for you... you're welcome.

WOOJER! PG. 38

This all means that when figuring out which game to while away a few more precious hours of my life with, the thought of shifting everything around just to play *ED* for a short stint feels like a trial. That hasn't stopped me enjoying the game, and the level of immersion that setup affords definitely adds to my experience, but it means I just don't play it as much as I otherwise might.

Fast forward to a future where we're plugging ourselves into an Oculus Rift-y VR headset, strapped into a full-body silent subwoofer delivering tactile senses *all over*, together with a Sixense-style limb-tracking system – and the effort required to suit up for a bit of gaming must surely become a royal pain. For the terminally lazy like myself, that could be a blessing or a curse. If it gets me out of my comfy chair to play my games, then that's going to lessen the sedentary level I currently live my life at. But it might also mean I stay away from such immersive experiences for the simple fact I can't be arsed. Could this lead to another tier in the gaming world, where the hardcore gamers fully sign up to the top level of VR immersion, while monitor-using, lazy luddites are regarded as simple casual gamers?

This is also making me think this whole standing desk malarkey might not be so batshit crazy. If we're having to leave our seats to get gaming we might as well ditch the chair altogether and get the blood flowing. Gotta say, I'm looking forward to the VR version of *Football Manager* – hoofing an errant boot at a rising star's head or storming onto the pitch after a winning goal will make for a much more visceral, active experience.



Playing *Elite: Dangerous* with a Woojer might be more immersive, but it's a hassle.

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.

Editor's One to Watch

What's in a name? With some boards, not enough.

WHEN *PC FORMAT* turned the venerable age of 300 issues old, we put together all the kit you'd need to build your own £300 gaming PC. Y'know, 'cos we're nice like that. Unfortunately, however, it's now come to light that we were wrong in our choice of motherboard.

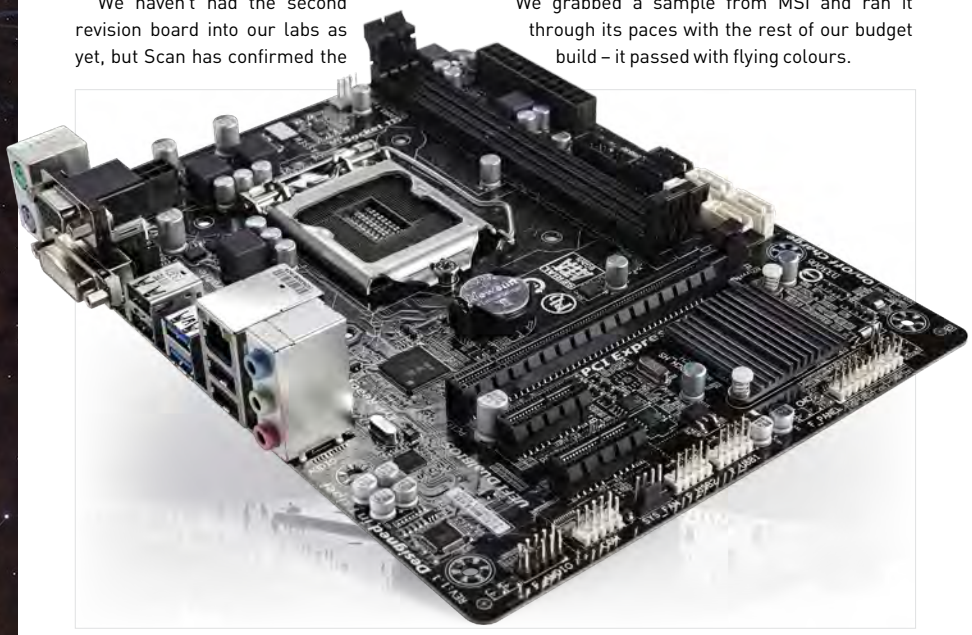
The problem was that while we were using a Gigabyte B85M-D2V in our actual build – a quality little bargain board, capable of overclocking the Pentium Anniversary processor up to a comfortable 4.2GHz – we were actually recommending the Gigabyte B85M-D2V in the magazine. Can you spot the difference, the difference between a capable budget board and a hobbled new revision?

Normally we would expect a new version of a motherboard to have a different name and product code so that you could tell in retail environment exactly which motherboard you were getting. Unfortunately our buddy Koen, over at Hardware.Info, discovered there were some serious differences between the first revision of the board we used in our setup and the version that's replaced it in the stores. Gigabyte has removed the DualBIOS function from the B85M-D2V and reduced the effectiveness of the board's power components, reducing the number of mosfets per power phase.

We haven't had the second revision board into our labs as yet, but Scan has confirmed the only version it's selling is the downgraded board. Essentially this means you're not going to be able to find the more powerful, original version of the B85M-D2V unless you can track down old stock or a second-hand board. Gigabyte has done the same to its B85M-HD3 too and in Hardware.Info's testing the different revisions perform noticeably worse than the originals in both stock and overclocked stakes.

You wouldn't know there were any changes as the shops are still using the images of the original board – because there has been no change of product code from Gigabyte – and are still advertising it with features that have since been removed. We reached out to Gigabyte for a comment, but it has not supplied us with one despite acknowledging what Koen discovered.

In the meantime we can't continue to recommend the latest revision of the B85M-D2V for our budget build. Instead we'll turn our attention to the MSI B85M-E45. It's another budget board, only £6 more expensive than the Gigabyte, but comes with another two DIMM slots and a full size PCI slot for expansion cards. It's also got six power phases to aid overclocking too; perfect for the Pentium Anniversary to really stretch its legs. And it's more than happy to clock up to 4.2GHz on the stock Intel cooler. We grabbed a sample from MSI and ran it through its paces with the rest of our budget build – it passed with flying colours.



We were actually recommending the Gigabyte B85M-D2V, not the Gigabyte B85M-D2V...

HIGHLIGHTS THIS MONTH...

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Next-gen PC tech preview

EVGA GeForce GTX 960 SuperSC

No alarms and no surprises – it's exactly the card you expect

THE GPU SWEET SPOT. That's how Nvidia is referring to its new mid-range Maxwell card. The bare minimum. That's how we're going to be referring to it. Nvidia has released the necessary replacement for the last remaining Kepler-based graphics card in its stack, the GTX 760, and this EVGA GTX 960 Super Superclocked is one of the fastest versions around. Though we still can't help but feel a little underwhelmed.

With the first-gen GTX 750 and 750 Ti Maxwell cards completing the low-end, and the GTX 970 and 980 rocking the high-performance world, the Maxwell stack is now pretty much feature complete. We're still waiting on the ultra-enthusiast cards to tip up later in the year to spoil the next expected AMD Radeon launch, but for the consumer segment, this is pretty much your lot for the foreseeable.

So, what *have* we got then? Nvidia has created a 'virtual reference design' for the GTX 960, which means manufacturers have

EVGA's SuperSC version is a seriously quiet, seriously overclocked card.

free reign putting their own cards together. It almost means there's no real base spec for the new card. That in turn means the first flush of GTX 960s us reviewers see will likely be the overclocked versions right from the off. And so it has fallen, with this Super Superclocked card from EVGA and the STRIX OC Edition from Asus.

But while the clockspeeds are more widespread than usual, thanks to a lack of Nvidia-led limitations and the wide variance of boost clocks, the core specifications of the GM 206 GPU are set in stone. The new mid-range Maxwell chip has a total of eight SMMs which gives the GTX 960 a full 1,024 CUDA cores, 64 texture units and 32 ROPs.

That's actually a little below the ol' GTX 760, which seems to have been a bit of an anomaly, using as it did the same Kepler GPU as the top consumer SKUs rather than the second-tier GPU the GTX 660 and GTX 560 used. That does though add to the general feeling of the GTX 960 being a bit of a sideways step in the mid-range.

Not doing anything to dispel that feeling is the memory architecture. Using a 128-bit memory bus for its 2GB of GDDR5 memory just seems like MechaScrooge territory.

Nvidia's practised response is that the GM 206 GPU uses the same improved memory compression techniques which made the GTX 980's 256-bit memory bus so effective.

Looking at the raw numbers though, doesn't make for great reading on that front. The memory bandwidth of the GTX 960 is a miserly 112GB/s, though Nvidia's compression wizardry puts that at an effective 149GB/s. Still, that's way short of the GTX 760's 192GB/s bandwidth or the R9 285's 179GB/s on its 256-bit memory bus.

QUIETLY DOES IT

It's probably a mid-range stunner in terms of gaming performance though, right? If that's what you've picked up from the tone of this review so far, you need to have a word with your intuition. The difference between a stock-clocked GTX 970 and this Super Superclocked EVGA card lies 25 to 35 per cent lower in the gaming benchmarks. The difference between the GTX 770 and GTX 760 was less than 20 per cent.

At £180 the EVGA card is looking squarely at the Radeon R9 285, with the GeForce card trading benchmark blows with the AMD. It's almost as if that was all it had to do and no more. We're not saying the GTX 960 is lazy, but we heard there's a homeless guy in there with a Casio calculator doing all the maths. With new gaming cards we've come to expect either new levels of performance at a lower price point or new levels of efficiency. It's true that the GTX 960's standard TDP of 120W is impressively low, but with these overclocked launch SKUs, that doesn't necessarily translate into a massive saving, if any, in peak platform power.

One thing Nvidia has pointed to with the GM 206 GPU though is just how overclockable it is. That's born out by the huge clockspeed boost EVGA has managed with this card. Nvidia's quoted base clock is a still-pretty-hefty 1,126MHz, with a boost clock of 1,178MHz. We never saw the EVGA card get close to that. Oh no, our GTX 960 was hovering between 1,417Mhz and 1,430MHz under gaming load. That is mighty impressive and we were able to boost even higher thanks to both the 8-pin PCIe connector mounted on EVGA's design and the new ACX 2.0+ cooling it. We saw a stable 1,502MHz on the GPU and 3,914MHz on the memory clocks – a stunning 410MHz memory boost. The Asus card we've also had in for GTX 960 testing only clocks in at 1,354MHz as a standard boost. But what does that translate to in performance difference? A couple of frames per second on average. If you're lucky. Sad face.

Still, the EVGA is amazingly quiet. Like many recent cards, this GTX 960 won't even start spinning its fans until the GPU hits 65ºC. Under normal desktop load it won't get near that, and in-game it takes a while to hit those heights given the peak temperature we saw was just 73ºC. And even when they do start spinning, they're so slow you'll barely hear them.

But we still can't shake that vague feeling of disappointment. Maybe we've just been spoiled by Nvidia's recent GPU releases, offering a heady mix of performance and efficiency, but this latest card doesn't feel like anything we haven't seen before. The GTX 960 isn't going to be the card anyone rushes out to buy. No, they'll pick one up if they haven't bought a card in three years and because it's the only Nvidia option at this price point. Though they'll probably still do so in their droves. **–DAVE JAMES**

VERDICT **8**

EVGA GTX 960 SuperSC

+ GEFORCE Seriously overclocked; ultra-quiet; supports Nvidia GPU tech.

– POLICE SQUAD OC doesn't actually offer much; doesn't feel 'new'.

£180, www.evga.com

SPECIFICATIONS

GPU	Nvidia GM 206
CUDA cores	1,024
ROPs	32
Base clock	1,279MHz
Boost clock	1,342MHz
Memory capacity	2GB GDDR5
Memory bus	128-bit
PCIe power	8-pin

BENCHMARKS

	EVGA GTX 960 SSC	Asus STRIX GTX 960	Nvidia GTX 760	Sapphire R9 285
Battlefield 4 (min/avg fps)	**43/64**	39/58	26/48	34/54
Shadow of Mordor (min/avg fps)	**20/37**	16/36	13/25	16/45
Metro: Last Light (min/avg fps)	20/34	21/33	13/27	**24/34**
Heaven 4.0 (2560 x 1600) (min/avg fps)	10/20	11/20	12/20	**12/21**

Best scores are bolded. Tested with an Intel Core i7-4770K at 3.9GHz, Asus Maximus VI Hero motherboard with 8GB 1,600MHz DDR3, 1,200W Xigmatek PSU and 64-bit Windows 8.1. All games are run at their highest settings with 4x MSAA at 1920 x 1080 except where stated.

Asus STRIX GTX 960 OC Edition

The ornitho-logically themed STRIX line gets the mid-range Maxwell treatment

Smaller, cooler and almost as quick. Though sadly more expensive too.

AS THERE ARE NO REFERENCE VERSIONS of the new GTX 960, it's all up to the manufacturers just how far they go with their cards. Nvidia has put out its own guidelines for base and boost clocks, but that's all they are. Because of that, the GTX 960 has spawned a glut of factory-overclocked cards being first out of the gate. But is that really where the sweet-spot lies for Nvidia's mid-range Maxwell?

As is its wont, Asus has released an owly version of the GTX 960 under its STRIX branding, replete with the always-impressive DirectCU II cooler. The stock 1,126MHz base and 1,178MHz boost clock laid out for the GTX 960 has been torn open once more, with the STRIX sitting at 1,291MHz and 1,317MHz respectively. Again though we didn't see the card at those frequency points once during testing. Our sample was instead intent on rock-solid gaming at 1,354MHz.

That shows just how much overclocking headroom there is in the GTX 960. Though the fact that the EVGA version is clocked even higher, yet still posts incredibly close gaming frame rates, does mean there's not really any great advantage to running at these speeds. But there's almost no reason not to. Temperature isn't really an issue, especially with the formidable cooling that Asus has layered on top of its GPU. The DirectCU II cooler on the STRIX kept our review sample running at its top overclock at only 58°C, considerably cooler than the ACX 2.0+ cooler on the EVGA SuperSC version.

Likewise noise isn't a problem either. The STRIX's fans only spin up once the GPU reaches 55°C, which means that on your Windows desktop the card is running entirely on passive cooling. And again those fans are incredibly quiet when they do get going.

TOO COOL FOR SCHOOL

So, why wouldn't Nvidia set its recommended clocks higher? Mostly for reasons of marketing and allowing its partners to charge that little bit more for overclocked iterations of its cards. After all, having huge overclocking figures on the packaging is a good sell for both Nvidia and the card makers.

And this brings us to the real problem with Asus's take on the GTX 960. The STRIX OC Edition is simply too expensive for such a middling GPU. At £190 it's a good deal more than other overclocked versions on the market, including the EVGA SuperSC. And it's a bit slower than that card too in the gaming benchmarks. Only a little slower because of the clockspeed differences, but still slower.

Because of the low-power, low-temp nature of the new GM 206 GPU, a £160 card – such as the Palit or Gigabyte cards – will offer similar levels of overclocking and gaming performance without the hefty price premium. And despite the impressive cooling, the STRIX isn't able to match the EVGA card's beastly overclocking prowess either. Our card tapped out at 1,478MHz, even though it was still only whispering away at some 58°C.

But this is the real triumph of the GTX 960. No matter how underwhelmed we've been with its overall performance, Nvidia has made a card where 1080p performance has been utterly nailed in a relatively small form factor and where noise, power and temperatures have all been rendered complete non-issues. Unfortunately for Asus though, the GM 206 doesn't need the might of the DirectCU II to achieve such feats, which means this kind of premium-priced, factory-overclocked version is mostly unnecessary. –DAVE JAMES

VERDICT 8

Asus STRIX GTX 960 OC Edition

+ STRIX Incredible cooling performance; small form factor.

– STRUCK OUT Comparatively expensive; the GM 206 doesn't need the DirectCU II.

£190, www.asus.com

BENCHMARKS

	Asus STRIX GTX 960	EVGA GTX 960 SSC	Sapphire R9 285
Bioshock Infinite (min/avg fps)	19/75	14/73	**17/78**
Company of Heroes 2 (min/avg fps)	20/32	**22/34**	19/33
GRID 2 (min/avg fps)	**70/90**	**70/90**	68/84
Peak temperature (°C)	**58**	73	68

Best scores are bolded. Tested with an Intel Core i7-4770K at 3.9GHz, Asus Maximus VI Hero motherboard with 8GB 1,600MHz DDR3, 1,200W Xigmatek PSU and 64-bit Windows 8.1. All games are run at their highest settings with 4x MSAA at 1920 x 1080 except where stated.

SPECIFICATIONS

GPU	Nvidia GM 206
CUDA cores	1,024
ROPs	32
Base clock	1,291MHz
Boost clock	1,317MHz
Memory capacity	2GB GDDR5
Memory bus	128-bit
PCIe power	6-pin

NO SOUND UNHEARD

FULL PC GAME INSIDE

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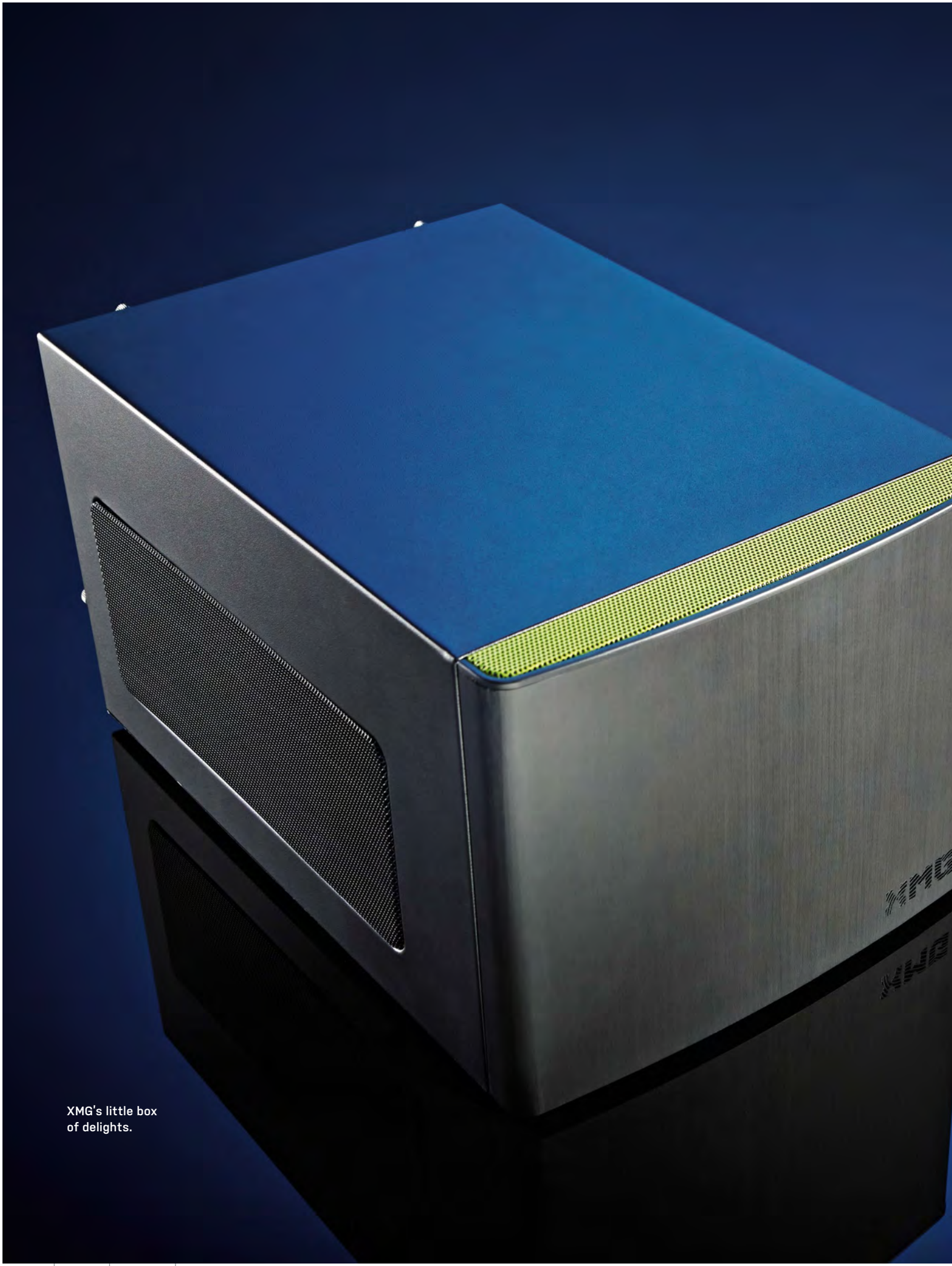

XMG's little box of delights.

XMG Prime Overclocked Nvidia Edition

An impressive tiny gamer that's a bit too pricey

THERE'S LITTLE DOUBT that were you to purchase this wee box of gaming joy from XMG, you'd be as happy as a badger at a barbecue pulling the Prime from its box. It's a quality gaming PC all the way from components to build to performance; but then it really ought to be considering you're paying nigh-on £2,000 for the privilege.

But a privilege it would be to own such a machine. The Fractal Design Node 304 chassis is as sleek and minimally stylish a Mini-ITX case as you could want, and being finished with the Nvidia-green highlights gives it a little edge, too. It's a visually pleasing system and also one that won't take up too much space. You're not sacrificing any functionality or performance opting for this smaller form factor.

Thanks to advances in motherboard technology and miniaturised case designs, the Mini-ITX motherboard is more than a match for its full-scale brethren and is the only compromise to diminutive components that you need to make. Everything else XMG has crammed into the Prime is standard ATX size, whether that's power supply, CPU cooler or graphics card.

The Gigabyte Z97N-Gaming 5 mobo is a quality mini motherboard, offering top-spec performance and is easily a match for the Devil's Canyon Core i7-4790K XMG has installed in this review machine. Our only issue with that Gigabyte board is the fact that, despite rocking the modern Z97 chipset, there's no support for PCIe-based storage in either SATA Express or M.2 trim. Granted, that's not a massive issue right now, but does put some needless limits on storage upgrades in the future.

The factory overclock this board offers the CPU though is a pretty hefty 4.5GHz. We've had the same board capable of hitting 4.6GHz with our old 4770K, so it could go even further were you feeling particularly sadistic towards the poor Devil of a processor. Also supporting this overclock is the Corsair H80i closed-loop liquid chip chiller. With a pair of fans arrayed around the cooling radiator in a push-me-pull-you configuration, it's able to keep the CPU cool and the machine quiet during use. Well, aside from at boot where the fans spin right up, like a heavy smoker's first deep lung-cough of the morning...

DEVIL'S ADVOCATE

On the graphics front we're looking at the top of the GPU tech tree right now, with our sights firmly on the pinnacle of Nvidia's Maxwell graphics architecture. The GeForce GTX 980 is supplied in EVGA Superclocked style. It's a moderately overclocked GPU, but is still essentially the Nvidia reference design with the same Titan-esque cooler and without the latest spin of EVGA's ACX cooling. That means you couldn't call the setup silent in-game, but it's definitely not loud enough to be any sort of problem.

The XMG Prime is up against a pair of the priciest gaming rigs we've tested in recent issues – the Carbon brothers from Chillblast and Scan. The Chillblast machine is some £700 more expensive, thanks to its twin-GPU AMD R9 295x2, and the similarly priced Scan is rocking a full X99 setup inside. The super-expensive Chillblast wins the gaming argument at the tested 1600p settings, and also has some serious 4K chops too, but the old GTX 780 Ti in the Scan rig is starting to show its age when throwing around *Battlefield 4*.

But gaming performance is pretty much a given, or ought to be, when you're spending this much cash on a PC. You don't have to though as XMG's configuration options do allow you to create a more reasonably priced setup, using an overclocked Devil's Canyon i5 and GTX 970 pairing offering performance that's not far off for a good £400 less. The Core i7/GTX 980 combo pushes the price up too much considering it isn't going to deliver decent 4K performance – you'll realistically be gaming at 1440p, or 1600p at most, and the GTX 970 is more than capable of that. At under £1,500 though we'd say the XMG Prime becomes worth very serious consideration in terms of both price and performance; this review spec though smacks of overkill. **–DAVE JAMES**

BENCHMARKS

	XMG Prime	Chillblast Fusion Carbon	Scan 3XS Carbon
Cinebench R15	896	886	**1,238**
X264 v4.0	54.33	53.97	**69.41**
Heaven 4.0 (min/avg fps)	**26.5**/42.3	8.5/**65.80**	8/44.3
Battlefield 4 (min/avg fps)	**61**/74	27/**86**	35/62
Metro: Last Light (min/avg fps)	21/32	**26/51**	22/33

Best scores are bolded.

VERDICT **8**

XMG Prime Overclocked Nvidia Edition

+ OPTIMUS PRIME Great chassis; beautiful build quality; great performance.

– ULTRA MAGNUS Super-pricey; still not a 4K gamer.

£1,885, http://mysn.co.uk/

SPECIFICATIONS

CPU	Intel Core i7-4790K @ 4.5GHz
Motherboard	Gigabyte Z97N-Gaming 5
Memory	2x 8GB DDR3 @ 2,133MHz
Graphics	EVGA GTX 980 Superclocked
Storage	250GB Samsung 840 EVO SSD, 2TB WD Black HDD

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- Two 4GB NVIDIA GeForce GTX 980 in SLI
- 16GB Corsair Vengeance 2666MHz DDR4
- 500GB SSD + 2TB HDD

The X99 Cyclone SLI is a fully water-cooled PC that features a hex-core Intel® Core™ i7 5820K CPU with Hyper-Threading which we overclock to 4.5GHz for amazing performance in your favourite games. It also has two 4GB NVIDIA GeForce GTX 980s graphics cards, which are also water-cooled so remain cool and quiet even in the most frantic games. Also included is 16GB of 2666MHz Corsair Vengeance DDR4, an Asus X99-S motherboard, a 500GB Samsung Evo SSD and a 2TB hard disk.

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- 8GB Corsair Vengeance DDR3 1600MHz
- NVIDIA GeForce GTX 860M
- 1TB HDD
- 15.6" 1920 x 1080 screen

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- Intel® Pentium® G3258 overclocked to 4.4GHz
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£639

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Our 3XS systems have been engineered to give you an edge over your competitors in the latest games. Each model has the perfect blend of cutting edge components to help you pwn noobs without breaking into a sweat.

3XS Z97 OC10

- Intel® Core™ 4690K overclocked to 4.6GHz
- Asus Z97-P Motherboard
- 8GB Corsair Vengeance Pro 2133MHz
- Phanteks U-Type

£419

Scan 3XS Graphite LG1720

- Intel® Core™ i7 4710HQ
- 8GB Corsair Vengeance DDR3 1600MHz
- NVIDIA GeForce GTX 970M or 980M
- 1TB HDD
- 17.3in 1920 x 1080 screen

£1149

3XS Z97 Performance GTK5

- Intel® Core™ i5 4690K overclocked to 4.6GHz
- 8GB Corsair Vengeance Pro 2133MHz
- 4GB NVIDIA GeForce GTX 970
- 240GB SSD
- Water-cooled whisper quiet

£1049

GAMING EXPERIENCE: GODLIKE

Unlock your true gaming potential with one of our 3XS systems. These no compromise systems provide the very best in frame rates in games thanks to their combination of overclocked CPUs and graphics cards.

3XS Z97 OC15

- Intel® Core™ i7 4790K overclocked to 4.6GHz
- Asus Republic of Gamers Maximus VII Ranger
- 8GB Corsair Vengeance Pro 2133MHz
- Corsair water-cooler

£569

Scan 3XS Graphite LG1725

- Intel® Core™ i7 4710MQ
- 16GB Corsair Vengeance DDR3 1600MHz
- Dual NVIDIA GeForce GTX 980M in SLI
- 1TB HDD
- 17.3in 1920 x 1080 screen

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3XS Z97 Vengeance 980

- Intel® Core™ i7 4970K overclocked to 4.7GHz
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Custom options are available on our entire 3XS range - we'll build it how you dream it

There's a hidden panel in the base that reveals replaceable op-amps.

Creative Labs Sound Blaster X7

The soundcard that's so nearly got it all

IN THE CONSTANTLY SHIFTING LANDSCAPE that is PC tech, soundcards have risked becoming a footnote, like dial-up modems and network adaptor cards before them. When a system seller like Dell or HP can shave even £15 off a build, it can shift the balance of power in a world of razor-thin margins. So when someone drops a device like the Sound Blaster X7 on us, it's almost disorienting. The X7 is a £330 audio station, available at a time when you can buy entire PCs for that much money. Creative Labs faces an uphill battle. What kind of beast could this be to justify its price tag?

At the heart of the X7 is the company's top-end ZxR soundcard. It features four digital signal processors on one die, a Burr-Brown PCM1794 127dB digital-to-analogue converter, a Texas Instruments PCM4220 analogue-to-digital converter, and a TI TPA6120A2 headphone amp capable of driving 600-ohm cans (it boasts 1/4-inch and 1/8-inch jacks). That gear might not sound familiar to you, but it's top of the line in the world of digital audio.

The back of the unit has a set of RCA jacks and banana plugs for analogue speakers, and the plugs are switchable between four and eight ohms. Out of the box, the X7 will drive two speakers at up to 38 watts, and you can buy an optional power brick that will push that to 100W. It connects to your PC with a bundled micro-USB connection, and has a full-sized USB port to act as a host for another device, such as a mobile phone or tablet. If that's not enough, the X7 has optical audio in and out. You can adjust its settings with an Android or iPhone app via Bluetooth and NFC. And besides the microphone jack, there's also an integrated beamforming mic. The X7 will do echo cancellation and noise reduction and let you fine-tune the width of the beam.

We could talk all day about the features inside this box – it will certainly keep audiophiles happy, and busy. The X7 also has Crystalizer, virtual surround sound, a loudness cut-off for nighttime viewing, Dialog Plus to make movie conversations easier to distinguish, and bass boosting, all under the collective banner of SBX Pro Studio. But audiophiles usually look down their noses at most of these, accusing them of unnaturally distorting the dynamic range of incoming sound. Creative Labs itself will tell you that the appeal of Crystalizer is subjective. The company says this feature can restore dynamic range lost when compressing audio down to an MP3 file and even undo dynamic range compression engineered during the compact disc mastering process.

WHERE'S THE HDMI?

For our ears, using a pair of AKG K240 headphones (the older version made in Austria) and Beyerdynamic DT 990 Pro cans, tweaking the equaliser during gaming produced cleaner acoustic distinction between booming explosions, the metallic rattle of a magazine reload, overheard conversation, wind and rain. Part of Crystalizer's impact also comes from a hidden volume boost of three to four decibels as soon as you activate it, which is a questionable move. But you can disable SBX entirely if you don't care for it, or adjust its software sliders.

The metal knob on the front of the X7 controls volume, and pressing it mutes all audio. Unfortunately, we don't get an input selector, nor does the X7 save profiles for different devices or scenarios. When you have audio from multiple sources, it will blend together. The X7 also lacks HDMI, so its use as a home theatre receiver is limited to lossy 5.1 surround sound. And although it's external, its dimensions and AC power brick disqualify it as a practical portable audio device.

The X7 is undoubtedly a premium piece of hardware, but that premium price means that it's fighting with devices that have better connectivity to appeal to true audiophiles. Gamers who want external and portable audio can find better options, in some cases from Creative itself, at a fraction of the price. **–TOM MCNAMARA**

VERDICT **8**

Creative Labs Sound Blaster X7

+ HI-FI Plenty of top-shelf components and features; lots of connections.

– LO-FI Pricey; unwieldy; lacks HDMI.

£330, www.creative.com

SPECIFICATIONS

Output	38W (100W w/ upgrade)
Audio processor	SB-Axx1
Signal-to-noise ratio	127dB (DAC)
Headphone amp	Up to 600 ohms
Supplied power adapter	2x 38W @ 4 ohms
Connectivity	USB 2.0; mini-USB; RCA; optical audio in/out; Bluetooth; NFC
Dimensions (H x D x W)	127 x 140 x 152mm

The Doko is one simple little streamer.

NZXT Doko

Stepping out of its chassis comfort zone, NZXT paddles into the stream

WE'VE GOT TO HAND IT to the Doko from NZXT. It really tries. And bless it, the little streaming box *almost* works. What we have here is a tiny client you plug into your 1080p television, then into your home PC's network, to allow you to use your rig as though it was directly connected to the remote screen. But there are some serious limitations to this bargain box of tricks which hold it back from being the smart little device we were really hoping for.

NZXT is primarily known as a chassis manufacturer, though it also makes PSUs and coolers too. The Doko is its first foray into the world of complete devices, partnering with streaming folk MirrorOp to marry its software to the off-the-shelf parts that NZXT has built the device from.

MirrorOp is a relatively established software setup, allowing the streaming of Windows and Apple PCs as well as phones and tablets too. The hardware that NZXT has used is an ARM 11-based SoC from Taiwanese manufacturer Wonder Media. Its Prizm WM8750 runs at 800MHz, with a 1080p video decoding engine and an H.264 encoder. It's also running with 256MB RAM and 8MB boot storage. All that adds up to a tiny box that's able to stream your Windows PC at 1,920 x 1,080, but only at 30Hz. It also has to be wired into the same network as your PC too as it's lacking support for wireless connectivity.

To make things as seamless as possible the Doko sports four USB 2.0 ports on the front, which operate exactly like plugging directly into your remote PC. It's ridiculously easy to set up too – just download the Doko software on your PC, start it up and the Doko device will spot your machine and get chatting. That means you can game with keyboard and mouse or with any controller of your choice. You can also plug in USB media as you would normally to view data, watch videos and so on. Seamless.

NO-FLOW ZONE

That's where it starts to go downhill though. On a side-by-side network in the office, with both the Doko and test machine plugged directly into the router, it works *okay*. There is noticeable input lag when you're using both mouse and keyboard and the video doesn't always stay particularly consistent. This is the big problem with it running at 30Hz. It would almost be acceptable if it remained at a constant 30fps, but even on the closest connection we could possibly make it was like an elderly gent at a urinal, struggling to maintain a consistent stream. When you're trying to game – a key selling point in NZXT's marketing strategy – that becomes a real pain.

And when you've got Steam's In-Home Streaming and Nvidia's SHIELD tablet offering better ways to access your games away from your desktop PC, it's tough for the Doko to really make a name for itself. Sure, it's a third of the cost of a SHIELD Tablet, but when the experience is nowhere near as good it becomes impossible to recommend on that front. We also had serious trouble across an otherwise rock-solid powerline network too. The lag became monstrous and it introduced severe artefacting on both the Windows desktop as well as in-game too.

Somewhat inevitably we arrive at one of those close-but-no-smoking moments. The Doko certainly does enable you to access your PC across a wired home network, and the USB functionality is neat, but it's low price doesn't make up for that inconsistent stream. –DAVE JAMES

VERDICT **6**

NZXT Doko

+ COUNT DUCKULA Bargain price; really simple setup; not bad for desktop work.

– COUNT DOOKU Inconsistent stream; 30Hz limit; struggles on powerline.

£100, www.doko.nzxt.com

SPECIFICATIONS

Processor	Wonder Media Prizm WM8750
RAM	256MB DDR3
Storage	8MB boot drive
Connections	4x USB 2.0, audio out
Video out	HDMI 1.3
Network	Gigabit Ethernet
Dimensions (H x D x W)	29 x 121 x 108mm

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- Cooler Master Liquid CPU Cooler
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Elite Vantage 2015

A well featured Mesh system at a knock-down price - An awful lot of PC for the price.

System specifications
- Intel® Core™ **i5 4590** Processor
- **MSI B85M - E45** Motherboard
- 1GB NVIDIA **GT 720 Video card**
- 8GB DDR3 1866MHz Memory
- 1TB SATA III - 6GB/s 7200rpm HDD
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Our No.1 Bestseller - The ideal gaming system to advance your playing power.

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- Intel® Core™ **i7 4790** Processor
- **MSI B85M - E45** Motherboard
- 2GB NVIDIA **GTX 750TI Gaming**
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- 1TB SATA III - 6GB/s 7200rpm HDD
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Elite 970 Special

The clue is in the name with this high-end power PC - Takes our offer of the month slot with ease.

System specifications
- Intel® Core™ **i7 4790** Processor
- **MSI B85M - E45** Motherboard
- 4GB NVIDIA **GTX 970 Gaming**
- 8GB DDR3 1866MHz Memory + 120GB SSD
- 2TB SATA III - 6GB/s 7200rpm HDD
- Zalman Z3 Plus Gaming case
- Microsoft Windows® 8.1
- **Lifetime Gold Warranty***
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The weighty little Woojer tit-kicker.

Woojer

Haptic feedback for your moobs

A SILENT, WEARABLE WOOFER. That's the claim Woojer is making about its... er... Woojer. It truly is a bizarre little device, designed to translate sound into feeling with the idea of immersing you more deeply into the music you're listening to, game you're playing, or movie you're watching.

And how is it to do this? By sitting in the middle of your chest, or just above your bottom, vibrating at different levels depending on the bass notes being pumped out of your system. Using a 3.5mm jack, you plug the Woojer into your PC and then your headset (or speakers) into a second 3.5mm output on the wee device. The Woojer then picks up the sound passing through it and vibrates. With its placement on either your breastplate or at the base of your spine, the Woojer is meant to translate the bass-picked rumbling throughout your body to fool your brain into believing the effect was all-encompassing. And bless it, the Woojer certainly does try.

It's simple to use – just charge it up, wire it in and play your games. There are no drivers to install as it translates the vibes in the hardware itself, leaving you to just strap it to wherever feels most comfortable and enjoy the rumbles. We suspect there may be a few 'other' uses for it, but our innocent minds can't think what they might be (speak for yourself - Ed).

As far as it goes the effect really isn't bad. We had to max it out for gaming – the device has three levels of intensity – and flip it around so the main bulk of the Woojer was pressed against flesh rather than the clip side. Set up like this the Woojer simulated the background rumble of an intense *Battlefield 4* war zone rather impressively. It was less impressive when it was trying to simulate things actually happening to your character – the haptic punch from being shot didn't translate particularly well at all.

Things were a little more intense switching tack and jumping into our Cobra Mk III in *Elite: Dangerous*. The almost constant rumble of our craft's engines, the docking clamps shifting it about and the hit of leaping into hyperspace really came through the Woojer's tactile vibrations.

ALL ABOUT THAT BASS

But did it enhance our experience? Did it feel more immersive? In a fairly miniscule way, yes. But at the same time it's a lot of effort and expense for the relatively minor difference it will make to your gaming experience. Having ever more wires trailing around your desktop doesn't help either, especially given the 3.5mm lead connecting the device is just 1m long and we've already got the TrackIR's extra cabling on our headset.

In truth we've seen few gaming vibration devices ever convincingly add anything to our games. Rumble pads, ButtKickers or compressed air-powered vests have all failed to impress. The only haptic response that's ever genuinely added anything has been from force feedback steering wheels actually delivering important information, through the steering, about what your vehicle's wheels are doing and the terrain they're traversing. That's information you couldn't get any other way and can totally change the way you play driving games.

The Woojer though isn't going to bring anything new to whatever you do with your PC. It does do what it says it will, but is that anything we'd actually want to pay for or would bother to make the effort of attaching to ourselves whenever we wanted to play a game? Woojer? No, we wouldn't. –DAVE JAMES

VERDICT 5

Woojer

+ WOOJER Decent background rumbles; easy to use.

– WOULDN'T Awkward trailing cables; doesn't really add anything tangible to our games; rather pricey.

£79, www.woojer.com

SPECIFICATIONS

Dimensions	68 x 41 x 23mm
Weight	73g
Latency	1.3ms
Battery	700mAh, 3.7V lithium-ion
Battery life	Three hours (high volume 'club' music)
Warranty	One year

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†Monitoring Report of the European Recovered Paper Council, (ERPC), 2010

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TWO SIDES

Samsung Portable SSD T1

The fastest external drive we've ever seen

Small, sleek and super-speedy.

STORAGE ISN'T SEXY. For all the advances of the last few years, mostly in terms of solid-state drives, it's still difficult to talk about PC storage in any way other than terms of functionality. We all want our PCs to boot from SSDs because of their in-OS speed, but they're not really going to make our games perform better or look more awesome. We're still always going to prioritise a quality graphics card.

But that's not to say things aren't rather interesting in the world of the SSD. It's one of the youngest, most vibrant areas of computing and has seen constant improvements as new tech, new controllers and new memory have arrived, boosting performance and reliability, though that's mostly been restricted to internal 2.5-inch drives.

Our first experiences with solid-state storage came with the faithful ol' USB stick and things have barely moved on in anything bar the capacity stakes for years. Of course we did have the switch from USB 2.0 to 3.0 back in late 2009, which hugely boosted the possible bandwidth, but still the overall speed of our external drives has always been a fraction of what you can get out of modern SSDs. And that's still true when you're talking about sticking a speedy SSD in an external USB 3.0 caddy too.

Samsung though has been riding the market mighty hard and are doing a damn fine job of making it very difficult to recommend anyone else's drives. And now they've split out into the external market, too, with this Portable SSD T1.

It's rather tough to get across just how small this drive is. When we first saw the initial images from CES in January, we weren't that impressed. Cut a few days forward to us receiving our sample in the lab and we're slack-jawed and drooling like the magpie-eyed geeks we are. It's almost exactly half the size of a 2.5-inch SSD. But the real kicker is it performs almost as quickly as most SATA 6Gbps drives.

In the SSD-taxing AS SSD benchmark we recorded average read and write speeds of 420 and 406MB/s respectively. That's seriously quick for an external drive, and the random 4K results were almost as impressive, hitting 23 and 37MB/s for its read/write performance. That's faster than the current SandForce-powered SSDs. You could theoretically run your OS from this drive and see little difference between it and a modern internal SSD.

LITTLE WONDER

This is over a simple, short USB 3.0 cable too. There's no magic to the 5Gbps USB 3.0 cable, we hit identical drive performance using a third-party cable from another USB 3.0 external drive. We say this because our worry was that Samsung had hocus-pocused the cabling somehow and we'd be royally screwed losing it, but thankfully that isn't the case.

We're used to using external SSDs over USB 3.0, as we run our benchmarking suite from an SSD using a SATA 6Gbps to USB 3.0 adapter cable and that's provided a speedy storage option that has been a mainstay in our testing suite. Our love has shifted though, as that drive is only half as fast as this super-speedy Sammy drive.

The big problem is that performance costs a pretty penny. This 500GB version is £230 and the 250GB version is still around £140, albeit with the same performance. That's a huge amount to pay for external storage. But for the pro-crowd, needing to regularly transfer big files, that spend may just be worth it. –DAVE JAMES

VERDICT **9**

Samsung Portable SSD T1

+ SSD Super-quick; tiny; lightweight; robust.

– OMD Super-expensive.

£230, www.samsung.com

SPECIFICATIONS

Capacity	250GB, 500GB, 1TB
Interface	USB 3.0, 2.0
Encryption	AES 256-bit
Dimensions (H x D x W)	9.2 x 53.2 x 71mm
Weight	30g
Warranty	Three years

BENCHMARKS

	Samsung T1 500GB	Samsung 850 Pro 512GB (SATA to USB 3.0)
AS SSD sequential read/write performance (MB/s)	**420/406**	248/239
AS SSD random 4K read/write performance (MB/s)	**23/37**	16/25
5GB zip compression (sec)	**87**	98
30GB file transfer (sec)	**179**	187
Peak transfer speed (MB/s)	**341**	206

Best scores are bolded.

Well-priced and functional, but little more than that.

MSI 970 Gaming

Bargain-priced AMD 970 board anyone? Anyone?

YOU MIGHT THINK THERE'S as much point building a new motherboard based on the elderly AMD 970 chipset as there is making a new transmission for a Model T Ford. But there is some method to MSI's madness. AMD has more or less given up on its FX range of CPUs, we can pretty much all agree, but it has gone and released some 'new' chips over the last six months.

We're using the floating punctuation there because none of the latest procs are using AMD's latest x86 CPU architecture, sticking instead with the old, inefficient Piledriver design. It did release the 9000 series processors however, with huge 220W TDPs and ambitious base and turbo clocks. Where this latest board makes sense though is with the lower powered E-series chips AMD also released late last year. The FX-8320E and FX-8370E are both 95W parts and that's what MSI has designed its 970 Gaming to support.

As you'd expect from a £73 mobo, the 970 Gaming isn't crammed with features. But it's not as bad as you might think. There are no PCIe storage interfaces, no PCIe 3.0 slots for your graphics cards and no board-mounted switches for overclocking and the like. No, this is a basic board designed to be dropped into a relatively low-end gaming PC and forgotten about. And to that end it's pretty effective. Those lacking modern touches aren't an issue for a board designed for this price point and the PCIe 2.0 slots are enough for the sort of setup you're going to build with this board too. After all, it's not the available PCIe bandwidth which will hold back your GPU's performance – that will be down to the lackadaisical AMD CPUs you're limited to fitting into it.

ONE FOR THE LOYALISTS

Despite the 970 chipset lacking native USB 3.0 support you do still get a handful of compatible ports, thanks to a pair of VIA chips. SATA 6Gbps support is there, offering six little black slots for your storage needs. And even without the OC Genie button on the board itself there's a software function you can access through the BIOS screen. You can get your hands dirty too and overclock manually – we got our old FX-8350 CPU up to the same 4.6GHz we managed from an Asus 990FX board, so it's definitely a tempting overclocker.

Inevitably, compared with a 990FX setup, performance is down. Our *BF4* numbers were around 10fps lower and straight CPU performance was a fair way off too. But considering the 990FX we're comparing it to is still over twice the price it's tough to complain about it.

What's hard to figure out though, is who we'd think should pick up the 970 Gaming board. For any PC gamer out there, we'd always recommend going for an Intel-based platform. Even if you don't go for a K-series Core i5, a proper quad-core 4570 with a cheap H97 board will outperform the similarly priced FX-8350, let alone the lower-powered E-series variants. And that's in both CPU tests and most especially gaming. MSI's 970 Gaming then is a decent, low-price AMD board. But it's only really a recommendation for the devout AMD followers determined to boycott an Intel upgrade. **–DAVE JAMES**

VERDICT 7

MSI 970 Gaming

+ GAMEY Great price; over clockable; decent feature set.

– GAMMY Elderly AMD platform; no native USB 3.0 or PCIe 3.0.

£73, www.msi.com

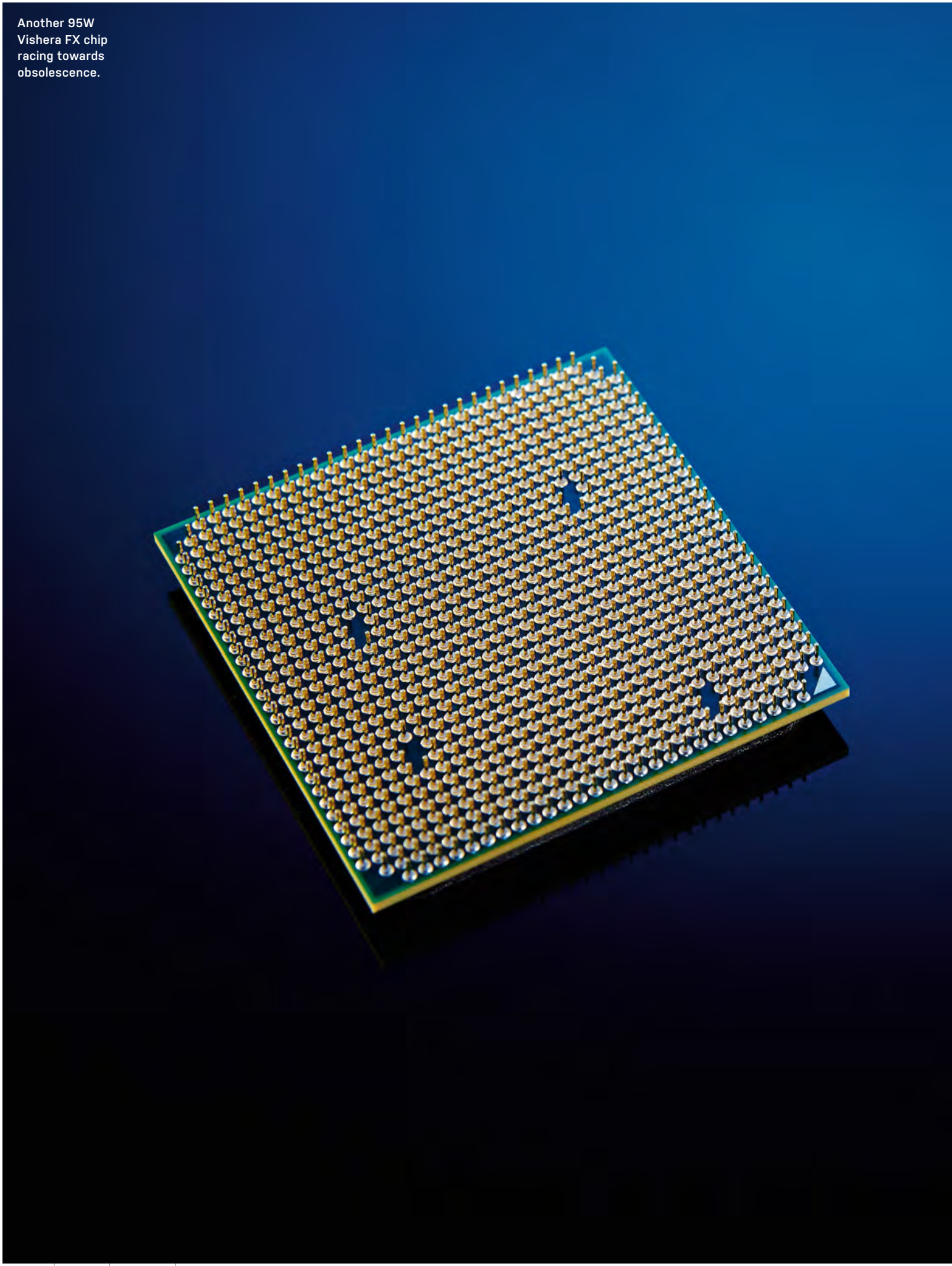
BENCHMARKS

	MSI 970 Gaming	Asus Crosshair V Formula
Cinebench 11.5 (index)	6.14	**6.83**
CB 11.5 @ 4.6GHz (index)	7.04	**7.75**
X264 v4.0 (fps)	36.52	**43.85**
Battlefield 4 (min/avg fps)	45/68	**54/79**

Best scores are bolded. All tests were carried out with an AMD FX-8350 at stock speed (apart from where stated), 8GB DDR3 @ 1,600MHz in Windows 8.1 64-bit. The gaming test used a reference GTX 780 Ti at top graphics settings with 4x AA and at 1080p.

SPECIFICATIONS

Chipset	AMD 970
CPU socket	AM3+
Memory compatibility	Dual-channel DDR3
Memory speed	Up to 2,133MHz
GPU support	2x PCIe 2.0 x16
Multi GPU support	AMD CrossFireX
Storage	6x SATA 6Gbps
Back panel	2x USB 3.0, 8x USB 2.0, PS/2, Optical S/PDIF out, audio in/out, Killer E2205 Gigabit ethernet



Another 95W Vishera FX chip racing towards obsolescence.

AMD FX-8320E

A budget octo-core CPU, but is it cheap enough?

WHEN AMD TELLS US it's sending over a new FX-series CPU, we can't help the sudden rush of excitement. It's an automatic response, born of a time when a new AMD CPU had the potential to offer something genuinely competitive. But those days seem long gone. All we get now are half-hearted revisions of increasingly elderly chips.

The FX-8320E is the perfect example of that. AMD released this chip late last year, along with the FX-8370E as a pair of lower-powered octo-core CPUs for the more power-conscious consumer. These two chips use AMD's Bulldozer processor tech and squeeze into a 95W TDP. They're able to do this by utilising a lower base clock, retaining the same Turbo clock as their non-E brethren. To that end, this FX-8320E is running at 3.2GHz as standard, with the ability to hit 4GHz as needed. The standard FX-8320's clockspeed sits some 300MHz higher at 3.5GHz.

So far, so good. For 30W less power you only sacrifice 300MHz of CPU horsepower, which seems like a pretty good trade-off. But the fact these CPUs are still running with an outdated version of the Bulldozer architecture makes them seem more like an afterthought than a proper processor release. In the Kaveri APU, launched a year ago, AMD used the latest revision of Bulldozer, codenamed Steamroller. Its next APU, Carrizo, will use the final Bulldozer revision which is codenamed Excavator. This 95W processor then, using the old Piledriver architecture, is two generations behind AMD's top x86 CPU cores. And it doesn't look like it has any interest at all in shifting the FX range over to the Excavator design, despite the IPC (instructions per clock) boosts that both the Steamroller and Excavator tech have over Piledriver.

THE COST OF SAVING

What's the game with the FX-8320E then? You'd assume that with the focus on hitting a lower TDP, this chip would be looking at small form factor machines, but that 95W TDP is still higher than the 84W Haswell Core i5 processors, even the K-series versions. But then there's the price. At just over £100, this is the cheapest eight-core CPU around – even if you baulk at referring to its quad-module design as a full octo-core setup it still sits as the cheapest, eight-threaded processor you can buy.

In this context, suddenly the FX-8320E looks like a more intriguing purchase. That's especially true if you're sitting on a lower core-count AM3+ chip and feel the need for an upgrade. In performance terms – in both straight CPU and gaming tests – the FX-8320E is evidently behind both the FX-8350 and Intel Core i5-4570, but it's a good £30-50 cheaper than those more powerful chips. And because it's an AMD chip, without the needless limitations imposed on it by overzealous marketing execs (looking at you, Mr Intel K-series), you can get happy with the overclocking. Well, should your chosen chip and board be capable of it anyways.

Our sample wasn't very happy running anything above 4GHz. We got a little more out of it with some voltage tweaks, but not enough to keep it stable on the 970 chipset board we were testing it in. Still, at that speed on all cores it runs mighty close to a stock-clocked, full-fat FX-8350.

For the AMD upgrader then, it's not a bad budget option. If you're looking to build an all-new machine though we'd still struggle to recommend an AMD setup. Even though you're getting eight threads of processing power, a resolutely quad-core, unoverclockable Core i5-4570 will still deliver better CPU performance, and in a smaller power envelope too. The Intel platform is also going to be more up to date and not much more expensive either. While AMD's AM3+ chipsets were queuing up for their pensions, Intel's motherboard chipsets were busy fitting themselves out with native USB 3.0 and PCIe 3.0 support...

And then there's gaming. If you're a PC gamer, your AMD CPU is stealing frames from your graphics card. The difference between the Core i5-4570 and this FX chip is nearly 20fps on average at 1080p settings with the same GPU. And that's with a 50W peak platform power saving over the AMD offering too. Yes, it's initially a cheaper option, but you're paying a different price going the AMD route. **–DAVE JAMES**

VERDICT **7**

AMD FX-8320E

BRIAN DENNEHY A decent upgrade for an AMD setup; relatively cheap.

BRYAN BROWN Old, old tech; still more power-hungry than Intel; no native USB 3.0 or PCIe support.

£105, www.amd.com

BENCHMARKS

	AMD FX-8320E	AMD FX-8350	Intel Core i5-4570
Cinebench R15 (index)	456	**570**	543
X264 v4.0 (avg fps)	29.41	36.52	**37.09**
Total War: Rome 2 (min/avg fps)	31/50	36/54	**41/62**
Battlefield 4 (min/avg fps)	43/58	45/68	**54/77**
Peak platform power (watts)	173	234	**115**

Best scores are bolded. The AMD tests were done at stock speeds on an MSI 970 Gaming motherboard, with 8GB RAM @ 1,600MHz on Windows 8.1 64-bit. The Intel tests were done on an Asus Maximus VI Hero motherboard with 8GB RAM @ 1,600MHz on Windows 8.1 64-bit. The gaming tests all used a stock GTX 780 Ti running at top settings with 4x AA and at 1080p.

SPECIFICATIONS

Socket	AMD AM3+
Core technology	AMD Piledriver
Clockspeed	3.2GHz (4GHz Turbo)
Core modules	4
CPU threads	8
Lithography	32nm
Cache	4x 2MB L2, 8MB L3
TDP	95W

The matte black coating hides psychedelic colour-changing abilities.

Corsair M65 RGB

I can shoot a rainbow, shoot a rainbow, shoot a rainbow toooo

WHAT IS THE COMPUTER mouse missing? It already has buttons, wheels, lasers, optics, weights, pulleys, secret chambers for hiding priests and fluffy patches you can stroke to reduce blood pressure. The bespectacled, white-coated boffins at Corsair, however, think they've struck upon the answer. What the computer mouse needs now, more than anything, is colour!

That's right, the thing hidden beneath your hand needs to be more colourful, to be a resplendent peacock advertising its virility in the hope other mice from across the district will come and mate with it. The M65 RGB claims to be able to display 16.8 million colours, which is presumably a rounded-up figure representing the 16,777,216 colours of the 24-bit RGB colour spectrum. The human eye, in comparison, can distinguish around 10 million colours.

You can literally make sunshine blaze out of the mouse's backside, as the illumination for the rear Corsair logo spills out of the back of the unit – where the casing has been pared away – and on to your desk. A beam also issues from the front of the mouse, as the wheel illumination leaks out, although at an infuriating angle.

Once you've finished customising, what are you left with? You get an 8,200dpi infrared laser diode on the bottom of an aluminium unibody that apparently lowers weight and increases rigidity. Although, frankly, if it's your mouse that's lacking rigidity in your hand, then you're doing something very wrong. It is much lighter than it looks, however. Weight distribution, the issue of which keeps some gamers up at night, is said to be 'optimal' – but that hasn't stopped Corsair from including three tuning zones on the bottom of the unit for you to adjust the weighting further with a screwdriver.

GETTING TOUCHY FEELY

In the hand, the body of the mouse feels broad and low, with a satisfyingly large contact patch below Mrs Palm. Her five lovely daughters get slightly uneven treatment, however, with the two fingers that rest on the main buttons kept happy but the little finger occasionally left to fidget in space as the body of the mouse vanishes at the wrong point. The edges of the body panels aren't too protrusive, and it's generally a comfortable mouse to use once you've got used to how low it sits.

The M65 has a smooth black coating on its upper surfaces that feels rather luxurious. The lower surfaces have a similar coating that's missed a few turns of the polishing machine, and which are halfway into fine sandpaper territory. It won't be taking any layers of skin off, but it's some of the roughest material we've ever felt on a mouse. This does have its uses – the M65 won't be slipping out of your fingers no matter how much sweat pours down your wrist.

The main buttons, rated for 20 million clicks, feel responsive, while the sniper key that reduces sensitivity so you can pull off smooth headshots falls perfectly under the thumb (if you're a right-hander, no ambidextrousness here). The two buttons above it are less perfectly placed, however, being just a little too indistinct from one another for our tastes. The mouse's greatest component must be its absolute beauty of a wheel: broad and grippy, with absolutely no chance of spinning it too far, it gives just the right amount of feedback as you turn it.

There's a good mouse here under the absurd customisation claims. You could easily use it all day without getting hand-fatigue, and the excellent wheel will still be providing manual satisfaction weeks after you start using it. –IAN EVENDEN

VERDICT **8**

Corsair M65 RGB

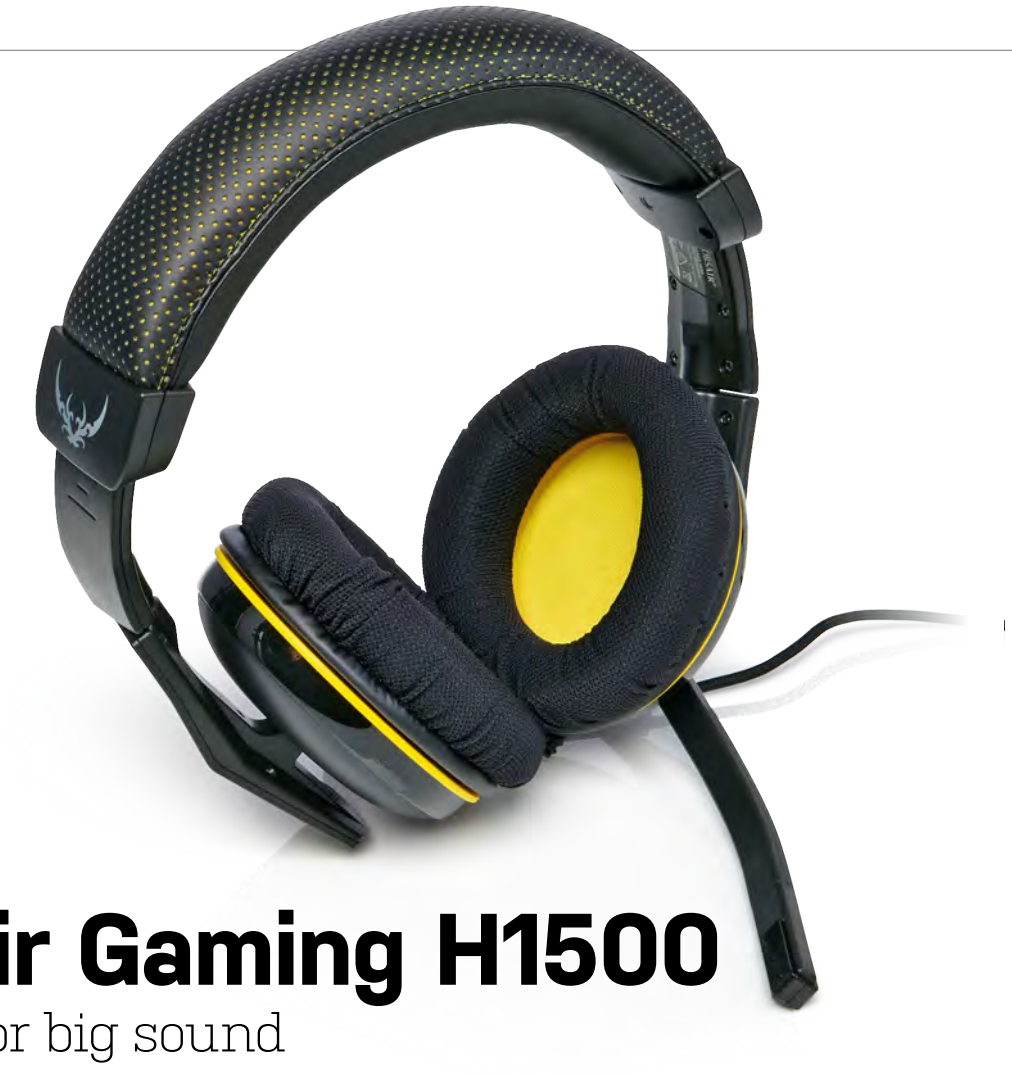
POTENT Looks great, feels great, moves great; it's got a wheel to die for, if that's not going too far.

RODENT This insane amount of colour customisation in a mouse is simply stupid, stupid, stupid.

£60, www.corsair.com

SPECIFICATIONS

Sensor	Laser
Max sensitivity	8,200dpi
Programmable buttons	Eight
Colours	16.8 million
Max response	1,000Hz



The striking black and yellow scheme is a bit of a departure for Corsair.

Corsair Gaming H1500

Big cans for big sound

WE SHOULD WELCOME MODEL numbers back to peripheral naming. They bring a simplicity to the product that would be lost if the marketing department were allowed to take a hit of clarky cat and name this the Pickelhaube XC71-T or the Aural SFX-treme. Numbers have defined PC parts since the 8086. It's good to have them back.

Eight. That's a number too. It's the number of speakers this 7.1 surround sound headset attempts to emulate. It's questionable how much someone with Mark I human ears would notice the difference between 7.1 and 5.1 in their headphones, as the separation of the sound sources is so much smaller than if they're dotted around your room. The technology at work here is Dolby Headphone, digital signal processing witchcraft that crunches a surround sound mix and pipes it to any pair of headphones, retaining a surround-like effect in the process. This can work well in big headphones, as their proximity to your ears is known and the closed-back design helps cut out extraneous noise.

The cans themselves are vast, completely encircling the most BFG-like of ears. They're nicely padded too, the sprung headband never feeling as if it's going to squeeze your head like a teenage pimple. Corsair has made daring and fashion-forward choices for the colour scheme, marking it out in bold black and yellow, but with blue lights on the inline remote. A more expensive wireless version omits the yellow for a fully blue outfit.

Naturally, headphones live or die based on their sound quality, and that put out by the H1500s really is pretty good, sounding clear, precise and remarkably loud. On first plugging them into a USB port and using the Corsair software to test them, we had to turn the volume right down to two. The 50mm drivers are probably the main reason for this, and you have to turn the volume up a long way before you begin to get distortions – up beyond the level our delicate little ears were comfortable with.

The closed nature of the headphones, along with the Dolby cleverness, certainly leads to an immersive soundscape. Standing in Havana in *Assassin's Creed 4: Black Flag*, the sounds of the city swirled around, although those coming from behind weren't really behind, not like they would've been with discrete rear speakers.

LOUD AND PROUD

In *Elite: Dangerous*, the rattle as our battered Eagle accelerated was pronounced, and we noticed the South African accent of the poor bloke giving us permission to land then watching, face on palm, as we mucked it up. Our piloting skills might be questionable sometimes, but at least we heard every scrape and thump. The low frequencies of starship engines were particularly good to hear, as in *Wolfenstein: The New Order* the sound mix tended a bit too far toward the treble, its meaty assault rifles never gaining the thick sound they deserve.

There's a microphone stuck on the front too, a boom design that can be easily swung out of the way when not needed. It's a noise-cancelling model, and in our tests caused no problems. But it's a little stiff, so if you need to pull it closer to your mouth you may have issues with it staying put.

It's unlikely anyone would use these for listening to classical music, unless it was accompanying a helicopter attack, but Corsair has produced a quality headset for gamers, with unsubtle, punchy sound reproduction that's simple to set up, comfortable to wear for long periods and packs a decent mic too. **–IAN EVENDEN**

VERDICT **8**

Corsair Gaming H1500

OF COURSE Big, comfortable headphones; clever surround sound tech targeted at the gamer.

NO THANKS Lack subtlety; can be too trebley; make you look like a dork.

£63, www.corsair.com

SPECIFICATIONS

Frequency response range	40Hz – 20KHz
Driver size	50mm
Connection type	USB
Cable length	3m
Mic	Unidirectional noise-cancelling condenser

The W1070+ is an incredible projector for the money.

BenQ W1070+

A budget beamer you can't afford... to ignore

NOT TOO LONG AGO, a projector of any kind was a luxury most of us could ill afford. And even if we could afford it, we couldn't really justify it. Not when the dingy beamers of yesteryear were so useless during the day and when anything even half cinematic in terms of image quality cost thousands. If that's roughly where your thinking still is with projectors, may we suggest you take a quick look at the BenQ W1070+. It'll throttle such misconceptions with the nearest HDMI cable to hand. It really is awfully impressive and utterly cinematic, especially for the money.

Right out of the box this thing is spectacular. The default settings are bang on the money, which we think is important for a projector at this end of the market, often bought by first timers looking at home cinema. The image is bright and oh-so-clean. Focus across the image is flawless and the black levels are as good as you'd hope for a DLP effort rated at 10,000 to one for static contrast. Okay, there actually are projectors with even better blacks, but not at this price. The W1070+ nails darker tones as well as a projector costing thousands of pounds from just a few years ago.

Both the black and white scales are hard to argue with at default settings too, with little to no evidence of compression. Yippee. Overall, it's just one hell of a punchy, vibrant, full-1080p projector. And did we mention how affordable it is?

While we're singing the W1070+'s praises, the optional wireless HDMI kit is nice, too. It's based on adaptor boxes at both the source and receiver end of the equation, which is handy if you want to use it part time with a different display of some type. It also comes with a nifty little remote control for switching sources. Nice. The whole shebang is 3D-ready as well, though doesn't come with glasses in the price. But then there's only so much you can expect for the money.

CHEAP AND CHEERFUL

If that's a healthy retinue of reasons why the W1070+ is a winner, here come some areas where it's not so wonderful. For starters, it's all built into a small, cheap box. That may be handy for tight spaces, but it certainly makes for a rowdy little projector in terms of noise. You're also not going to get decent optics in this class of device. Okay, the geometry is actually spot on. But there's no lens shift, so positioning is key to achieving a good image. As it happens, that's not necessarily going to be easy given yet another drawback of the cheap optics, namely a limited zoom range. It means you have to position the projector in quite a specific location to achieve a given size and location of image. Flexible the W1070+ most certainly is not.

Like pretty much any DLP at this end of the market, the dreaded rainbow effect makes an appearance here. As ever, it's one of those things that some notice more than others. If it's a major issue for you, the W1070+ may not be the best choice. Oh, and the one-year or 1,000-hour lamp warranty is pretty stingy too.

That said, we're willing to forgive the W1070+ quite a lot given its tempting price point. It would simply be unrealistic to expect a full-feature, 1080p DLP beamer in a box big enough for near-silent cooling and complete with lens shift and wide-range zoom. But what you do get is seriously snazzy image quality that will blow any HDTV clean out of your living room. Even at this low price, we'll happily admit that a projector isn't going to be an automatic purchase, but it is one we think you can't afford to not even try. And this BenQ wouldn't be a bad place to start experimenting at all. –JEREMY LAIRD

VERDICT **8**

BenQ W1070+

OSCAR WINNER Affordable for a decent 1080p DLP projector; zingy image quality; lots of features.

RAZZIES WINNER Noisy fan; cheap optics; stingy lamp warranty.

£639, www.benq.com

SPECIFICATIONS

Projector type	Single-chip DLP
Native resolution	1920 x 1080
Brightness	2,200 lumens
Contrast	10,000:1 (static)
Projection ratio	2.59 - 2.87:1
Inputs	2x HDMI, component, composite, MHL
Wireless connectivity	Wireless Full HD Kit is optional (£235)
Projector warranty	Two years (one year or 1,000 hours for lamp)

The EH-TW6600W is a big old beamer designed with movies in mind.

Epson EH-TW6600W

The LCD alternative to DLP dominance is still alive

IGNORANCE, THEY SAY, IS BLISS. We don't know for sure about that, but just occasionally it can certainly come in handy for reviewing products. Like this new Epsom projector for instance.

When we first fired it up, it looked pretty darn nice. Except the black levels weren't quite what we're used to with the latest DLP beamers. And that was when we remembered. Epsom only does LCD projectors. Ah. Of course. Had we known from the get-go, we'd have already been expecting mediocre black levels. And expectations can get in the way of objective assessments. But not here. We really did notice the black levels. Hold that thought. Let's get the basics covered first.

The Epson EH-TW6600W is a full-on movie projector rather than an all-rounder. That means it's a bit pricier than your typical all-purpose beamer. In return, you get a large chassis that allows for a bigger and therefore quieter fan. This thing makes very little noise.

You also get proper optics. By that we mean firstly a setup that maintains focus when you adjust the size of the image. Secondly, there's significant lens shift available. In other words, you can adjust the trajectory of the image with the lens rather than ratcheting up and down some shonky legs. Finally, there's a generous 1 to 1.6 zoom factor. That allows you to stick this thing in most rooms and achieve your desired image size.

Next up, there's wireless HDMI functionality. In this case, there's an adaptor for plugging into your source, or sources (it sports no fewer than four HDMI inputs). But the wireless receiver is integrated into the chassis. That's tidy, but it means you won't be able to use the wireless HDMI for other displays. As ever, your mileage will vary in terms of signal integrity. It may work room to room depending on wall thickness, but it's better as a line-of-sight connection. Anyway, the other major feature is active-shutter 3D support (including over the wireless HDMI connection) which you can take or leave. We'd mostly leave it, but for 3D fans it's nevertheless part of the package.

NATURAL BEAUTY

As for performance, let's get back to those blacks. While noticeably off the pace set by the latest DLP units, don't go thinking the TW6600W lacks contrast. It's a very plausible cinema projector. Notably, colours and especially skin tones are that little bit more natural than DLP technology, which looks spectacular, but can be a bit contrived and over-saturated.

On the downside, the default settings involve quite a bit of compression in both whites and blacks, so you'll need to manually tweak colours and contrast if accuracy gets your knickers in a twist. We also note that while achieving consistent focus across the image is easy enough, image geometry is a little off. The picture isn't quite perfectly rectangular. Nor is it blazingly bright, which isn't a surprise given the 2,500 lumens rating.

The final demerit regarding image quality involves some hideous digital pixel sharpening enabled by default. It can be disabled (though the setting is comprehensively buried in the OSD menu), but it's awful and shouldn't be on by default.

All of which makes this Epsom projector an acquired taste. We can understand how movie buffs who prize a natural cinematic image over visual pop could well favour the TW6600W. The wireless connectivity is a real boon for achieving a neat installation, too. But as an all-round proposition for games and daytime use along with movies in the evening, there are simply better, cheaper options. –JEREMY LAIRD

VERDICT 7

Epson EH-TW6600W

+ CINÉMA VÉRITÉ Lovely, natural colours; super optics; very quiet; easy wireless connectivity.

– TV MOVIE Mediocre black levels; iffy geometry; duff default settings.

£1,699, www.epson.co.uk

SPECIFICATIONS

Projector type	Triple LCD
Native resolution	1920 x 1080
Brightness	2,500 lumens
Contrast	70,000:1 (dynamic)
Projection ratio	1.32 - 2.15:1
Inputs	2x HDMI, component, composite, VGA, MHL
Wireless connectivity	4x HDMI
Projector warranty	Two years (three years or 3,000 hours for lamp)

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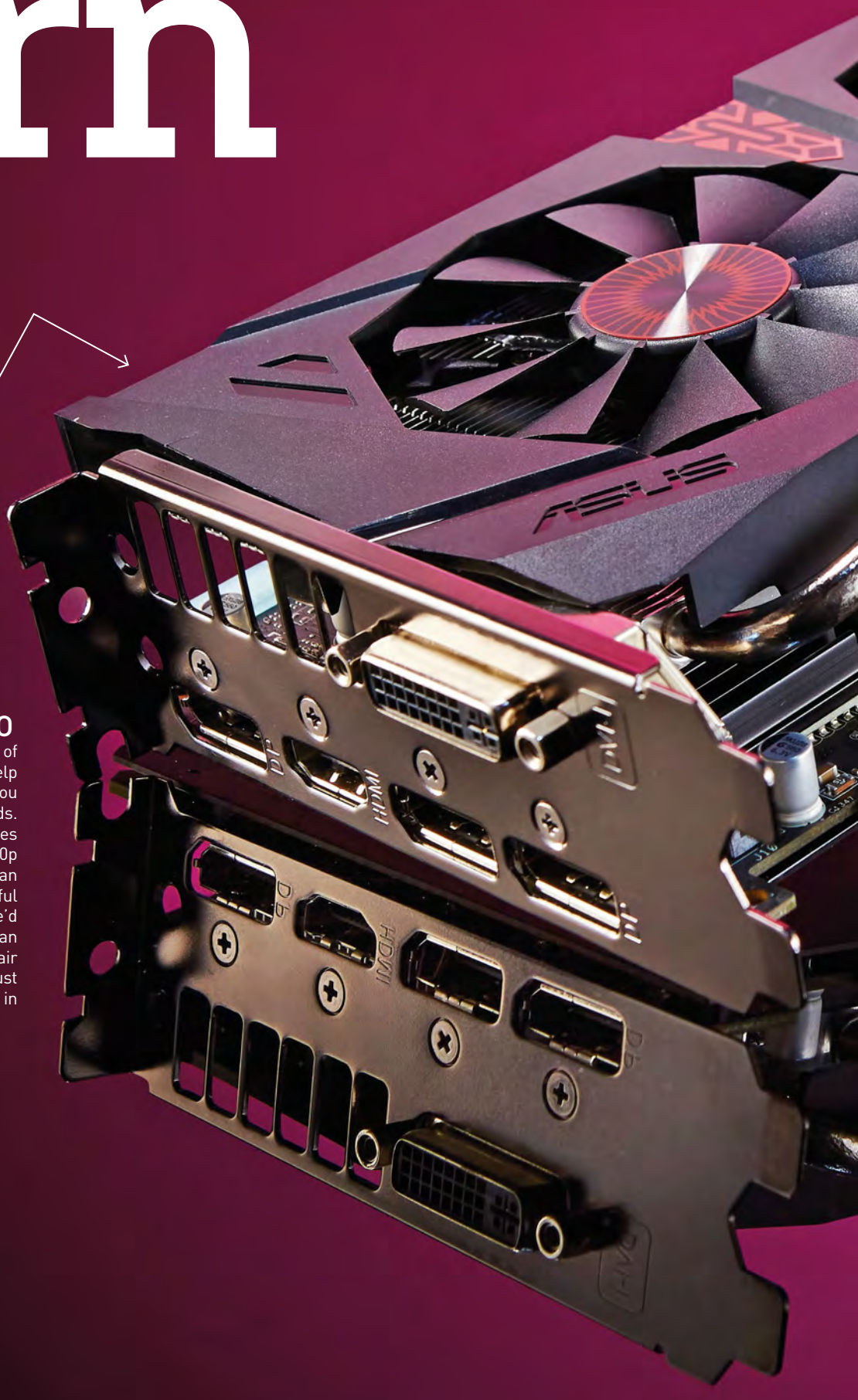


1 THE POWER OF TWO

When it comes to the lower end of the graphics card market we can't help but think about the SLI performance you might get from a pair of these boards. Unfortunately, while they can sometimes best a GTX 980 – notably in *BF4* at 1600p – the 128-bit bus really hobbles such an SLI setup from offering a powerful alternative to a single GPU card. But we'd still recommend one card over an equivalently priced pair. Even if that pair is slightly quicker – SLI is more robust now, but still not 100 per cent reliable in every game in your Steam library.

2 COOL, LIKE AN OWL

It's the DirectCU II cooling which sets the Asus STRIX cards apart from their competition. They might be more expensive, but if you want the absolute chilliest GTX 960 then look no further. Whether the GM 206 really needs this level of cooling, however, is another matter entirely...

Asus STRIX GTX 960 OC Edition

ASUS HAS GONE AND RELEASED THE COOLEST version of the Nvidia GTX 960 we've seen. EVGA's ACX 2.0+ might be pretty capable at keeping the same GPU cool, but the DirectCU II cooling array on this STRIX OC Edition manages to stay a full 15°C more chilled, even running at its top speed.

The Nvidia GTX 960 is the latest addition to the Maxwell range of GeForce graphics cards and offers 1080p gaming at the highest settings without breaking the bank or melting the rest of your PC into so much expensive slag either. The new GM 206 GPU at its heart uses the same graphics architecture as the top Maxwell cards, the GTX 980 and GTX 970. The GM 204 chip in those cards though has a full 5.2 billion transistors in its make up, whereas the GM 206 has 'just' 2.94 billion.

So where the top Maxwell cards are pretty cool and quiet, this thing is like an icy ninja, especially with the Asus DirectCU II cooling setup. When it's just messing around on the Windows desktop you're unlikely to even get to the 55°C necessary for its fans to get out of bed and actually start spinning. –DAVE JAMES

RIG BUILDER

BY DAVE JAMES

Build Your Perfect PC

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. Want more power elsewhere? Grab a new processor or go for that old favourite: the memory boost. There's a wealth of upgrades that can transform your machine, plus 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 getting 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 at our guide. 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. Our budget PC will get you gaming at 1080p for a bargain price, our mainstream machine will cope with pretty much anything at 1440p, and our high-end rig will do pretty much whatever it wants...

On these pages are our recommendations for putting together those budget, mainstream and silly high-end machines. These rigs all include a screen and peripherals in the ticket price, so if you're keeping your existing goodies then you'll have more cash to spend elsewhere. And what's our recommendation if you find yourself with that pleasant problem? Either get a larger SSD or a more powerful GPU. Happy building you lovely people!

HOW TO... BUY AN SSD

RIGHT NOW THE SSD MARKET is in a transitional state. We're shifting from the classic SATA and AHCI-based design towards a new gen of hyper-quick SSDs running over the PCIe interface with a new NVMe protocol. But we're not there yet, so how do you choose a drive for your current build?

There are already M.2 drives available, like the Samsung XP941 and possibly by the time you read this the new 850 EVO too. Plextor has also released an M.2 drive as well, but they're all still using the old AHCI protocol. That's an issue because even though the PCIe interface offers a huge amount of bandwidth, the drives are all going through reams of legacy checks, designed for the days of mechanical hard drives, which hobbles general performance. So right now you're still better off opting for a SATA-based version. When the NVMe drives do arrive you can merely switch that to data duties and fill out the single M.2 slot your motherboard offers.

BUDGET

MOTHERBOARD	
MSI B85M-E45	£46
CPU	
Intel Pentium G3258	£51
MEMORY	
Crucial 2x 2GB DDR3 1,600MHz	£31
GRAPHICS CARD	
MSI GTX 750 Ti OC	£111
SOLID-STATE DRIVE	
OCZ ARC 100 240GB	£75
CPU COOLER	
Intel Stock Cooler	N/A
POWER SUPPLY	
SilverStone Strider E 500W	£39
CHASSIS	
Corsair Carbide 200R	£47
OPTICAL DRIVE	
LiteOn IHAS124-14 24x DVD±RW	£10
SCREEN	
AOC E2250SWDNK	£80
TOTAL	**£490**

MAINSTREAM

MOTHERBOARD	
Asus Z97-A	£111
CPU	
Intel Core i5-4690K	£191
MEMORY	
Corsair Vengeance LP 8GB	£67
GRAPHICS CARD	
Sapphire R9 285	£170
SOLID-STATE DRIVE	
Crucial MX100 512GB	£160
CPU COOLER	
Enermax ETS-T40	£30
POWER SUPPLY	
OCZ ModXStream Pro	£64
CHASSIS	
Cooler Master CM690	£77
KEYBOARD	
Corsair Vengeance K65	£65
SCREEN	
Viewsonic VX2363Smhl	£132
TOTAL	**£1,067**

HIGH-END

MOTHERBOARD	
Asus X99 Deluxe	£296
CPU	
Intel Core i7-5960X	£790
MEMORY	
Corsair Vengeance LPX 16GB	£209
GRAPHICS CARD	
MSI R9 295X2	£530
SOLID-STATE DRIVE	
Samsung 850 EVO 1TB	£342
CPU COOLER	
Cooler Master Nepton 240M	£84
POWER SUPPLY	
CM Silent Pro Gold 1,000W	£172
CHASSIS	
CM Cosmos 2 Ultra	£271
KEYBOARD	
Corsair Vengeance K70	£112
SCREEN	
Philips BDM4065UC	£641
TOTAL	**£3,447**

BUDGET

When every pound counts, spend them wisely

MOTHERBOARD
MSI B85M-45

With the change in Gigabyte's previously impressive B85M-D2V we've switched to the slightly better MSI board for our budget build.

CPU
Intel Pentium G3258

Poor AMD, it's a clean sweep for Intel on all our recommended rigs. The new Pentium is simply the best budget chip around right now, offering Haswell for peanuts.

CPU COOLER
Intel Stock Cooler

The Pentium Anniversary chip is a very cool-running CPU, even when overclocked. We managed a stable 4.2GHz on this stock Intel cooler.

MEMORY
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.

GRAPHICS CARD
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.

SOLID-STATE DRIVE
OCZ ARC 100 240GB

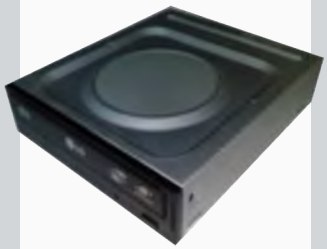
OCZ's ARC 100 drive may not be the quickest, but it's great value, incredibly consistent and quicker than Crucial's MX100 at this capacity.

POWER SUPPLY
SilverStone Strider E

We may be talking about a budget rig here, but it's still a 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.

OPTICAL DRIVE
LiteOn IHAS124 DVD+RW

We really wonder whether you actually need an optical drive anymore, but for now we'll err on the side of caution and include one in the list. Don't feel bad if you forget to buy it though.



CHASSIS
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
AOC E2250SWDNK

This 21.5-inch panel has a native resolution of 1,920 x 1,080 and looks pretty good despite that ridiculously low price tag. It's no IPS-beater, but it'll do for half the cash.

MAINSTREAM

A stunning rig doesn't have to cost a fortune

MOTHERBOARD
Asus Z97-A

We've seen a lot of Z97 motherboards since this Asus offering landed, but nothing newer has managed to push it off this list. Great features at a great price. Simple really.

CPU
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 helps with overclocking.

POWER SUPPLY
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.

CPU COOLER
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.

KEYBOARD
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.

CHASSIS
Cooler Master CM690

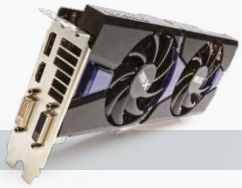
The CM690 eschews silly gimmicks in favour of producing a no-nonsense chassis that has plenty of cooling options for your mainstream rig. There's space aplenty inside, and all at a reasonable price.

MEMORY
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
Sapphire R9 285

The newer Tonga Pro GPU in AMD's R9 285 is an impressive wee thing, making it our favourite sub-£200 card. The 2GB frame buffer might be a worry for the hi-res future, but it's a beauty.



SOLID-STATE DRIVE
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 pricier M550.

SCREEN
Viewsonic VX2363Smhl

The old 23-inch Viewsonic IPS seems to be EoL now, but this white one has got the budget IPS panel and decent performance for its bargain £132 price tag.

HIGH-END

For when you *really* want to treat yourself

MOTHERBOARD
Asus X99 Deluxe

As usual this Deluxe board from Asus is absolutely stuffed with funky features. It's one of the finest, and best-looking, X99 boards around and not a bad overclocker either.

CPU COOLER
Cooler Master Nepton 240M

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

MEMORY
Corsair Vengeance 16GB

The Haswell-E platform is the first to bring DDR4 to the consumer. That does come at a hefty price, but it's damned quick.

CPU
Intel Core i7-5960X

If you're after the fastest, most advanced CPU around, then this 8-core, 16-thread Haswell-E is it. There is also the 6-core i7-5820K for a more reasonable £300, but the 5960X is the pinnacle of modern CPUs.

GRAPHICS CARD
MSI R9 295X2

The dual-GPU R9 295X2 is undeniably the quickest graphics card around. We still worry about these sort of cards, but the liquid-chilling helps those concerns, and besides, it's a beast at 4K.

SOLID-STATE DRIVE
Samsung 850 EVO 1TB

This new spin of the Samsung's 3D NAND means high-capacity is no trouble for its mainstream SSD range. And the 1TB drive has the performance to match its new endurance.

POWER SUPPLY
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 PCF246.

KEYBOARD
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 with the red backlight glowing against its black-brushed metal chassis.

CHASSIS
CM Cosmos 2 Ultra

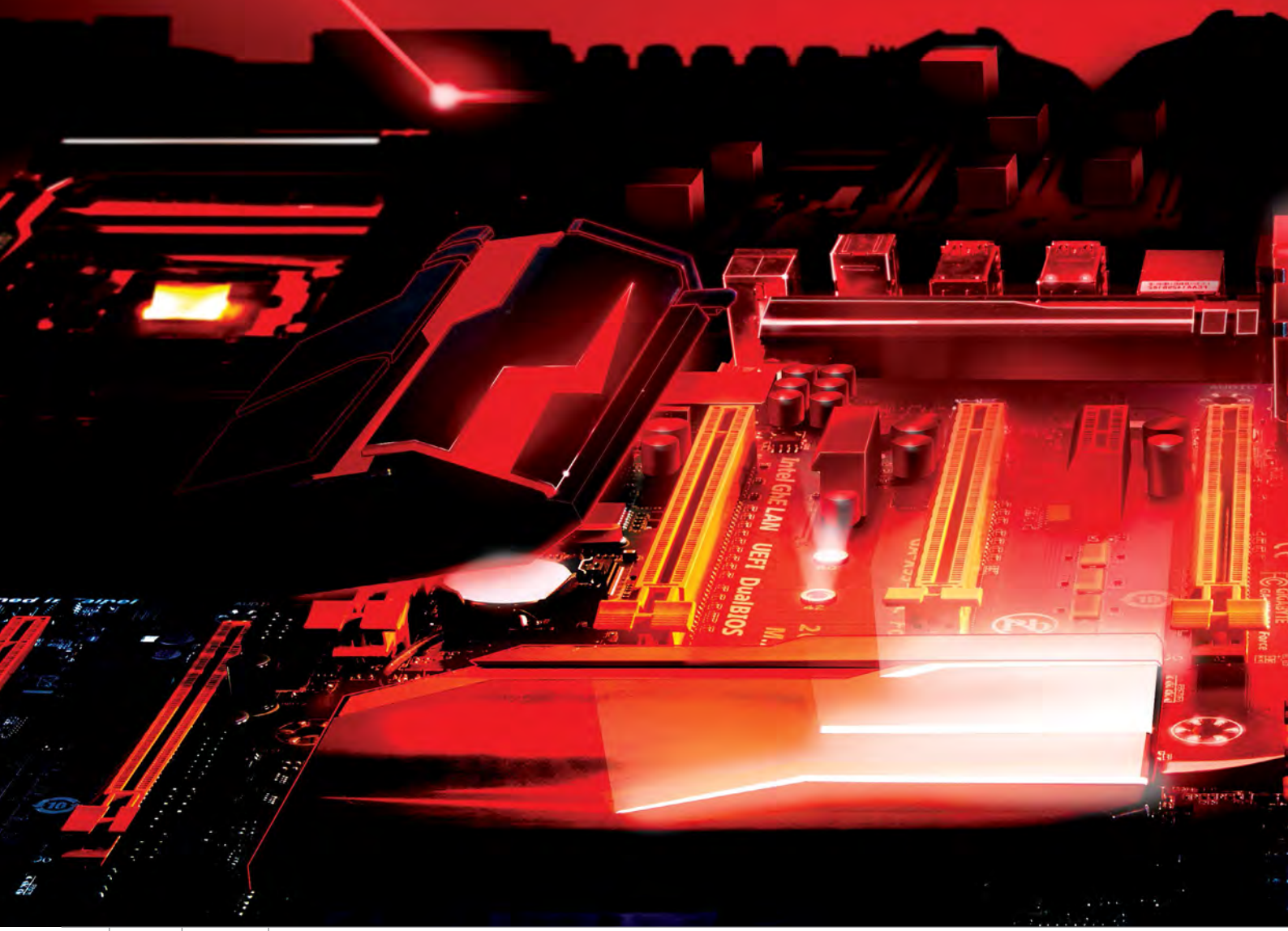
Cooler Master has always been an impressive maker of cases, but it has truly stunned us with this chassis. Yes, it's expensive, but if you can afford to drop this much on your case, you'll be more than happy.

SCREEN
Philips BDM4065UC

This 40-inch 4K behemoth is the first screen to make us think that super-high resolution actually looks super. It's a decent VA panel and a great price, too, and will really take advantage of the R9 295X2.

NEXT-GEN TECH PREVIEW

With so much new kit to cram into 12 months, it's going to be one jam-packed techgasm of a year. Here are some of the highlights... by Dave James



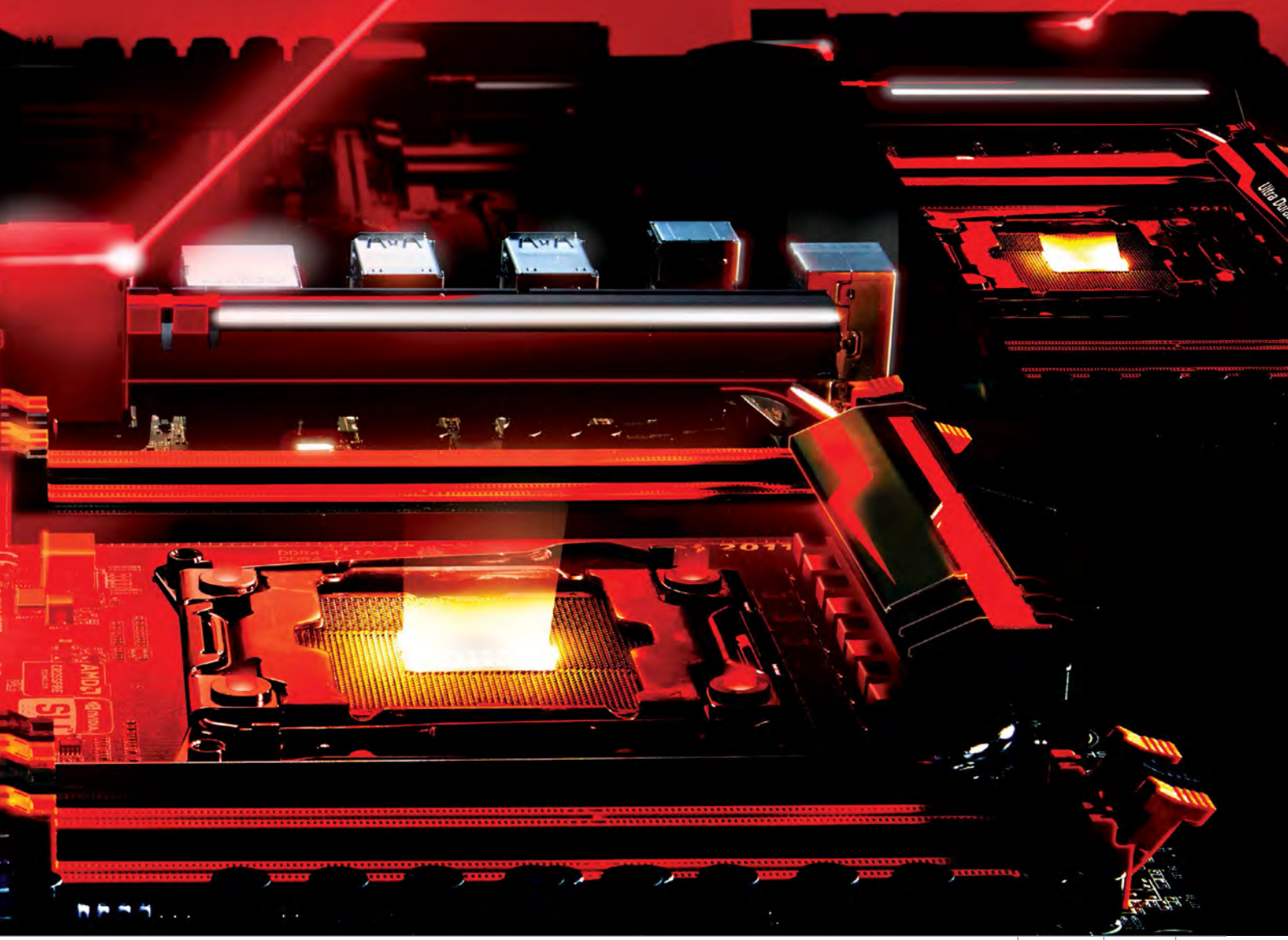
Have you seen the price of crystal balls recently? They're super-expensive. Obviously fortune tellers have vast sums of money from their numerous lottery wins to call on, but us tech journalists don't have such resources to fall back on. No, we need to do research, ask questions and investigate, all in order to figure out what's going to happen over the next 12 months. Not like those feckless fairground rich-kid psychics...

On the surface of it though, predicting what's coming up for the rabid technorati in 2015 should be pretty simple. There'll be new, quicker processors, faster graphics cards, laptops with longer-lasting batteries and screens with more pixels than stars in the night sky. Digging into the specifics though is a mite trickier, and more difficult still is to figure out the motivations and unspoken intimations behind what's going on with new releases.

There are also areas where we may not have expected much progress, let alone anything new or even interesting. Things like the sudden resurgence of virtual reality as a tangible product, evolving from being purely about a single tantalising device into an increasingly crowded future marketplace. We're also seeing tech being born entirely from burgeoning past-times, like game streaming, coming to the fore too. So while there will certainly be the usual suspects releasing iterative updates of their previous generations, there will also be a huge amount of innovation coming over the next year.

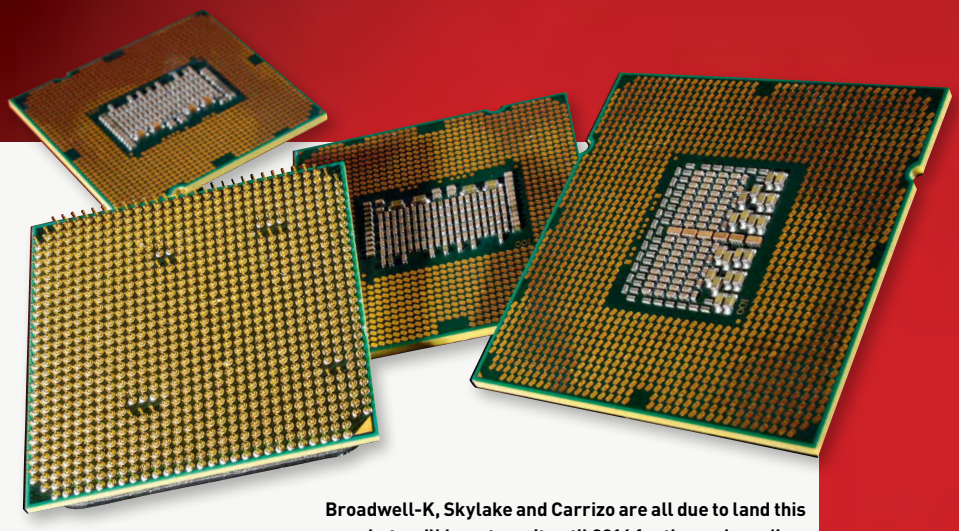
And this is all vital stuff for us PC folk too. We're the fixers, the upgraders, and we need to know when, and indeed if, we should be looking for that next major PC update. Should we stick with our current CPU for the next 12 months, for example? Install some new release now or wait for something better to arrive in the summer? Picking the right time to upgrade is a perennial struggle for the PC builder – there's always something new on the near horizon – but fearlessly spending big on the 'new thing' can be a huge waste when the 'newer thing' comes out only a month later.

So what are we waiting for? Let's dive headfirst into 2015 and figure out what's going to be on the wishlist for this year's perfect PC.



INTEL PROCESSORS

The silicon giant has got a chip-packed year on its hands. Maybe a little too tightly packed...



Broadwell-K, Skylake and Carrizo are all due to land this year, but we'll have to wait until 2016 for the real goodies.

THE NEXT 12 MONTHS are going to be big for Intel. There are two huge desktop launches coming this year, one a process shrink down to 14nm with the socketed Broadwell chips and the next a new microarchitecture to take that die-shrink even further with Skylake. Having two new processor generations, the fifth- and sixth-gen core architectures, both arriving in 2015 is a bit odd, and shows how delayed the Broadwell die-shrink has been in the final reckoning.

Intel though will tell you it launched Broadwell in 2014, but for us the Core M simply isn't the Broadwell processor we've been waiting for. No, Broadwell proper isn't due to arrive until 'mid-2015' according to a presentation we had around the release of the latest low-power mobile U-series chips. So we're waiting until the summer for both the quad-core 14nm laptop chips and the K-series socketed desktop parts to go in our waiting Z97 motherboards.

But, and this is where things get complicated, we're also expecting Skylake processors to arrive in the summer. Speaking with motherboard manufacturers, they've been prepping to release their new Skylake mobos, the Z170s, at Computex in June. These aren't backwards compatible as they're pinned specifically for Skylake processors and some will be rocking DDR4 compatibility.

Double trouble

So yes, this all means we ought to be getting sixth-gen desktop chips around the same time as Broadwell-K parts go on sale. Sadly, that points to overclockable K-series Skylake chips being held back until next year, along with the beefy 14nm Broadwell-E chips too.

Speaking of those Extreme Edition chips, it looks like we'll be getting new LGA 2011-compatible sockets from mobo manufacturers soon. After Asus's bespoke OC Socket on its X99 range surprised the industry, Gigabyte is joining in with its own 2,038-pin socket, taking advantage of some extra voltage control and DDR4 overclocking capabilities.

Stepping outside of the capacious innards of your PC box though, Intel is also preparing an intriguing little Bay Trail-powered device to launch this year – the Compute Stick. Packing a Z3735F chip into a design that's only four inches long, the Compute Stick is a super-tiny PC that you plug directly into an HDMI port to turn almost any display into a PC. The $150 device comes with Windows 8.1, 2GB RAM and 32GB of solid-state storage. Because the Bay Trail chips are the first Atoms to come with proper Intel HD Graphics, it could be a fine game-streaming device.

AMD PROCESSORS

New APUs are not to be confused with spicey Spanish sausage or ginger stars of *NYPD Blue*

WHILE AMD ALWAYS seems to be in the midst of some sort of transition, its current shape *is* changing quite dramatically. From the appointment of Lisa Su as CEO last year, and the departure of John Byrne at the start of this year, AMD looks to be repositioning itself as a tech firm led by its engineers rather than its musketeers. Or marketeers. We forget which. One flounces around with over-stylised facial hair, dandified clothing and a reckless disregard for anything but themselves. The others are musketeers. Ha.

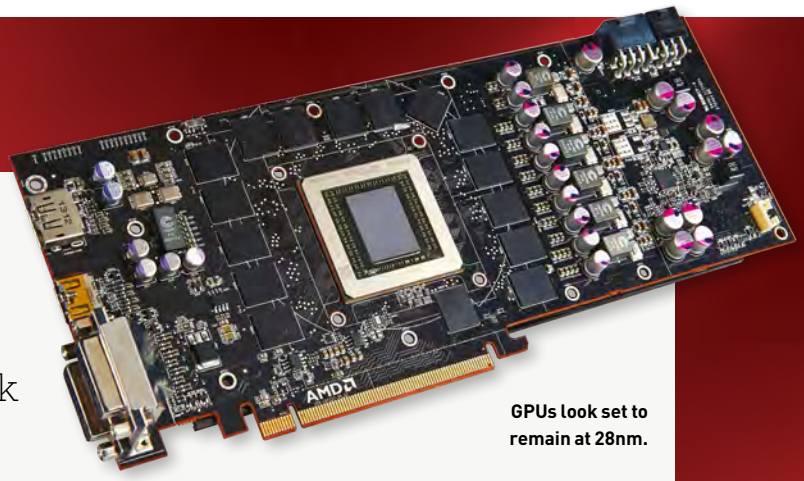
Tech-wise, the processor half of AMD is most definitely evolving, with 2015 being the intermediate year and 2016 set to introduce the real fruits of its current labours. Or that is the ever-mutable plan anyways. The big push for mid-2015 will surround the release of its new Carrizo APUs, the follow-up to the Kaveri range launched at the start of last year. It introduces a new Excavator core and GPU component, plus will be the first full HSA 1.0 chip, the goal being to implement totally transparent hardware where apps can access any part of the tech directly and unfettered, whether that's CPU, GPU or memory components.

The Excavator core is the last hurrah of the outgoing Bulldozer architecture, and should give the Carrizo APUs a little performance boost, likely up to 10 per cent in CPU terms. The GPU component is coming from the Tonga GPU of R9 285 fame. Sadly though, Carrizo is a resolutely mobile part, destined to never arrive on the desktop. Along with the low-power, Puma processor-toting Carrizo-L, AMD is looking to compete with Broadwell-U in the thin 'n' light laptop space.

This year is also set to see the rise of AMD's Project Skybridge, its ambidextrous platform set to provide a pin-compatible setup which will take either an x86 Puma+ based SoC or an ARM Cortex A57 with an integrated GCN-class GPU. Again though, we're talking about mobile parts – AMD desktop aficionados are going to have to wait until 2016 to get a bead on its high-end K12 Zen processors.

AMD GRAPHICS CARDS

Hawaii, Caribbean or Pirate? We don't care, just make 'em quick



GPUs look set to remain at 28nm.

IF 2015 IS LOOKING LIGHT on the processor front for us desktop PC folk, it should be a more exciting 12 months for the graphics half of AMD. Its strategy is looking like a two-pronged attack on Nvidia. The first will be a refresh of its top-end Hawaii-based graphics cards, while the second will see the launch of its new Caribbean Island range.

The Hawaii refresh is likely to produce a small performance boost over the existing R9 290X, but will essentially be a mildly tweaked Hawaii core taking advantage of the matured manufacturing process allowing for more reliable, higher clockspeeds and potentially less heat. We were expecting this refresh at the tail end of 2014 in order for AMD to introduce some competition for the new Maxwell cards, but we're now expecting them early this year instead. And given the refresh is now happening in 2015, it could be branded as an R9 380X instead.

The Caribbean Islands (née Pirate Islands) cards will be coming a little later, with current guestimates suggesting June. From shipping manifests, and the ever-grinding rumour mill, it looks like final silicon has started moving around the globe. It's likely then we're moving into mass production of AMD's next-gen GPU.

The rumoured specs for the purported Fiji XT GPU – the chip possibly powering the R9 390X – has it containing a mammoth 4,096 streaming processors with a 4GB frame buffer. That mightn't sound much, but the video memory should be the first release of a GPU with the high bandwidth memory (HBM) AMD has been working with Hynix to produce. HBM is similar to the 3D stacked memory in Samsung's latest SSDs, using TSV interconnects to boost bandwidth through the stacked video memory. That should give AMD's new GPUs huge bandwidth numbers, perhaps three times that of the GTX 980.

What's less clear is the production process. Given AMD's historically hot and power-hungry GCN GPUs, we were expecting AMD to need the 20nm lithography. But the purported prohibitively poor yields of high-end 20nm parts means we might not see *any* 20nm GPUs from either company. AMD has stated it's producing 28nm and 20nm parts this year, moving on to 16nm in 2016, and with the lighter transistor load of Carrizo being announced at 20nm, it looks like the GPUs will need to remain at 28nm.

NVIDIA GRAPHICS CARDS

There's a Titan waiting in the dark, ready to pounce

THIS YEAR IS LIKELY to be more of a reactive year for Nvidia in the graphics game. It's going to be busy enough though with its new mobile processing beast, the 256 CUDA-core'd Tegra X1. But that's not to say we won't see movement from the green team on desktop GPUs. We've already had the release of the middle order Maxwell GPU, with the GTX 960 rocking a new GM 206 GPU. That gets Nvidia's current generation to a state where it can wait to see what its rivals do before releasing anything else.

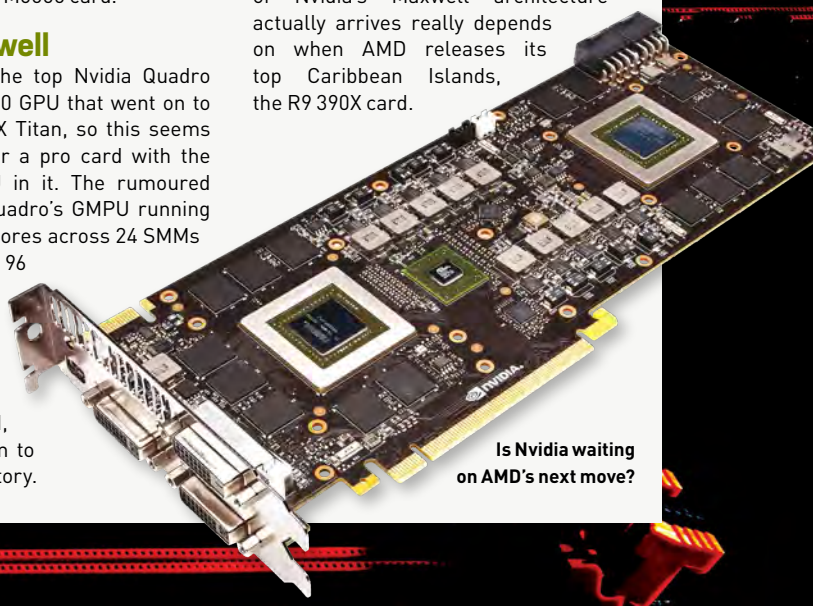
And that's likely to be how the rest of the year goes. Nvidia will be waiting in the wings for AMD to drop its new R9 3xx series of cards, holding fire until it can get a bead on exactly how this new generation of GPUs stands against its own. Once the full might of the R9 390X is known, that's likely when we'll see the full power of the Maxwell graphics architecture.

As with Kepler before it, we know the GM 204 GPU inside the GTX 980 is not the pinnacle of its new technology. There will be a full GM 200 part being prepped for the next professional cards, which will then find its way into a GTX Titan card and maybe a GTX 980 Ti, too. There are already reports of the GM 200 GPU, most recently a GPU-Z validation submission detailing a Quadro M6000 card.

Mighty Maxwell

The K6000 was the top Nvidia Quadro running the GK 110 GPU that went on to feature in the GTX Titan, so this seems to make sense for a pro card with the top Maxwell GPU in it. The rumoured specs have the Quadro's GMPU running with 3,072 CUDA cores across 24 SMMs with an enormous 96 ROPs. An earlier SiSoft Sandra database entry detailed a 3,072-core card with 12GB of VRAM, which would seem to corroborate this story.

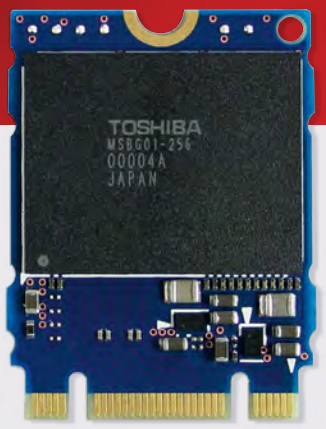
The subsequent Titan release (possibly a Titan X) will likely come with the same GPU configuration but probably a smaller frame buffer, perhaps the same 6GB that the existing Titan houses. But when the new ultra-enthusiast SKU of Nvidia's Maxwell architecture actually arrives really depends on when AMD releases its top Caribbean Islands, the R9 390X card.



Is Nvidia waiting on AMD's next move?

SOLID-STATE DRIVES

Get ready for a big SSD fight over NVMe



It's all change in solid-state land this year.

OKAY, THIS YEAR looks like becoming a serious bunfight in the SSD world. Things have been shaken up entirely by the demands of the new NVMe standard to replace the existing AHCI protocols that rule both current SATA and M.2-based SSDs. That means 2015 will see a raft of new SSD controllers and all the usual suspects are involved – it's going to be fascinating watching how it all shakes out.

Samsung has already gotten its NVMe SSD controllers running in the enterprise world, so expect to see that roll out to its consumer drives later on this year. The SM951 is the M.2 NVMe set to replace the XP941 we've already tested and has just gone into mass production. It's also PCIe 3.0 compatible, running over four lanes to offer sequential read and write speeds of a reported 2,150MB/s and 1,550MB/s respectively. That drops over PCIe 2.0, but still looks seriously quick.

Comeback kid OCZ is also prepping a new NVMe controller, called the JetExpress. Again it's PCIe 3.0 compatible across four lanes with potentially 10 NAND channels per controller chip. In the enterprise world, where the JetExpress will first hit, it's possible to double down on the controller chips to boost performance. Whether that will come down to the future consumer versions we don't yet know.

But OCZ-owner Toshiba hasn't been demonstrating the fruits of collaboration, instead using a new Marvell NVMe controller to make up the single package SSD it's been showing off at the start of the year. The unit Toshiba has been demonstrating packs 128GB of Toshiba NAND into a package with the controller to make a single-chip SSD that's smaller than an SD card.

That's likely to be the new 88NV1140 controller from Marvell, designed for small form factor mobile devices, but it's also started demonstrating its 88SS1093 controller designed for PCIe 3.0 M.2 drives running on NVMe protocols. Again, it will be a four-lane setup, backwards compatible with PCIe 2.0. This is probably going to be the most prevalent controller in a range of SSDs, with Crucial/Micron again likely to base its NVMe drives on Marvell.

But SandForce isn't dead and buried. It's coming back with the SF3700 which has been shown off in the upcoming ADATA SR1020 M.2 drive. It's another NVMe-capable controller, but the top-end SF3759 option only stretches up to four-lane PCIe 2.0 connections. Still, with those caveats the ADATA drive was hitting 1,800MB/s on both reads and writes. SandForce says it's also gotten around the incompressible data problems, shutting off its own compression algorithms when it comes to the tricky data sets.

COOLING

An explosive year for PC cooling?

Chip chillers could be going plastic fantastic.

SOME INTRIGUING DEVELOPMENTS are set to happen in PC cooling this year and one of the most interesting uses plastic explosive. Don't worry, CapTherm isn't asking you to strap some C-4 to your CPU. It's using a process called explosion bonding to join dissimilar metals to form a mixed copper, aluminium and stainless steel radiator for its vapour-chamber cooler. It also uses a refrigerator coolant inside with a far lower boiling point than water to help dissipate heat from the CPU quicker and more efficiently than a standard air or water cooler.

Using the phase change from liquid to vapour, the MP-1240 cooler can absorb a huge amount of energy, up to 325W. This is a relatively new way of putting together CPU coolers, and because CapTherm is only a small Canadian startup, the initial products are likely to be hugely expensive. It is though, more likely to be looking to license its technology than really become a full manufacturer in its own right.

Cooler Master is also up to new things and has been busily showing off new CPU block designs which fully incorporate 3D vapour chambers. Traditional CPU blocks restrict the vapour chamber to the plate in contact with the chip, but the new design has the heatpipes built into block itself, extending the chamber vertically inside them. This offers just a single heat transfer from chip to chamber, rather than from chip to chamber to heatpipe as is the normal way. Fingers crossed we'll see these new designs ship later this year.

Cooler Master has also teamed up with CoolChip Technologies to create the consumer versions of its licensed kinetic cooling tech. Essentially it's a rotating heatsink, in place of a fan, sitting on the CPU baseplate separated by a few microns-thick cushion of air. CoolChip says it offers 50 per cent better cooling in a smaller form factor, with less noise too. The holy grail of cooling tech then. It could be at a great solution for notebooks.

But if those Cooler Master designs are pushing it for a 2015 release, Corsair's new line should be coming basically now. Its new H110i GT cooler uses a 240mm radiator that's less than 3cm thick and pairs it with two chunky 140mm fans. Corsair will also be launching the Nvidia version of its already AMD-ified HG10 GPU cooler to attach to its AIO water-cooling range.

MOBILE TECHNOLOGY

Desktop GPU power for tablets and full desktop CPUs and GPUs for your laptop. Boom!

Say hello to your new desktop.

FROM A MOBILE STANDPOINT, Nvidia's latest SoC is probably the most exciting. The Tegra X1 is the Maxwell-powered successor to its Kepler-based Tegra K1 chip, and brings a pair of the same SMM modules you'll find in the GTX 980 into a 20nm SoC. That provides 256 CUDA cores and 16 ROPs in a mobile chip, which will deliver some serious graphics power. The chip has a 1GHz top clockspeed, which will allow it to deliver a full 1 TFLOP of graphical processing, though in tablet form factors it's unlikely to be able to sustain this speed for very long.

But because Nvidia had always been looking towards the mobile sector when designing Maxwell, the new TX1 is capable of bringing all that extra performance to bear with lower power demands. The next SHIELD Tablet could be an absolute beast.

AMD is focused on its own laptop chips in the form of Carrizo. As we've said earlier, it's the successor to Kaveri and brings the new Excavator cores and Tonga GPU to the mobile APU market. Whether it gets many design wins though is debatable, which is a shame given that it's likely to be very powerful, with potentially almost double the GPGPU performance of Iris Pro.

Put a dock in it

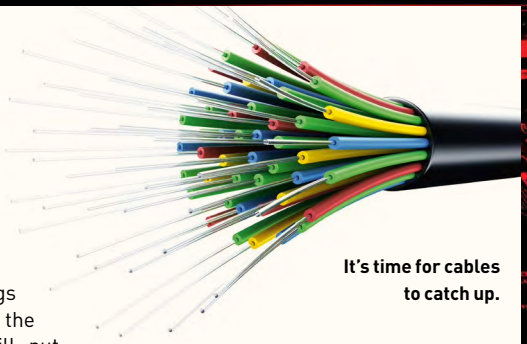
We'll also see Broadwell and Skylake mobile chips this year, though likely only full quad-cores on the Broadwell side this summer. Still, they'll be drop-in upgrades and we're seeing an interesting new trend emerging in laptops: the gaming dock.

MSI will ship the GS30 with its Gaming Dock this year, offering a slimline i7/Iris Pro laptop with a x16 PCIe connection to a base dock. With extra storage, audio and support for full desktop PSUs and GPUs, the dock will essentially turn your laptop into a desktop when you're at home.

But you can have desktop goodness in laptop form too. MSI's GT80 Titan has got a full mechanical switch keyboard while Clevo has created a design housing full desktop processors in a 4kg notebook. Scan and XMG, among others, have already signed up, looking to produce more customisation than the future BGA-only CPU designs will offer.

CONNECTIVITY

It's going to be a cabling revolution, people



It's time for cables to catch up.

CABLES, HUH? Connections. Mmmm, fascinating... But seriously, fascinating! This year is going to see a bit of a cable renaissance as the increased amount of power and data we're looking to shift between systems and devices is moving upwards at a pace the current connections simply can't keep up with.

First off we've got the update to USB coming in 2015, moving us to USB 3.1 and doubling theoretical transfer rates up to 10Gbps, putting it on a par with the first iteration of Thunderbolt. At CES in January, MSI was demonstrating an X99 motherboard, shipping in Q1 2015, with a pair of USB 3.1 ports. It had a pair of Intel SSDs in RAID 0 to raise the bandwidth roof, hitting a full 695MB/s writes.

We also saw some demonstrations of Samsung's SSDs in RAID topping 800MB/s. The fact that folk are having to RAID SSDs to show what the connection is capable of is quite astounding.

The next update to USB is even more exciting though, giving us the new Type-C connector. We've had to put up with mono-directional plugs for many, many years now, but the reversible Type-C connector will put pay to the most annoying part of USB connectivity – *always* getting it the wrong way up. Not only that but Type-C is also able to offer boosted power delivery too, from 5W to 10W up to 100W. Being able to charge your laptop and phone from the same cable will soon be a possibility.

Port of cool

Type-C though can do even more, potentially doing away with the need for any display ports too. The 'Alternate Modes' feature allows for video as well as data and power to pass along the cable. VESA has created an alternate mode, linking with DisplayPort 1.3, allowing a single cable to provide 10Gbps bidirectional data, a 4K video stream and 100W of power. Are we going to start seeing Type-C ports on graphics cards? Quite possibly by the end of the year and they're coming to mobos very soon.

But what if you want more than 4K? In order to hit 8K, the Mobile High-definition Link (MHL) Consortium has come up with the superMHL cable and connector. The full six-lane version will be capable of 8K at 120Hz and up to 40W of power, but needs its own cable. Like Type-C it's going to be reversible (yay!) and we're likely to see versions with both superMHL at one end and USB Type-C at the other.

MONITORS

Will it be the year to sync some money into a gaming screen?

Fancy potential refresh rates of up to 144Hz?

COULD THIS BE THE YEAR the perfect gaming monitor arrives? Given the amount of progress over the last 12 months, we're hoping 2015 will bring us mighty close to that magic Jesus cup.

The big news will be around refresh rates. Oh yeah, sexy time. The most exciting part is we're not far from getting 120Hz/144Hz IPS gaming monitors on our desktops. Asus's upcoming MG279Q isn't an RoG panel, but it's got serious gaming chops with its 27-inch IPS panel sporting both a 1440p resolution and a refresh rate up to 120Hz. Speaking with Asus, it reckons the MG279Q might even get up to 144Hz if its engineers can get the electrics and panel to play nice together.

But what of GPU synchronisation? Well, this panel isn't a G-Sync panel, but it will support DisplayPort 1.2a, so it will support Adaptive-Sync and the compatible Radeon card will then be able to deliver FreeSync smoothness. Funs. And for AMD folk, 2015 will be the year of FreeSync. Asus's new gaming panel may not be FreeSync branded, but BenQ, Viewsonic, LG and Samsung have all announced screens that are. It's a wide spread of screens, from 27-inch, 1080p, 144Hz panels, to 31.5-inch 4K screens at 60Hz.

Panel beaters

But what of G-Sync? Well, Acer is set to make a splash with its 27-inch, 144Hz, G-Sync screen, mostly for the fact it's rocking an IPS panel. There's a possibility it's actually an AU Optronics AHVA panel, but they're almost indistinguishable from IPS screens anyways. Asus is also fleshing out its G-Sync line with a 4K IPS screen rocking Nvidia's synching hardware, the RoG Swift PG27AQ.

And if you're already bored of 4K resolutions, LG is introducing its Z27q, a 27-inch panel with a 5,120 x 1,880 resolution. So, if you thought Windows scaling at 4K was bad...

PERIPHERALS

Membrane or mech switch? This year you may need to choose

Yeah, RAT fans! Prepare for the "future-proof" ProX.

KEYBOARDS are probably going to show the biggest change in this coming year, with the inexorable rise of the mechanical switch looking to take over entirely. Not just content with jumping into the gaming laptop market with the crazy MSI GT80 Titan, the not-so-humble mechanical switch keyboard is trying to ape membrane switch boards on your desktop too.

SteelSeries is producing a board called the Apex M800 with a set of QS1 switches. These new switches aim to offer the performance of a linear mechanical switch with the feel of a membrane switch. So even if the clicky feel and tall key caps of mech switches puts you off, you'll still be able to get the accuracy and reliability with the same membrane smoothness. The M800 should be released in just a few months, though is likely to have a pretty hefty price tag attached.

But Cherry, the main mech-switch maker, is also working on a new switch. The Cherry RK, or RealKey, uses an analogue controller designed to offer a 1ms response time within the keyboard itself. Current switches rely on a digital controller to tell when a key has been pressed a single time, which Cherry has measured at a 20ms response. Another upshot of this is that ghosting isn't possible as every key produces its own analogue signal, so according to Cherry, ghosting "simply does not happen". It's only going to be available on the Cherry MX Board 6.0 as it isn't licensing the tech out just yet, so expect to see it around Q1 this year.

We'll also probably see advances in optical sensors, as they start to catch up with laser opticals in terms of speed, so gaming mice fans shouldn't feel too left out. And with Mad Catz promising the release of its RAT ProX they really shouldn't. Billed as the most future-proof mouse ever, the ProX is designed to allow different modules to be upgraded by the end user. We're used to the RATs being customisable, but being able to change the sensor itself is unprecedented. At launch there will be three different sensors available: Philips 2037, Avago 9800 and the Pixart 332WM10. You can choose whichever one you want at purchase, or buy upgrades at the Mad Catz store.

VIRTUAL REALITY

Strap on your goggles and lose the rest of the world

The VR vanguard is no longer just Oculus.

ONE OF THE BIGGEST CHANGES in tech is that virtual reality has become an actual category of product rather than just a singular entity. Of course the Oculus Rift is still going strong in the vanguard of the latest VR revolution, but a number of other manufacturers have now thrown their helmets into the ring.

Several industry players have formed the Open Source Virtual Reality (OSVR) ecosystem, including Sixense, Razer and Leap Motion. Razer is going to be offering its OSVR Hacker Dev Kit in June. At $200, it has everything you need to get started, with a headtracker, display and optics all included. But with the onus being on open source-ness, you can already download the prototype's schematics and components list if you wanted to build your own device from scratch.

This isn't going to be about putting together some next-gen Oculus beater though, more about getting affordable VR into developers' hands so they can get on with giving us more involving worlds for us to get virtually obsessed with.

Joining the revolution

There are also rumours floating around that the long-awaited consumer version of the Oculus Rift (CV1) is being slated for release this winter. Details are still sketchy and nothing has been confirmed; indeed an interview with *The Telegraph* has been altered to remove a section that purported to have CEO Palmer Luckey estimating a winter 2015 release of CV1. Oculus is also remaining tight-lipped about the resolution, meaning we may end up with the device displaying at 1080p, but using downsampling (such as Nvidia's Dynamic Super Resolution) to create a sharper image.

Inputs are going to be hugely integral to the success of this second coming of VR and Sixense is looking to be at the fore. Its STEM system is the evolution of its collaboration with Razer in designing the Hydra controller. It's wireless and uses magnetic fields to track movement. The setup looks incredible and is the sort of thing that will make or break VR. The initial three-tracker setup is more than the cost of a DK2 Oculus Rift though and is set to ship in May or June.

OPERATING SYSTEMS

Microsoft takes a hop, skip and a jump to a new OS. Hell, it's a whole new ecosystem...

LATER THIS YEAR we should see the final launch of Microsoft's next operating system. And to sweeten the deal, Microsoft is set to distribute Windows 10 gratis for the first 12 months for both Windows 8.1 users and Windows 7 folk. That last bit is important as it shows Microsoft is determined to pull the Win8 naysayers from their Win7 bolt holes.

Microsoft is also looking to create a unity between Windows 10 on the PC, phone and tablet. And also on the Xbox. Yes, you read that right. Xbox. With a new pre-loaded Xbox app for Windows, you'll be able to connect to an Xbox One and play your console games on any Windows 10 device. Of course, with our powerful gaming PCs, we'd be more interested in doing it the other way around, taking our games into the living room with the Xbox console, so hopefully that will also be made an option.

Still, because MS is talking about streaming to *any* Windows 10 device, that means low-power laptops, tablets and phones too. That's the sort of unified setup that Microsoft has been chasing for years. Taking that even further, with the release of DirectX 12, Xbox and PC gamers will be able to play together. The next *Fable*, *Fable Legends*, has been revealed as allowing Xbox and PC gamers to enjoy the game together. Whether that will be limited to co-op games or open to competitive multiplayer, *CoD*-style gaming too, is still unclear. The age-old problem of mouse-accuracy versus joypad sensitivity is always going to be a thorny subject.

And, as we've mentioned in the past, there is a Start menu for the new operating system – though with the new 'Continuum' system (the method for the OS to mold itself to whatever device it's running on) you can explode it to take over the whole screen for that Win 8 nostalgia. MS is also bringing its phone-y personal assistant, Cortana, to the desktop. With Windows 10 then you can have a personal relationship with your PC that people aren't going to think is really creepy. And our offices will be filled with people not just shouting at their computers, but having them shouting back too.

You'll be able to play Xbox One games on any Windows 10 device.

It certainly looks like Microsoft has learnt from the difficulties it had moving people to Win8, and Win10 could be the most inclusive, versatile and powerful OS we've ever seen on the PC. Poor Linux... ■

GAMING

BECAUSE GAMING IS A WAY OF LIFE

What Are You Playing At?

The battle of the banned...

"Perhaps it's time for us to question how we rate our games in the UK."

OH, WHAT'S THAT? The video game you just spent the last few years making has been refused classification, added to a 'black list' and turfed from the premises like a petulant youth? Well, you know what they say? When life gives you lemons... pirate the hell out of them.

That's the advice from Swedish developer Jonatan 'Cactus' Soderstrom, AKA the co-creator of 2012 cult hit *Hotline Miami*, upon discovering its eagerly anticipated sequel had been banned in Australia. When quizzed by an Aussie fan via email regarding how best to get hold of *Hotline Miami 2: Wrong Number*, Soderstrom's reply was simple (if not entirely legal): "If it ends up not being released in Australia, just pirate it after release," he wrote. "No need to send us any money, just enjoy the game!"

THE BEST GAMES OF 2015 PG. 66

While Oz now has a specific R18+ adult rating (the equivalent of an 18 in the UK), the actual guidelines became even stricter to further scrutinise anything being granted a release with that rating. Sexual violence, simulated or even implied, almost guarantees a film or game will be outright banned. *HM2: WN* will almost certainly be a stellar game, but the whole debacle sheds an uncomfortable but necessary light on the question of artistic expression versus censorship. The mock rape scene in question is entirely skippable, but should it even be there in the first place? Whether we're desensitised or not, sexual violence has no place in real life, never mind fiction.

It might seem like Australia is a hotbed of easily offended prudes, but its take on classifications is far more progressive than it first appears. Sure, the country has gone from one extreme to the other in the space of 25 years (up until 1991, Australia didn't even rate games, and it took another 12 years to finally introduce a realistic 18-style rating), but the Aussies have one system for all forms of entertainment. Despite the attention it gets for banning games (which happens to a tiny proportion of titles released), the system has proved hugely popular with Aussies thanks to its clarity. And with UK audiences continuing to show frustration with the awkward PEGI system, perhaps it's time for us to question how we rate our games and start swinging the ban hammer with more confidence. –DOM RESEIGH-LINCOLN

HIGHLIGHTS...

72
Final Fantasy XIII-2

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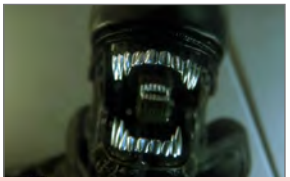
Resident Evil HD Remaster

76
Saints Row: Gat Out of Hell

RECOMMENDED...

CIVILIZATION: BEYOND EARTH 2K
PCF299 p62 Its foundation is familiar, but this is a game that's full of surprises and is difficult to master.



ALIEN: ISOLATION
Creative Assembly
PCF298 p64 The game the *Alien* series has always deserved. A deep, fun stealth game set in an evocatively realised sci-fi world.

WILDSTAR
NCSoft
PCF294 p64 Clever questing and a stand-out combat system make for an entertaining MMO that is as large as it is full of character.

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

GAMES PREVIEW 2015

The upcoming games worth getting excited about by Daniel Griliopoulos

With every year, the PC lineup only gets more crazy. While console firms pay millions for temporary exclusives, the PC has so many exclusive games each year it's untrue. And many of them are now free, from twine and inform text adventures, to endless Ludum Dare titles such as *Titan Souls*, to huge AAA games like *Path of Exile*. No console lets developers just experiment like the PC does.

Every developer with any sense will co-develop for PC, as all the console creators have dumped their fancy tech and the machines are now standardised, repackaged PCs, meaning every game that isn't a platform exclusive tends to end up on PC. What was there that was worth buying a console for in 2014? *Destiny*, a handful of derivative Mario- and Zelda-related exclusives, and... Actually, that might be it.

So compiling a list of the games to look out for in 2015 is a huge task. We've picked out just a few here, with one major thing in mind – no list is definitive and every list is personal. These are the games we're most excited about, meaning some big, eagerly anticipated titles, such as *Evolve* and *Dying Light*, didn't quite make the cut. So, without further ado, here's our list. Some might surprise you!

Pillars of Eternity

Release date: 26 March

The Infinity Engine games – *Baldur's Gate*, *Planescape: Torment*, *Icewind Dale* – are the stuff of RPG legend. *Pillars of Eternity* is a loving recreation of that party-based RPG genre, replete with witty dialogue, puzzle-heavy combat and hand-drawn 2D fantasy locations. It's also one of the biggest Kickstarter successes of all time, netting nearly $5 million.

» **Developer** Obsidian
» **Publisher** Obsidian, Paradox

Minecraft: Story Mode

Release date: TBA

From the people who made *The Walking Dead*, *Game of Thrones* and *The Wolf Among Us*, comes... *Minecraft*?! It's as an adventure game though, available in episodic form and featuring characters from the original game. No, we're not making this up. Mojang has said: "We're not creating an 'official' story for Steve, or explaining the world of *Minecraft* in detail. It will be a cool game." And that's all we know!

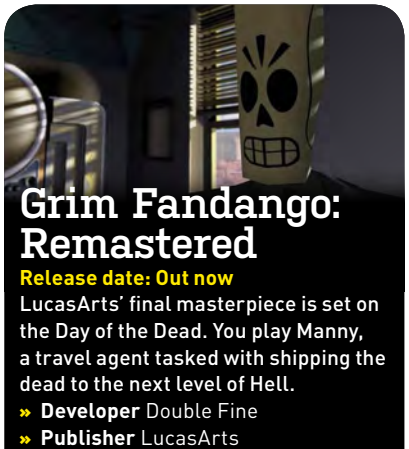
» **Developer** Telltale » **Publisher** Microsoft

Total War: Attila

Release date: 17 February

Wonderfully rejigging *Total War: Rome II*, *Attila* quickly skips over the broken bits of that game, and changes how factions behave. Expect campaign and battle improvements, such as better maps and the return of the family tree system. It also introduces nomadic cultures, who live in tents and move in giant hordes, including the Huns. Starting in 395 AD, this is really the story of the fall of the Roman Empire, at the hands of Attila.

» **Developer** Creative Assembly
» **Publisher** Sega



Grim Fandango: Remastered

Release date: Out now

LucasArts' final masterpiece is set on the Day of the Dead. You play Manny, a travel agent tasked with shipping the dead to the next level of Hell.

» **Developer** Double Fine
» **Publisher** LucasArts

Mad Max

Release date: TBA

From the makers of *Just Cause* comes this open-world car-action game based on the famous movie franchise.

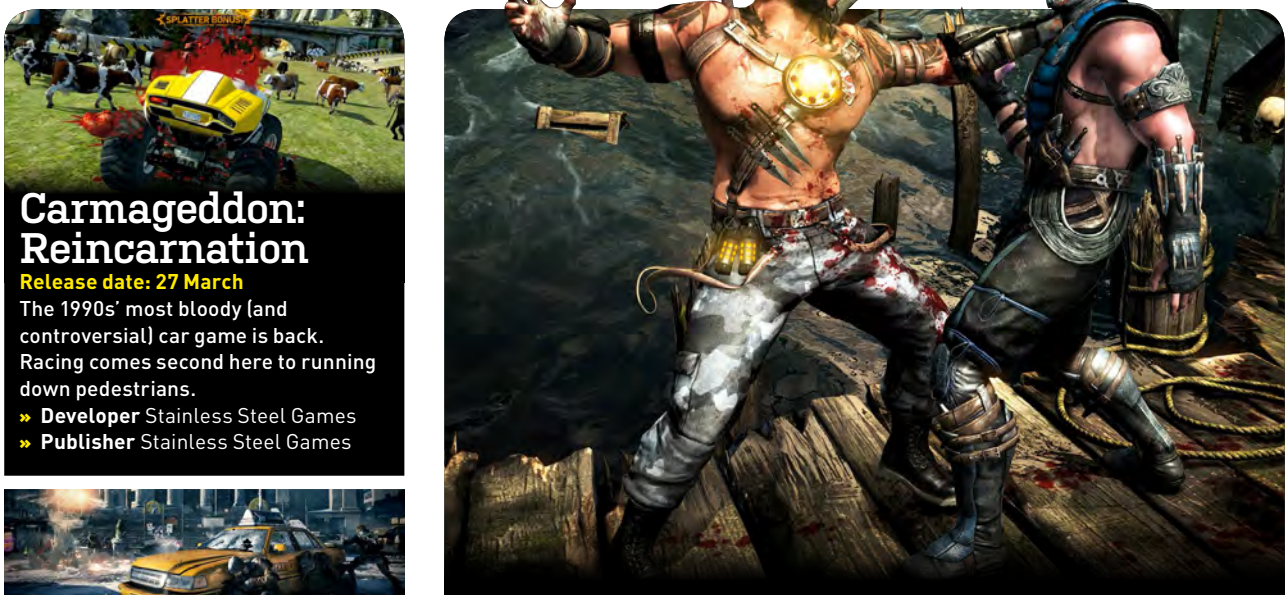
» **Developer** Avalanche
» **Publisher** Warner Bros

GTA V

Release date: Out now

The big daddy of open-world video games, Rockstar's series has come a long way since DMA Design's top-down arcade game. Number five has been out for a long while on console, but frankly it was as ugly as a politician's soul until the PS4/Xbone release. It's a grisly, misanthropic farce, following three unlikeable characters as they cause shooting and driving chaos in a huge open world (AKA LA). Its multiplayer mode, GTA Online, is almost a game in itself.

» **Developer** Rockstar
» **Publisher** Rockstar



Carmageddon: Reincarnation

Release date: 27 March

The 1990s' most bloody (and controversial) car game is back. Racing comes second here to running down pedestrians.

» **Developer** Stainless Steel Games
» **Publisher** Stainless Steel Games

The Division

Release date: TBA

An open-world third-person shooter multiplayer role-playing survival game set in the Tom Clancy universe. It's still in early development.

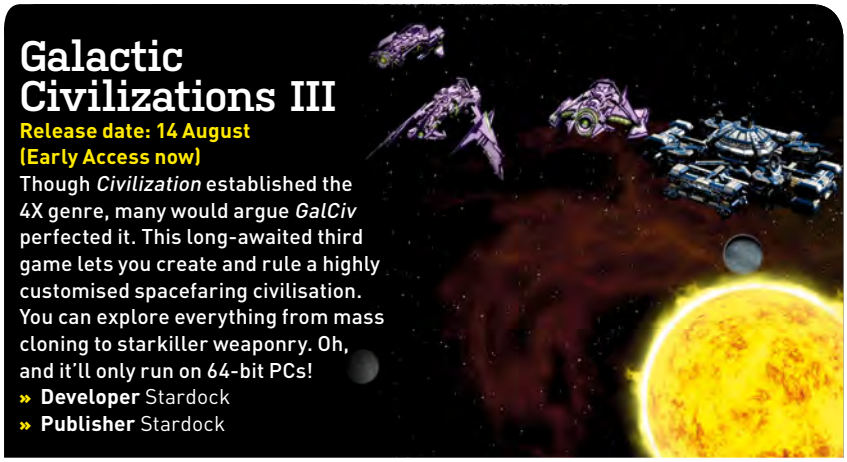
» **Developer** Ubisoft Massive
» **Publisher** Ubisoft

Mortal Kombat X

Release date: 14 April

The long-running fighting game series was rebooted in 2011, killing off many of the franchise's characters. This latest iteration carries on from that game, before slowly moving 25 years into the future, having the series' ageing veterans face off against the offspring of their compatriots. In terms of mechanics, each character now has three variations, with different styles of play and special moves.

» **Developer** NetherRealm Studios
» **Publisher** Warner Bros



Galactic Civilizations III

Release date: 14 August (Early Access now)

Though *Civilization* established the 4X genre, many would argue *GalCiv* perfected it. This long-awaited third game lets you create and rule a highly customised spacefaring civilisation. You can explore everything from mass cloning to starkiller weaponry. Oh, and it'll only run on 64-bit PCs!

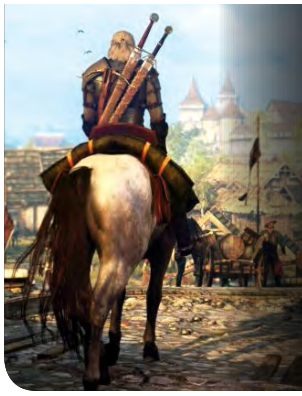
» **Developer** Stardock
» **Publisher** Stardock

Street Fighter V

Release date: TBA

If it's not the best fighting game of all time, it's certainly the most popular. For many years, PC versions of *Street Fighter II* were made of twigs and paper, liable to fall over at the slightest dragon punch. But the recent iterations of *Street Fighter IV* on PC have been hugely polished. This new release is, controversially, going to have cross-platform play between PC and PS4.

» **Developer** Capcom
» **Publisher** Capcom



The Witcher 3: Wild Hunt

Release date: 19 May

Considering its origins in obscure Polish fantasy novels, it's stunning that *The Witcher* is still such a big deal, but the series has proven consistently original, tough and divergent. *Wild Hunt* moves to an open world 30 times larger than the previous two games and bigger than *Skyrim*. It's also introducing underwater swimming, horseback combat, a day-night cycle and a huge array of monsters, plus it's concluding the twisty story.

» **Developer** CD Projekt Red
» **Publisher** Bandai Namco

Also coming out are... 1979 Revolution, Adrift, Apotheon, Armikrog, The Banner Saga 2, Batman: Arkham Knight, Battlecry, DomiNations, Dragon Ball Xenoverse, Evolve, Godzilla, Grave, H1Z1, Hatred, Heroes of the Storm, H-Hour: World's Elite, Home-

Mighty No. 9

Release date: April

The spiritual successor to *Mega Man*, Keiji Inafune's most famous creation, the *Mighty No. 9* is a classic side-scrolling action game. You play as Beck, the ninth in a series of powerful robots, and the only one not infected by a mysterious virus that's sent robots across the world haywire. You can transform your body, changing legs and arms to get past obstacles and enemies, and learn new abilities from the robots you defeat. Graphically it moves like a kid's cartoon, much like the bizarre *Cuphead*.

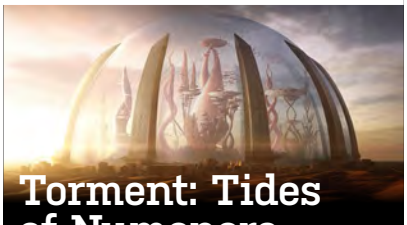
» **Developer** Comcept, Inti Creates
» **Publisher** Comcept

That Dragon, Cancer

Release date: Mid-2015

A game about what it's like to raise a son born to die. It's sure to be divisive.

» **Developer** Ryan and Amy Green
» **Publisher** Ryan and Amy Green



Torment: Tides of Numenera

Release date: Late 2015

The spiritual sequel to *Planescape: Torment* is a story-driven RPG, focusing more on character than combat and loot collection.

» **Developer** InXile » **Publisher** InXile

Chaos Reborn

Release date: May (Early Access now)

Julian Gollop is best known for his *XCOM* series, which was recently rebooted by Firaxis. But *Chaos* is the game he always wanted to remake and Kickstarter has now let him – *Chaos Reborn* is a nicely polished modern version of the rather unusual wizard combat simulator. Players take turns to cast spells and summon monsters, but it's actually much more complicated than that makes it sound. This new version has a persistent online mode and crafting, but the core game is as tight, complex and intriguing as ever.

» **Developer** Julian Gollop
» **Publisher** Snapshot Games

Project CARS

Release date: 20 March

It might have a slightly daft name, but you certainly know what it's about. This heavily delayed crowdfunded motorsport simulator is built on the same Madness Engine as *Need for Speed: Shift* and promises an open sandbox experience, with dynamic day-night and weather cycles. All vehicles and tracks are unlocked from the game's start, and players can attempt multi-day races, compete online or build a career.

» **Developer** Slightly Mad Studios
» **Publisher** Bandai Namco

Battlefield Hardline, Blood Bowl 2, Boid, Call to Arms, Cities: Skylines, Cuphead, Darkest Dungeon, Dead Island 2, Dollhouse, front: The Revolution, Hollowpoint, Hotline Miami 2: Wrong Number, Human Element, Hyper Light Drifter, Inside, Invisible Inc.,

Space Hulk: Deathwing

Release date: TBA

A conversion of the classic board game into a FPS, *Deathwing* is already looking beautifully polished.

» **Developer** Streum On Studio
» **Publisher** Focus Home Interactive

Titan Souls

Release date: Q1

Imagine a *Zelda* game that's all boss fights? That's *Titan Souls*. The extra twist is that you have a single arrow to do it with.

» **Developer** Acid Nerve
» **Publisher** Devolver Digital

The Witness

Release date: TBA

Designer Jonathan Blow has only made one commercial game so far – but the care he put into *Braid* demonstrated why his follow-up, *The Witness*, is so anticipated – and why it's taken so long. It's a first-person puzzle game like *Myst* or *The Talos Principle*, where players wander an uninhabited island covered in ruins, deciphering the story as they discover hidden audio logs from previous visitors. Many of the brain-teasers are mazes and, as you complete them, you'll unlock access to a central set of puzzles inside the island's mountain.

» **Developer** Thekla
» **Publisher** Thekla

Hellraid

Release date: TBA

While we wait (and wait and wait) for Bethesda to give up on *The Elder Scrolls Online* and make a new *Skyrim*, *Hellraid* seems tailor-made to fill the gap. By the team behind *Dead Island*, this is a first-person hack-'n'-slash game built around four-player co-op. You play a cursed man in a world based on old European folklore, and fight a series of monstrous enemies with magic, swords and bows as you raid Hell itself.

» **Developer** Techland
» **Publisher** Techland

Mushroom 11

Release date: Mid-2015

One of the weirdest indie games around, *Mushroom 11* answers the everyday question: "What would happen if sentient fungi took over the world?" You control a mycelium traversing a post-apocalyptic world. As you delete aspects of the fungal mass, it grows everywhere else, meaning that you can move it at high speed by careful editing. It's essentially a post-apocalyptic pruning game.

» **Developer** Untame
» **Publisher** Untame

Kholat, Kôna, Last Life, Life is Strange, Love You To Bits, Lovers in A Dangerous Spacetime, Need for Speed 2015, Night in Proven Lands, Quantum Break, Rainbow Six: Siege, Resident Evil: Revelations 2, Satellite Reign, Seasons After Fall, Shadow

SUPERHOT

Release date: June

A jam game turned full product. A FPS where bullets and enemies only move when you do, making this like a time-based first-person puzzle shooter.

» **Developer** Blue Brick
» **Publisher** Blue Brick

Assassin's Creed Victory

Release date: Autumn

The latest in Ubisoft's series will be set in Victorian London. Here's hoping Spring-heeled Jack shows up...

» **Developer** Ubisoft
» **Publisher** Ubisoft

Star Citizen

Release date: 2016 (Early Access now)

Chris Roberts, beloved creator of *Wing Commander* and *Privateer*, took the crowd-funding universe by storm when he announced *Star Citizen* back in October 2012. The game quickly hit its funding goals and indeed the clamoring to hand over cash hasn't abated – at the time of writing the game had accrued $69 million of funding, purely from gamers. As far as the game is concerned, *Star Citizen* has lofty aims – it isn't just a space trading sim, it's a "living, breathing science fiction universe with unparalleled immersion". Apart from being able to fly around, it'll be possible to land on planets and space stations and run around in a first-person mode.

» **Developer** Cloud Imperium Games » **Publisher** Cloud Imperium Games

Metal Gear Solid V: The Phantom Pain

Release date: TBA

Though Hideo Kojima's filmic *MGS* series has thrived on the Playstation, its sad history with the PC was restricted to a so-so port of *MGS 2* in 2003. However, last year's *Ground Zeroes* established a toe-hold which will be capitalised on by 2015's *The Phantom Pain*. This time it's set in an open-world Afghanistan with real day-night cycles.

» **Developer** Kojima Productions
» **Publisher** Konami

Just Cause 3

Release date: TBA

Avalanche's series of open-world action games has got impressively huge. The latest installment has Rico Rodriguez returning to take on another petty dictator, with a new ability to scale buildings more easily. It's likely to be set more in skyscraping cities than the low favelas of the past.

» **Developer** Avalanche Studios
» **Publisher** Square Enix

No Man's Sky

Release date: TBA

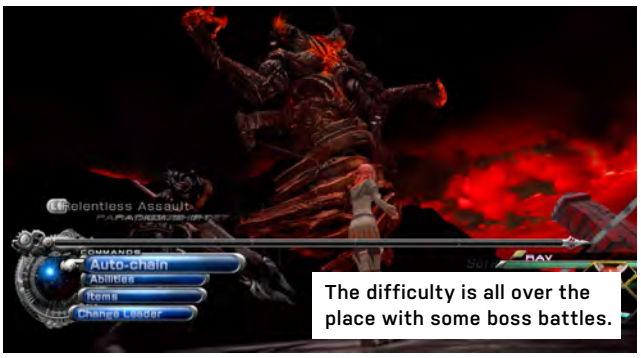
The 2015 game that most developers we know are looking forward to. Hello Games may have only worked on stunt arcade game *Joe Danger* before, but *No Man's Sky* looks hugely ambitious. It's a space opera sim where you explore a procedurally generated but shared universe, both in space and on the surface of bizarre planets. Every scene in the game looks like it's from a 1960s sci-fi magazine cover.

» **Developer** Hello Games
» **Publisher** Hello Games

the Woods, Nuclear Throne, Obduction, Octopus City Blues, Ori and the Blind Forest, Overwatch, Paradigm, Project Phoenix, Realms, Star Wars: Battlefront, Sub Rosa, Tangiers, There Came An Echo, War for the Overworld... among hundreds of others.

Serah's politeness makes us pine for some good old-fashioned misery.

Cutscenes provide a stage for some awful dialogue.



The difficulty is all over the place with some boss battles.

Final Fantasy XIII-2

Time travelling to a bunch of new problems

THE *FINAL FANTASY XIII* TRILOGY is a bizarre series, each game clearly fashioned around the reactions of its fanbase to the one before. *FFXIII* was a cloyingly linear affair with a brilliant combat system, so it follows that direct sequel *FFXIII-2* is so freeform it's sometimes hard to keep up with what you're supposed to be doing. While it's mostly the better game, it comes with a whole host of new problems.

It's set a few years later, and Lightning, moody heroine of the last game, has vanished into Valhalla. It's up to her sister, Serah, and a displaced Valhalla native called Noel to look for her. An initially confusing time travel concept shapes the structure. Using a menu screen-cum-timeline stupidly named the Historia Crux, you can jump between different timeframes of the same environment.

When you're progressing nicely, poking through new time periods, fighting bosses and exploring, it's classic *Final Fantasy* RPGing and deserves to be lauded. But there are stretches with unskippable battles and dreadful '90s-era switch puzzles that show a developer blatantly out of its depth.

You need a history with *FFXIII* before you even consider buying this. The story is awful, with interminable cutscenes and two lame protagonists. Noel is a walking, talking spiky-haired nothing in pants, while Serah is so boringly polite she makes a case for why every *FF* hero needs to be a miserable and broken human being (yay RPGs!). But while we never enjoyed the story, which piles on new characters without any effort to create emotional investment, the world is tonally laidback and pleasant. Towns, explorable environments and interactive NPCs all make a welcome return.

BATTLE STATIONS

The pacing is better too, letting you start levelling your character's roles right away. The combat, which automates your party's attacks while you change their roles, is functionally identical, but instead of a third-party member, you deploy monsters with their own classes and attacks. It's very flexible. With this excellent combat system, however, comes bad quest design. Chasing sheep to collect wool marks a low point.

Rough stabs at variety don't pay off, such as the intrusive boss fight QTEs – already on their way out when *FFXIII-2* hit consoles in 2012. One poorly judged and irritating platforming sequence feels like it belongs to a different game entirely, while the newly added dialogue options are entirely pointless and only highlight the bad script.

The port brings its own problems. Unlike *FFXIII*'s original 720p-locked release, *FFXIII-2* does have a bare minimum range of visual options, but the obvious, unaddressed issue is frame rate. It's a little cheeky that the Steam page boasts 60fps when achieving that is so infrequent on even a moderate rig. We'd say *FFXIII-2* is annoyingly slow on a mid-ranged PC, regularly dropping to around 20fps at 1080p with mid-level anti-aliasing and shadow

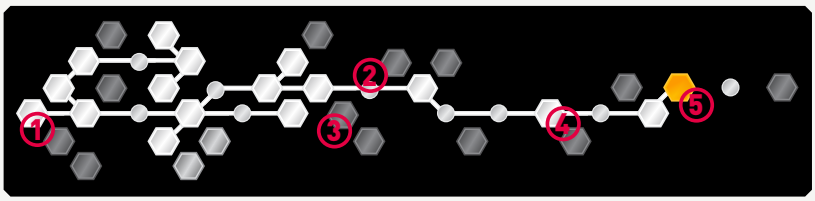
ABOVE RIGHT **Noel with another character you won't care about.**

TOP **The combat makes the story tolerable. Almost.**

ABOVE **The quick time events (QTEs) felt outdated in 2012.**

CLOCK BOTCHERS

Explaining the historia crux and how time travel works in *XIII-2*



1 Each hexagon represents one specific environment at one specific point in time. Selecting one will warp you to that time and place.

2 This line stretching from the centre to the end is the 'main' timeline, but in the order of the game, rather than a chronological order of events.

3 The greyed out hexagons are times and places you need to unlock by collecting fragments and opening time gates – a lot of fetch quests.

4 Many of the hexagons represent somewhere you've been before but at a different point in the timeline, sometimes hundreds of years later.

5 Finally, while the culture shock of landing in a different time and place is pretty cool, none of this makes any sense in the story. Not cool.

settings, and it hardly looks cutting-edge even then. For those seeking the definitive *FFXIII-2*, this really doesn't feel like it.

FFXIII-2 is an inconsistent sequel, and one we can only recommend to a subsection of the series' audience. It is better than *XIII*. It fixes a lot of its predecessor's problems, focusing on the airtight combat and upping the exploration, but tries its hand at a bunch of new ideas that entirely fail. This feels like a game crafted around a survey of unhappy fans. As such, it's one of the oddest *Final Fantasy* entries to date. –BY SAMUEL ROBERTS

VERDICT **6**

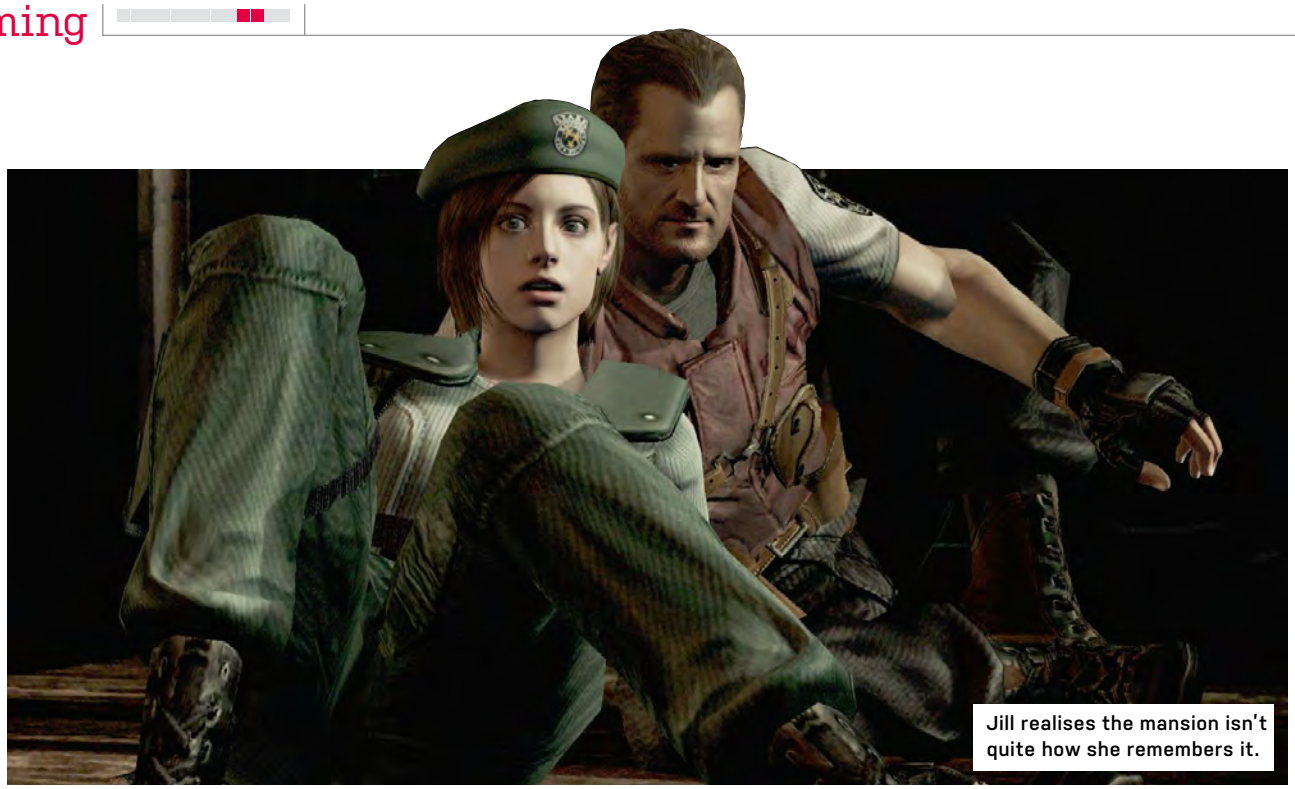
Final Fantasy XIII-2

FANTASY: Better than *XIII*; great combat system.

NIGHTMARE: Awful puzzles; dated QTEs; terrible story; dull characters.

RECOMMENDED SPECS: GeForce GTX 460, Intel Core 2 @ 2.66GHz, 2GB RAM.

£13, http://bit.ly/1ENhN0v, PEGI: 16



Jill realises the mansion isn't quite how she remembers it.

The locals don't really get the whole personal space thing.

Whatever you do, don't waste your bullets.

Resident Evil HD Remaster

Shinji Mikami's horror classic rises from the dead

WE'RE USED TO FEELING like the centre of attention in games, like the whole world revolves around us. But *Resident Evil*'s zombie-plagued mansion doesn't care about you. It's a place where death lurks around every pre-rendered corridor, and if you stumble into one of its sadistic traps or undead denizens, bad luck. It's back to the main menu with you, and you better hope you saved. *Resident Evil* doesn't hold your hand: it rips it off and eats it.

This is a remastered version of a remake of the original 1996 game, which was released for the Nintendo GameCube in 2002. It retains the fixed cameras, rendered backgrounds and tank controls of Mikami's pioneering survival horror, but mixes a few things up. If you know the Spencer mansion from the PlayStation game inside out, there are plenty of surprises. But if you've never played the original, this is the best place to start. Even though it's 13 years old (and based on a 19-year-old game), it's worth it.

You can play as one of two characters, each with their strengths and weaknesses (see "His and Hers", opposite). There are no respawning items in the haunted house setting, so it becomes a game about management: knowing when to fight, when to run away and conserve ammo, and whether to use a health item now or save it.

Even your saves are finite. *Resident Evil* really is a survival horror game. Every wasted bullet or typewriter ribbon (which are used to save) could come back to haunt you later. Even defeated zombies can be a problem, springing back to life as more powerful 'crimson heads'. You'll have to burn their corpses to avoid this.

LOW RESI

The remastering isn't as good as we'd hoped. We thought they might have dug the original pre-rendered backgrounds out of some dusty archive and presented them at a higher and previously unseen resolution, but it seems as if they've just added a filter to the existing GameCube files. As a result it doesn't look spectacular, especially on larger monitors, but the lighting and atmosphere make up for it. Light sources in the world illuminate your character as you move past them, which does a surprisingly good job of fooling your brain into thinking these are 3D spaces.

The mansion is a wonderfully eerie setting, and the fixed cameras, although archaic, actually add to the tension. The game uses blind corners to great effect, and you'll often hear the groan of a zombie before you see it. This makes you play cautiously as you creep through the dingy corridors. Sometimes the camera will be peering at you through a window or floating above you, which gives you an uneasy feeling of being watched. Rather than being hamstrung by their two-dimensional limitations, the developers have used them to make a really effective horror game.

ABOVE You've got red on you, mate.

ABOVE RIGHT The fixed camera adds to the tension.

TOP Where's a snake charmer when you need one?

HIS AND HERS

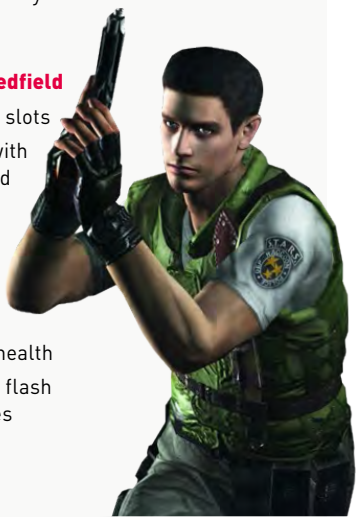
The key differences between *Resi*'s two playable characters

Jill Valentine

- Eight item slots
- Starts with gun and lockpick
- Low health
- Can find and keep grenade launcher
- Can use stun gun

Chris Redfield

- Six item slots
- Starts with knife and lighter
- Deals high knife damage
- Lots of health
- Can use flash grenades



With hardcore survival games frequently topping the Steam charts, Capcom has picked a good time to revive *Resident Evil*. It's a punishing, but immensely satisfying game, even if the 'remaster' isn't as dramatic as the title suggests. If you can't stomach the tank controls there's a new analogue option that works well with a controller, but the keyboard and mouse controls are pretty clunky. This was a game originally designed for a Nintendo console after all. –ANDY KELLY

VERDICT **8**

Resident Evil HD Remaster

ALPHA: Genuinely scary, creepy and very atmospheric.

BRAVO: Remastering is visually underwhelming; keyboard and mouse controls aren't the best.

RECOMMENDED SPECS: GeForce GTX 560, Intel Core 2 Quad @ 2.7GHz, 4GB RAM.

£16, www.capcom.co.jp/biohd/en, PEGI: 18

You can now fire exploding frogs. We have no problem with this.

Saints Row: Gat Out of Hell

Welcome to expansion pack purgatory

WE LOVE *SAINTS ROW IV*. It's funny, silly and surprisingly warm-hearted. It's important you know that. Because we don't love *Gat Out of Hell*. We don't hate it, by any means, but it seldom displays the spark of creativity that made the last two games so good.

In this standalone *Saints Row IV* expansion you play returning characters Johnny Gat and Kinzie Kensington on a mission to rescue 'The Boss' – the moldable agent of chaos at the centre of all previous games – from Satan. More specifically, from Satan's arranged marriage plans. This is all great. But it all takes place in a cutscene.

Gat Out of Hell's best moments are all in cutscenes, where the characters are free to break out of the rigidity of the game itself. Even worse, the game's best joke was released in its entirety as a trailer. It ruins what could have been a wonderful surprise.

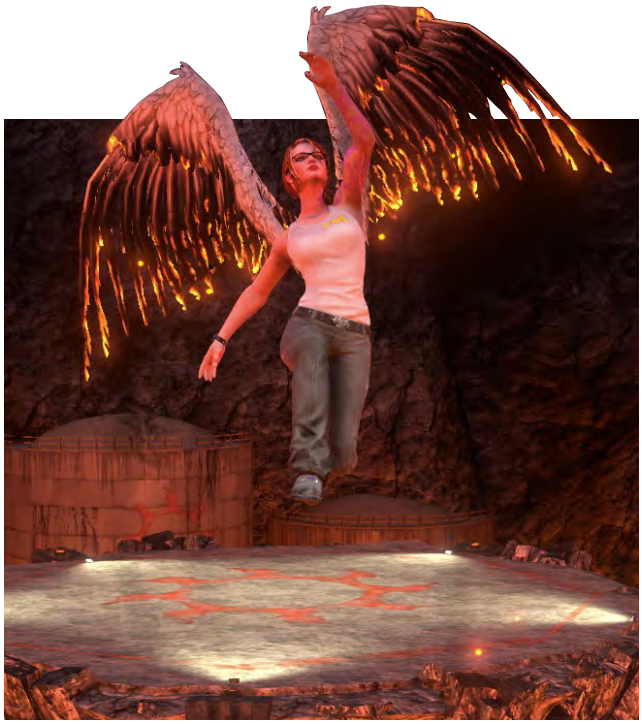
The major problem with *Gat Out of Hell* is that the series' other traditional methods of delivering jokes – through its mission design and scripting – are almost entirely absent. Instead, the game's mission-givers offer playlists of open-world mini-game activities. *Saints Row IV* did this as a diversion between the main missions, but here, there are no missions. Your job is to complete activities until you've caused enough carnage to attract Satan's wrath. Do so, and you'll unlock the final boss fight. It took us around five hours, albeit with plenty of other activities left on the map.

HELL FLIER

With no missions, the entire game is reliant on its open-world design. Some of this is exceptional. Where in *Saints Row IV* you could super-jump and glide, in *Gat Out of Hell* you can fly. It's brilliant. Your job is to maintain momentum, and with practice you can reach some exhilarating speeds. It gives an entirely new sense of freedom, and makes collecting 'Clusters' – collectible souls that upgrade your powers – a joy.

Aside from such notable exceptions, most of the activities, weapons and superpowers are lifted from the previous game. Some of the new weapons are fun. The exploding frog launcher was our constant companion throughout the game, and the armchair Gatling gun was funny enough to regularly make it into our rotation. *Saints Row*'s combat has never been its strong suit, however. It's functional, but the system feels more suited to large-scale carnage and mayhem than it does to the moment-to-moment headshotting of demons. In *Gat Out of Hell*, the smaller scale stuff seems more prevalent, and the grand set-pieces sorely lacking.

There are only a handful of different activities, each repeated multiple times. Torment Fraud is essentially a reskin of *Saints Row IV*'s Insurance Fraud, in which you throw yourself in front of cars and fight against an irritatingly imprecise ragdoll system. Survival and Mayhem also make



ABOVE Cutscenes remain a highlight.

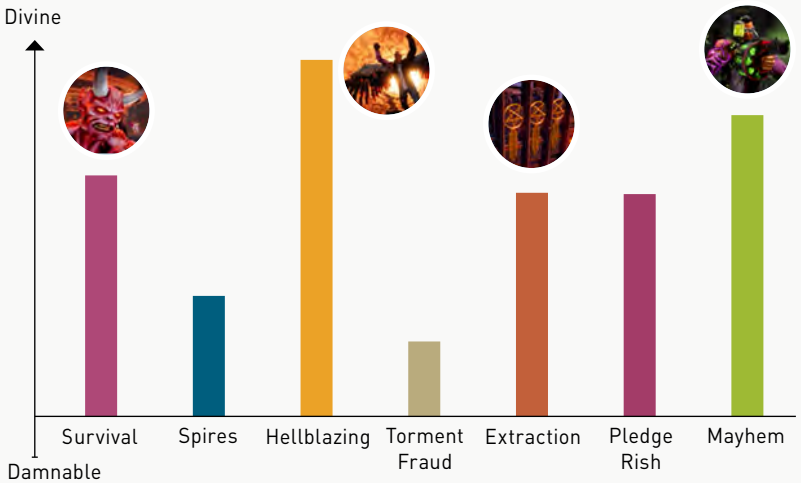
TOP Kinzie's getting out a bit more these days.

ABOVE RIGHT A quick game of Twenty20, Hell-style.

TOP It's been a tough day at the office for Vlad.

HEAVEN OR HELL

Are *Gat Out of Hell* activities saintly or Sisyphean



the transition, and are similarly identical to previous versions. Of the new events, Hellblazer and Salvation make use of Gat's flight ability, and as such are the best.

Our disappointment comes with caveats. First, this is an expansion, and so of course will be smaller in scope than a full game. Second, it's priced like an expansion. That absolves *Gat Out of Hell* of a lot of its sins, but nevertheless leaves it feeling restrained and underwhelming. **–PHIL SAVAGE**

VERDICT **7**

Saints Row: Gat Out of Hell

SAVIOUR: Great new flying ability; open world as good as always; fun new weapons.

SINNER: Lack of missions; mini-games too repetitive; too dependent on cutscenes.

RECOMMENDED SPECS: Intel i3 2100T, 4GB RAM, Nvidia GTX 560.

£15, www.saintsrow.com, PEGI:16

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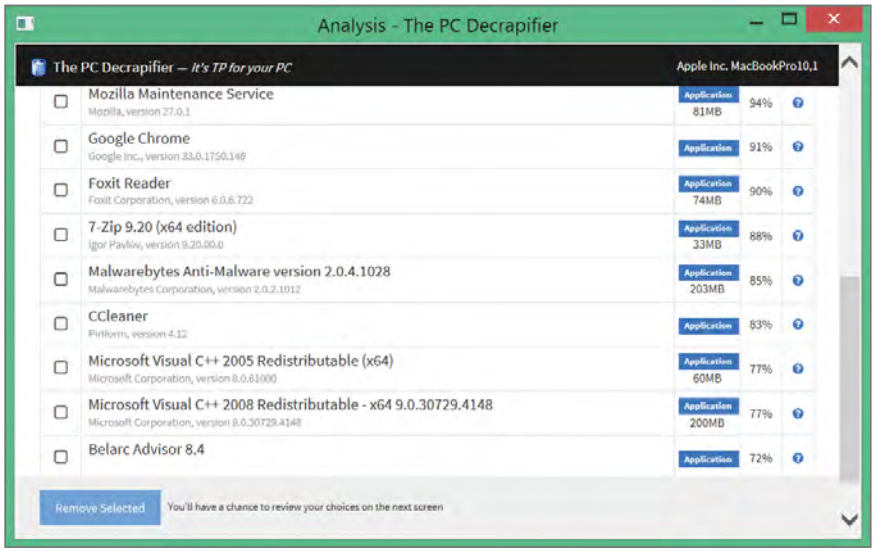
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

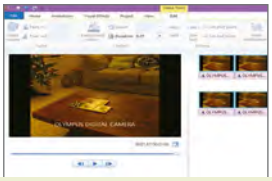
WINDOWS TIP OF THE MONTH



START ON THE RIGHT FOOT WITH PC DECRAPIFIER

New off-the-shelf computers and laptops usually come preloaded with a bunch of unwanted software. Speed up your PC straight away by running PC Decrapifier – it automatically finds tons of common bloatware, and lets you uninstall them with a single click. Get it for free by pointing your favourite browser at www.pcdecrapifier.com.

MAKE – USE – CREATE



GRAHAM BARLOW
CONTRIBUTING EDITOR

MACS AND PCs CHEW THE EXFAT

As somebody who can remember when 50GB seemed like more storage space than you'd ever need, the ridiculousness of reaching for a 2TB hard drive to store my home videos on never escapes me. And yet, 2TB portable drives are not only easily available these days, they're also crazily cheap – around £70 – and there are larger sizes available.

The problem is, it can be hard to share a portable drive between a PC and a Mac once you go over the 2TB limit. It's down to the file system. The limit for the universal FAT32 file system is 2TB. Formatting larger drives with the standard NTFS or HFS will only result in problems if you try and plug the drive into both types of computer, as without special software it will be read-only.

Luckily Microsoft has provided a solution in the form of the ExFAT file system. This is supported by Macs and Windows and there's even limited Linux support, although Microsoft hasn't released the full specification into the public domain. So, if you've got yourself a portable drive bigger than 2TB and you want to make sure it can be plugged into any machine you use, ExFAT is the way to go.

At the rate things are going, I'm pretty sure it won't be long until we'll look back at any PC with less than 64TB of hard drive space as inconsequential. Until then, ExFAT is your best friend.

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BUILD IT

BY TOM MCNAMARA

Video Production On-the-Go

We discover that balancing size and power is a delicate process when building a specialist rig for content creation

LENGTH OF TIME: **1–2 HOURS** | LEVEL OF DIFFICULTY: **LOW**

THE MISSION

SOMETIMES WE BUILD SYSTEMS to test out the latest hardware, or to experiment with different ideas. Here we're constructing a purpose-built machine with one usage case in mind - video editing. With YouTube, Twitch and other video sites becoming increasingly integrated into our daily lives, it's a good time to think about what we use to create this content, rather than what we use to watch it. And if you want to start your own YouTube channel or get involved with video creation, you don't need a super computer.

As long as you have a CPU with four or more cores, a few hard drive trays, and a decent graphics card, you can get along just fine. These bullet points are reasonable enough that we can fit them into a pretty low-profile PC that you can truck around without throwing your back out. With the type of case that we chose, you can also fit a full-sized power supply, high-performance CPU cooler and full-length graphics card in it without much hassle. This case is even designed to stack with multiple units of the same base model, giving you upgrade options further down the line.

AN EYE FOR ITX

WE'VE BUILT WITH 'SHOEBOX' PC CASES before, and they taught us that things can be a pain, due to their sheer compactness. Silverstone even ships some cases with power supplies pre-installed, along with custom shortened cables. They've a minimal footprint on your desktop and look cool, but woe betide you if you need to troubleshoot anything – you'll need to unpack entire chunks of PC guts to get at the problem, usually. So we wanted a shoebox that was reasonably easy to build into and out of. Especially with video encoding, where you want the ability to swap hard drives in and out. The Cooler Master HAF Stacker cases make those drives easy to access. You can also choose a case with the PSU mount on the front or on the back. We went with the front mount to keep the weight of the case balanced.

Inside this case we've used an Asus RoG Maximus VII Impact mobo, which employs the Intel Z97 chipset and offers up a selection of its own handy features, too. We've kept costs down by putting an Intel Core i5-4670K CPU at the build's heart, and we've the ever-popular Cooler Master Hyper 212 Evo for some moderate overclocking. Our GPU is the Sapphire Radeon R9 285 Compact, which is roughly equivalent to a GeForce GTX 760. Our storage is a Samsung 850 EVO SSD and two 3TB hard drives from Seagate.

INGREDIENTS

PART		PRICE
Case	Cooler Master HAF Stacker 915F	£48
PSU	Cooler Master V550 550W	£60
Mobo	Asus RoG Maximus VII Impact	£171
CPU	Intel Core i5-4670K	£168
GPU	Sapphire Radeon R9 285 Compact	£200
RAM	2x 8GB Kingston Fury Black	£130
Drive Cage	HAF Stacker 935 Storage Kit	£10
HDD	2x Seagate Barracuda 3TB	£168
SSD	250GB Samsung 850 EVO	£110
OS	Windows 8.1 64-bit OEM	£73
Total		£1,138

1 CART BEFORE THE HORSEPOWER

IF YOU'RE USING an aftermarket CPU cooler like we are on this occasion, you'll need to install its backplate on the motherboard before thinking about getting the board into the case. These ITX cases generally don't have cut-outs that enable you to access the motherboard tray from the other side. Thankfully, this is an easy task with the 212 Evo cooler.

For our LGA 1150 board, you choose the middle of the backplate's three screw positions, then put the mounting screws in, and fasten the screws on the other side of the board with the nuts that should be provided. Our board also has a tall riser card, so we needed to shift the CPU fan vertically a few notches to make sure that everything fit. Low-profile RAM is also something highly recommended.

2 AIN'T THE SIZE OF THE BOAT

THIS SAPPHIRE COMPACT GRAPHICS CARD is short enough for us to install this three-tray drive cage right in front of it. Without that, we're limited to the drive mount on the 5.25-inch bay (which is removable), the one below this drive cage, and the one on a reinforcement plate (which we removed for this build). This cage also has enough room behind it that we don't require right-angle SATA cables.

This case doesn't actually come with a 3.5-inch drive cage; you need to order the HAF Stacker 935 Storage Kit from Cooler Master to get it. The SATA cables that come with our motherboard aren't long, so we slapped them in, too. It doesn't matter which port you use on the motherboard end – they can all do SATA III speeds.

3 BACKWARDS AND FORWARDS

HERE WE HAVE THE FRONT OF THE CASE with the bezel taken off. This right-angle power cable gets juice to the power supply while lying flat enough to fit behind the bezel. The PSU's power switch ends up on the inside of the case, which is a bit awkward. But the bezel pops off pretty easily, giving you access to the switch in a pinch. (We should also add that this is a pre-production version of the HAF Stacker, because we're hardware hipsters. Some cosmetic stuff is different from the retail version). The case has an intake fan below the PSU mount, and its heat is exhausted through the front of the case. Sometimes ITX cases make their PSUs expel heat into the case, which may cause overheating or lower your overclock ceiling. For our needs, this 550-watt unit is plenty. If you put in a 290 or 290X, we'd recommend bumping it up to 600 watts.

4 A LOVER, NOT A WI-FIGHTER

THESE TWO GOLD-PLATED COAXIAL CONNECTORS are for the motherboard's integrated Wi-Fi. You definitely want some of that in an ITX system, since it will have only one PCI Express card slot on the motherboard, and you want to use that for your graphics card. Since our system is designed for mobility, we don't want to have to rely on Ethernet for network access. These coax connectors each have a nut and a washer that you need to remove before putting the connectors through the back of the I/O shield here. You re-attach them on the other side, and your coax is secure. This Asus motherboard comes with an antenna on a cable about two feet long, from which we were able to get a strong connection. Windows 8.1 recognised the adaptor right out of the box, which made our initial setup much easier.

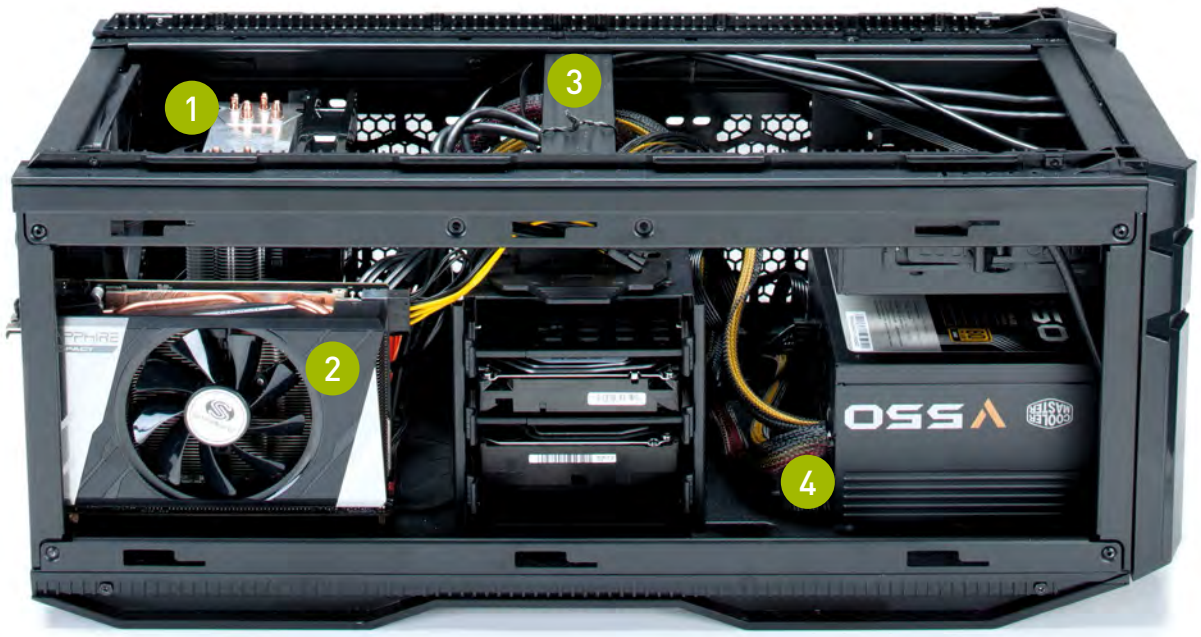
5 GETTING HIGH

THIS IS WHAT THE INSIDE of the HAF Stacker's side panel looks like. It has 'captured' thumbscrews, which means they stay attached even when fully unscrewed. It's basically one big grill with a bunch of fan mounts. You can mount two 140mm fans or up to three 120mm fans. In practice, you can't use all of these, because internal components get in the way. The top of the case has no fan mounts, but it's also one giant grill. In case you were wondering, HAF stands for "High Air Flow". Cooler Master aren't kidding.

The other side panel is identical, so you can squeeze more fans in. We kept it simple and stuck with the 120mm stock exhaust fan. This ITX mobo has only two fan headers anyway, so we'd have to plug extra fans directly into the power supply, which can be noisy. On the other hand, you could use that 5.25-inch bay to install a fan controller, if you don't mind sacrificing the bay's drive mount.

6 TANGLES AND DANGLES

THE UNDERSIDE REVEALS a couple of interesting things. Besides the drive mount, there's a set of rails and a rubber grommet. The rails give clearance for the power supply's intake. But you can also remove them and connect a second HAF Stacker. That's how the case gets its name. The grommet is for feeding data and power cables between the two cases, so they can share storage devices and a power supply. Three of these 915 cases stacked on top of each other will be roughly the height of a full ATX tower. Cooler Master also sells a '935' SKU, which combines this 915 with a 925 mid-tower that they don't sell separately. The 935 has Stacker attachment mounts both on top and on bottom, so you could build something pretty colossal.



1 **You could actually squeeze a second CPU fan on the other side of the cooler, and the 212 Evo comes with an extra set of clips for that.**

2 **This Radeon R9 285 boasts just one fan, but doesn't generate much heat anyway. Even so, it performs better than the Radeon 280.**

3 **We put a twist tie here to secure the thick USB 3.0 cable coming from the front panel. You can also lift the case by this crossbar.**

4 **The PSU is 5.5-inches/140mm long. As you can see from the photo, you could go another half inch without meeting too much trouble.**

IT'S A QUIET RIOT

WE MADE SURE only one drive was connected when we installed Windows, otherwise it puts a system partition on a drive other than the SSD. We wanted to be able to swap out the other drives, and putting the system partition on one of them makes Windows unbootable if that drive is disconnected. While we were installing Windows, we noticed it didn't recognise the mobo's integrated Ethernet adaptor, which uses an Intel I218-V chip, even though it recognised the integrated Wi-Fi. We're used to the opposite being the case.

We used the Wi-Fi connection to download the Ethernet drivers, along with the latest versions of AI Suite (for managing fan speeds, monitoring temperatures and doing some tweaking), plus HomeCloud. We needed HomeCloud to enable Wifi GO, a feature that allows you to use your system as a wireless hotspot, which is a neat extra for our build. If your system boots without Ethernet or wireless connectivity, you can pull older drivers off a DVD bundled with the board, or you can download the drivers to a mobile device and transfer them via a USB cable.

With just one 120mm fan in the case and another on the CPU cooler, this was a pretty quiet build. In fact, we actually removed a side panel to check the fans were spinning. Of course, the CPU fan cranks up a bit when the chip is firing on all cylinders, but it shouldn't be distracting. We took this opportunity to update the BIOS, since the newest one said it improved stability, and the one before claimed to improve performance. It's unfortunate mobo vendors are so vague about what their BIOS updates do. Either way, we couldn't resolve an issue where the PC wouldn't boot when we had a USB thumb drive plugged in.

Since we're not testing new hardware, there aren't any benchmarks to run. This build was more about concept and execution. The results will vary a lot according to what kind of video footage you're dealing with and what programs you use to edit and encode. But the Radeon R9 285 is on Adobe's approved list for hardware-accelerated encoding via OpenCL, and four Haswell CPU cores pack plenty of performance poke, too.

By default, this Asus motherboard will set all cores of the Core i5-4670K to 3.8GHz, when a load is applied. That's the CPU's official maximum "Turbo" setting. Without this motherboard setting, one core will run at 3.8GHz when only one core is being used. When all four are in action, they'll run at 3.5GHz each. When three are being used, they'll run at 3.6GHz each; for two, they'll run at 3.7GHz. The motherboard's "Sync All Cores" setting streamlines this business and gives you a performance edge for video encoding, which typically uses all the cores and threads that you can throw at it.

If you have some downtime, this system doubles as a respectable gaming rig. We averaged 79fps in *Tomb Raider*, using the "Ultimate" setting at 1920 x 1200 with TressFX disabled. *The Hitman: Absolution* benchmark averaged 48fps on "Ultra" with 4xMSAA. This compact 285 retails at a higher price than average, so it's not the best bang for your buck, but it's the best value after you've factored in size. Nvidia's partners have started coming out with mini versions of the GeForce GTX 970, but those are about £60 more.

Overall, we're happy with how this system turned out, though we might have opted for a less expensive motherboard, since the Maximus VII Impact is designed to take advantage of more exotic CPU cooling than a Hyper 212 Evo. ■

Build Your Own Social Network

YOU'LL NEED THIS

UBUNTU SERVER
We'll help you transform a basic Ubuntu installation into a web server.

ELGG
The freely available open source software that powers our social network (www.elgg.org).

WHEN J. A. BARNES COINED THE TERM 'SOCIAL NETWORK' IN 1954, he had no idea that, with the internet as catalyst, online social networks would change the dynamics of interaction for individuals around the world. As a means of connecting people, social networks can bring together students and provide them with the tools to collaborate on projects, exchange class notes and even advertise the availability of dorm rooms. Similarly, a corporation could deploy such a social network on its intranet as a virtual water cooler for its employees, and as a means for them to exchange notes and recommend their peers.

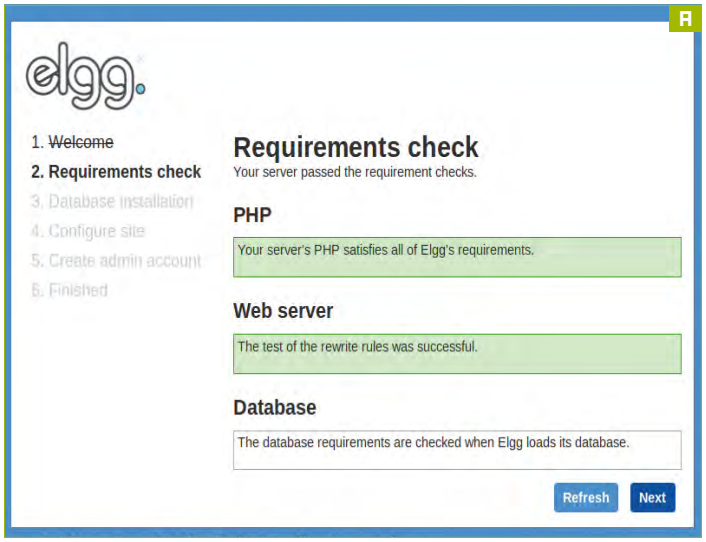
Elgg is a wonderful piece of open source software that's designed to create such niche social networks. Using Elgg, members can have their own blogs, form and join communities, share files, plus collect news and articles using feeds aggregation. The software already powers social networks within several universities and corporations around the globe. In this tutorial we'll help you deploy an Elgg instance on your own infrastructure. **–MAYANK SHARMA**

1 DEPLOY ELGG

Begin by installing the required web server components into an Ubuntu installation (see "Setting Up a LAMP Server", opposite, for detailed instructions). For the rest of this tutorial we'll assume that '/var/www/' is your web server's DocumentRoot directory. When your server's set up, head to www.elgg.org and download the latest version of the software that's available as a zipped archive. Next, unzip and upload it to your server's DocumentRoot directory with the 'unzip elgg-1.10.0.zip -d /tmp' and 'sudo mv /tmp/elgg-1.10.0 /var/www/elgg' commands.

» With the files in your web server it's now time to create a database for Elgg. The command 'mysql -h localhost -u root -p' will prompt you for the password for your MySQL server before invoking its shell. Enter the 'create database elgg;' command at the MySQL shell to create the database and then type 'exit' to return to your web server's shell. Your MySQL connection settings will surely be different, so make sure you use the correct username, password and host. You'll also need these later to hook up Elgg to the MySQL database.

» Elgg also needs a folder to house any uploaded files such as user icons. For safety reasons, you should create it outside your DocumentRoot with 'sudo mkdir /var/www/elgg-data' and hand over control to the web server with the 'sudo chown -R www-data /var/www/elgg-data' command.

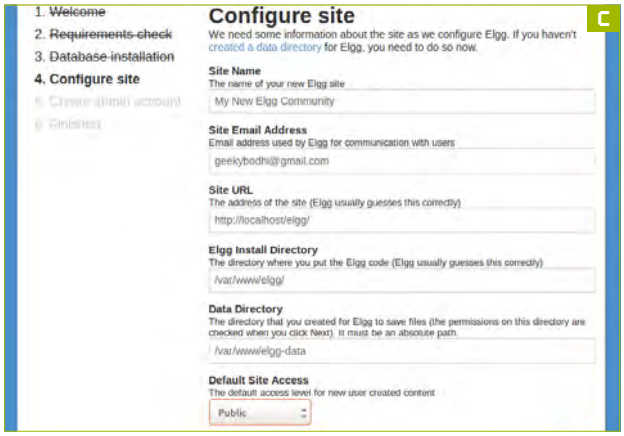


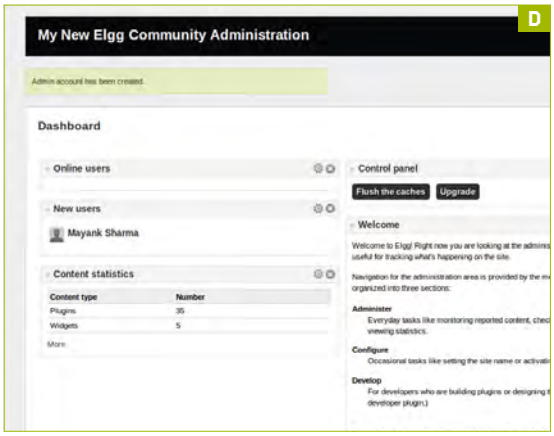
2 SET IT UP

You're now all set to deploy your social network. Fire up a web browser and point it to the Elgg installation, such as http://localhost/elgg/. If you're deploying Elgg on a remote server, substitute localhost with the server's IP address. You'll be greeted by Elgg's six-step setup wizard. The wizard will first check whether the server meets all the requirements. If you've set up the server as per the instructions in the box opposite, you shouldn't face any issues (**Image A**). The next step asks you to enter the details of your database server and the database you've created for Elgg (**Image B**). The Database Table Prefix helps you to easily identify Elgg's tables, especially when you share the same database with other web apps as well. You can leave this blank if you're using the database exclusively for Elgg.

» In the fourth step you're asked for some basic information about your social network, such as its name and the administrator's email address (**Image C**). Other information, such as Elgg's URL, install directory and data directory are automatically picked up by Elgg, but be sure to check them for errors.

» You can also define the default access permission for user-created content from this page. 'Public' will show the content to non-logged in users, while 'Private' will hide all content behind a login page. Remember you can change these settings, especially the social network's name, even after you've run through the wizard. In the last step you're asked to enter the details of the Elgg installation's administrator. Once you've run through all the steps, Elgg will connect to your database server and populate its database and set up a basic social network based on the information it's gathered via the setup wizard.





3 ADMINISTRATOR DASHBOARD

When you're finished with the setup wizard you can then log into your newly set up social network. Now when you visit http://localhost/elgg, instead of the wizard, you'll be greeted with a login page. Enter the credentials of the admin user you created during the setup wizard to sign yourself into the social network and get you to Elgg's administration dashboard (**Image D**).

» The main administration settings are listed on the right side of the dashboard divided under two broad categories – 'Administer' and 'Configure'. The options under the 'Administer' category give you various statistics about the server, plus let you view online users, add new users and put the network in maintenance mode while you're setting it up. The 'Configure' category houses quite a lot of functionality.

» The 'Settings' section in particular is useful for altering options that affect the entire Elgg deployment. From here you can change the name of your social network that you specified in the wizard while deploying Elgg. Furthermore, you can also optionally add a description about the network and even change the default language of the network. In addition to English, Elgg supports over two dozen languages, including French, German and Japanese.

4 CUSTOMISE APPEARANCE

At this point, your Elgg network is very generic. Click on the 'View Site' link at the top of the administration dashboard to view your network as it'd appear to any logged-in user. By default, your network is very bare-bones. You can start by customising the layout at the top. To change the order of the menu items displayed at the top (such as Activity, Blogs and Bookmarks), expand the 'Appearance' menu under the 'Configure' section in the administration dashboard and click on 'Menu Items'. On this page you can specify the order of the main menu items by selecting them from the pull-down menu (**Image E**). Any unused items will be available under the 'More' drop-down menu. Besides the built-in sections, you can also add a custom menu item by specifying a display name and URL. This is useful for pointing users to another web app outside of Elgg, such as the corporate mailbox.

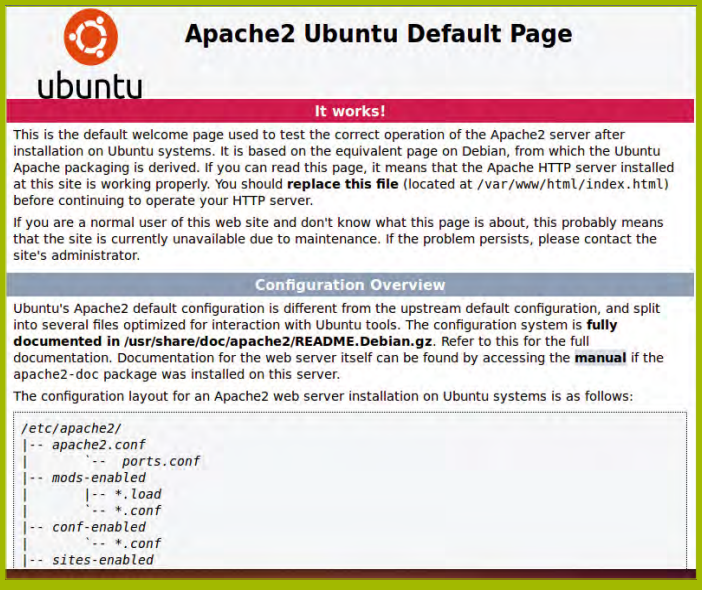
» Next, you may want to modify the default profile fields. If the existing items in the profile (like About me, Brief description, Interests and Skills) don't work for you, you can easily replace them with something that suits your

SETTING UP A LAMP SERVER

The latest version of Elgg v.1.10.0 requires MySQL v5 or greater, PHP v5.3.3 or greater, and the Apache web server with support for URL rewriting. To install these components, fire up a terminal and enter the 'sudo apt-get install apache2' command to install the Apache web server.

Once that's done, enter 'sudo apt-get install mysql-server' to install the MySQL database server. While setting it up, Ubuntu will ask you to specify a password for MySQL's root user. Finally, install PHP and hook it up with MySQL and Apache with 'sudo apt-get install php5 libapache2-mod-php5 php5-mysql'. Also, remember to enable Apache's rewrite module with 'sudo a2enmod rewrite'.

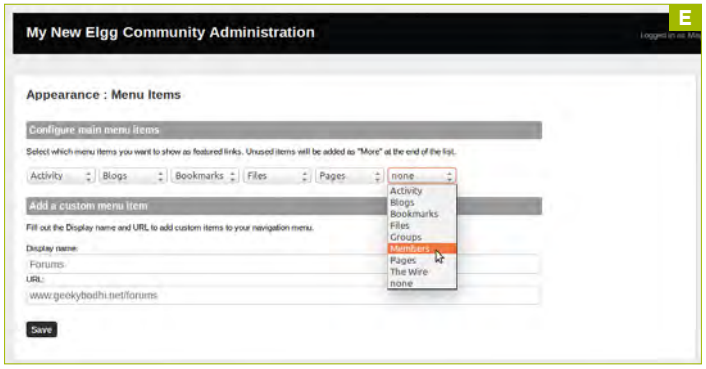
Next, turn on the AllowOverride directive, which tells Apache to follow the directives in the .htaccess file instead of the preset ones. Point your text editor to the file '/etc/apache2/sites-available/000-default.conf' and change 'AllowOverride None' to 'AllowOverride All'. Also, to ensure your users can share large files, crank up PHP's maximum upload file size, which defaults to 2MB (upload_max_filesize = 2M). The setting is controlled by PHP's configuration file, 'php.ini', which is typically somewhere under '/etc/php5/'.

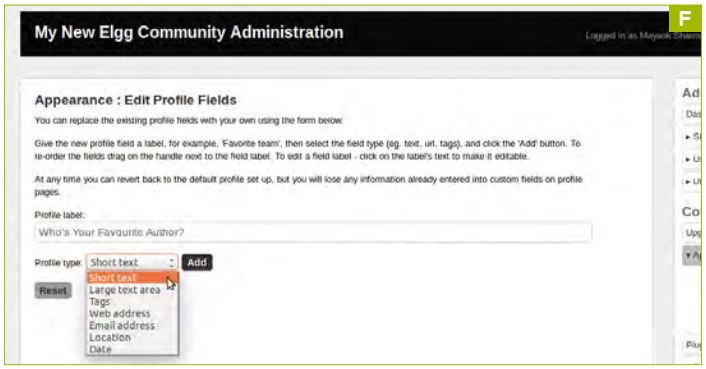


If you get 404 errors while installing Elgg, check the DocumentRoot points to '/var/www' in Apache's configuration file (/etc/apache2/apache2.conf).

requirements. Remember that if you choose to add custom fields they'll replace the default set, which is to say that you can't keep the 'Description' field and replace or delete the 'Skills' field. Either you keep the default set as is, or replace them completely. You can create your own profile fields via 'Appearance → Edit Profile Fields' (**Image F**). The page displays a form that lets you specify the label, for example 'Who's your favorite author?'. Every label must have one of the seven supported field types, such as Short text, Large text area, Web address and Location. Repeat the process until you've got all the custom fields you want. Remember to add the fields in the order you want them to appear in the profile.

» For more flexibility in designing a custom profile page you can use the popular 'Profile Manager' plug-in. Elgg ships with several plug-ins (and you can download more from the web) that you can enable to add more feature and functionality to the stock Elgg experience (see "Go Further With Plug-ins", below). If you wish to revamp the front page, enable the 'Front Page Demo' plug-in. You can then head over to the '/var/www/elgg/mod/custom_index directory' which contains the files that make up the front page.





USE THE NETWORK

Now that you've set it up, you can start exploring your social network. An Elgg social network is like the other popular networks out there. There's a login page, which also points users to the registration page (**Image G**). You can also manually add users from the administration dashboard. Users have a profile page and a landing page, known as the dashboard. Both areas can be populated with widgets that pull in data from various sources, on and off the network, to show the user's activity.

» You, as the administrator, can set up a default layout for all users that the individual users can then rearrange as per their own preferences and requirements. Users can write blogs, plus create and participate in groups which can have their own blogs and forum boards. They can also host their own pages, upload all kinds of multimedia content in their file repository, and link them along with the text content. Elgg also has a Twitter-like microblog known as The Wire, as well as an impressive access permission system that lets you define parameters for accessing a particular type of content. It offers four parameters – Private, Friends, Logged-in Users and Public. These self-explanatory parameters define what type of user can view every shared content. Elgg users can also use the built-in messaging capabilities to send messages to other registered users on the network.

» Along with the administrator, all users on the Elgg network also get options to customise their experience. From their dashboard all users can edit their login credentials, flesh out their profiles and upload an avatar picture. They can also define how they wish to be notified when a certain friend shares new content. However, make sure you spend some time customising your social network before you throw open the doors. ■

GO FURTHER WITH PLUG-INS

While Elgg has all the features you'd expect from a typical social network, you can extend the core software and add new functionality by enabling plug-ins. The default Elgg installation ships with over 30 plug-ins. Of these several are enabled by default and provide several core features that are mentioned in the tutorial, such as blog, bookmarks, pages and notifications.

To activate plug-ins, head to your social network's administration dashboard and select the 'Plugins' option from under the 'Configure' menu. The page lists all the available plug-ins, though you can filter them based on their type and priority. Some of the interesting ones you might want to activate are 'Site Pages', which lets you create simple web pages; 'Tag Cloud' for displaying all tags; and the 'Front Page Demo', for customising the front page.

Furthermore, Elgg has an active plug-in community that churns them out more useful add-ons by the hundred. In the Elgg world, themes are also treated as plug-ins. To install a third-party plug-in, download and extract it under the 'mod/' directory of your Elgg installation, such as '/var/www/elgg/mod/'. This will list it under the 'Plugins' section in the administration dashboard from where you can activate it like any other plug-in.

Remember that they're loaded according to the order they are listed on the 'Plugins' page. Make sure any theme plug-in is at the bottom of the list. Some of the popular third-party plug-ins include 'Profile Manager' for creating custom profile fields; 'Tidypics' photo gallery plug-in; and the 'Chat' plug-in, for adding instant messaging functionality.

Supervise Your Family's PC Usage

YOU'LL NEED THIS

FAMILY SAFETY

The parental controls service is included in Win8/8.1. If you have Win7, you can get some of the features by downloading Windows Live Family Safety, part of Windows Essentials, for free (www.microsoft.com).

WINDOWS 8 INCLUDES A USEFUL SET OF PARENTAL CONTROLS to insulate your children from inappropriate content strewn across the web. It also helps ensure they don't inadvertently compromise the security of your PC by downloading malware and other nasties. You can define when your children can use the PC, which apps they can use, what games they can play, and what kind of websites they can browse. However, before setting it up, you need to make sure you have a password-protected Administrator account so that your children can't simply log in with unrestricted access and turn the parental controls off. Also, create separate Standard accounts for all your children so that you can set up different restrictions for each person.

To get started, head to the Control Panel and click 'User Accounts and Family Safety'. Then click 'Family Safety' to see a list of the user accounts for which Family Safety can be set up. Windows warns you to set up a password for the Administrator account if one hasn't already been set. You can also add a new Child account. **–MAYANK SHARMA**

1 TURN ON SAFETY

To activate parental controls, select a child's account to open their User Settings. Under the 'Family Safety' heading, turn on the 'Enforce current settings' option. Similarly, under 'Activity reporting', turn on 'Collect information about PC usage' to get detailed reports about your child's computer use. Family Safety is now enabled with the default settings.

2 DEFINE TIME RESTRICTIONS

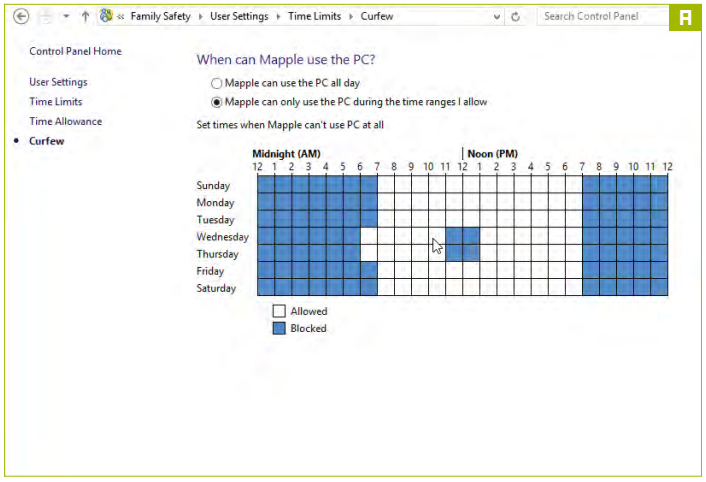
To limit access to the PC, click 'Time limits', which gives you two options. Click 'Set time allowance' to restrict the number of hours and minutes your child is allowed to use the computer each day. The restrictions can be set for weekdays and the weekend, or independently for each day.

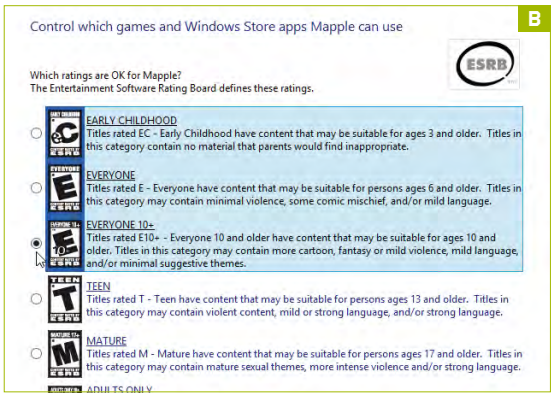
3 SET CURFEW

The 'Set curfew' option enables you to define the hours of each day that your child can use the PC. They're shown in a grid, with each square containing two half-hour slots (**Image A**). Click in a square, or click and drag through several, to turn slots blue and block access. Click again to remove.

4 FILTER WEBSITES

To block websites, click 'User Settings' and then 'Web filtering'. Select the second option to define permitted websites, and then select 'Set web filtering level' to open the Web Restrictions window. Here you can choose to block sites broadly, based on their type of content, and also block all file downloads.





5 RESTRICT APP USAGE

Head back to User Settings, click 'Desktop app restrictions' and select the second button to define the apps the user can open. The page now lists all installed apps. Tick the box next to an entry to allow the user to access that app. Any apps that aren't selected will be blocked by default.

6 BLOCK GAMES

To restrict access to mature games, head back to User Settings and click 'Game and Windows Store app restrictions'. Again, select the second option to define what the user can open, and then click 'Set game and Windows Store ratings'. This shows a list of game ratings broken down by age (**Image B**). Your child can only open games rated as suitable for up to the age you pick.

7 VIEW REPORTS

That's it. Your children will not be able to log in during a blocked time slot, nor can they run blocked apps or visit blocked websites. To view their activity, head to their User Settings window and click 'View Activity Reports' on the right-hand side of the window. These show when they've used the PC; the websites, apps and games they've used the most; and pages blocked. ■

Safely Clean The Registry

YOU'LL NEED THIS

AUSLOGICS REGISTRY CLEANER
Download the lightweight cleaning tool from www.softpedia.com.

LET'S BE HONEST. We're not big fans of Registry cleaning tools. Through the pages of Support Squad we've seen first-hand the damage they can do to perfectly functioning Windows systems. They're often billed as a magic cure for problems, or promise performance improvements, but if you scan blindly and let a Registry cleaning tool simply delete everything it finds, you'll eventually run into trouble – and you won't notice any speed boost either.

Despite all this, Registry cleaning tools *can* help fix problems by tracking down rogue entries and deleting them. The trick is knowing how to use them carefully. In this tutorial, we'll show you how to selectively search for, analyse and remove the right entries. Just as importantly, we'll also reveal how to put them back again should your clean-out create more problems than it solves. –NICK PEERS

1 INSTALL PROGRAM

First, install Auslogics Registry Cleaner after downloading it, for free, from www.softpedia.com. During installation you'll be prompted to install Auslogics BoostSpeed alongside it. We recommend unticking this box. The next screen will offer you additional programs – make sure 'Custom install (advanced)' is selected, with no additional boxes ticked, to skip installing them all. Click 'Next' and the program will install.

2 TAKE PRECAUTIONS

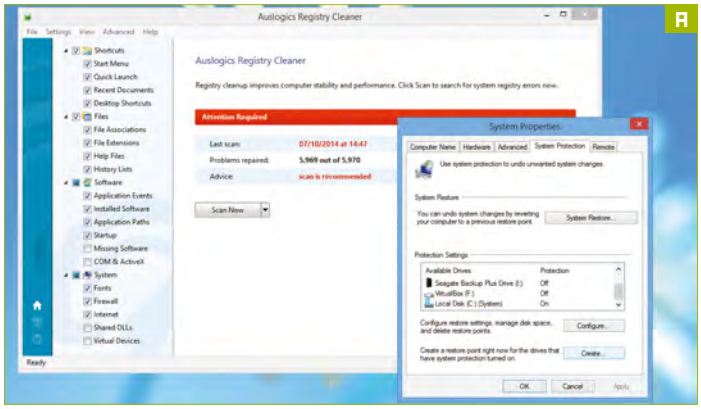
Before proceeding any further, make a System Restore point – open the Start menu or press [Win] + [Q] to open the Search charm in Windows 8. Type "system restore" and click 'Create a restore point' under Settings. Click 'Create', give your Restore point a suitable name and click 'Create' again to set up a fail-safe backup which you can restore should it prove necessary [**Image A**].

3 PRE-SCAN CHECKLIST

Switch back to Auslogics Registry Cleaner, then open the Settings menu to verify 'Back Up Changes' is ticked. The left-hand panel reveals which areas of the Registry have been selected for scanning – right-click this column and choose 'Check Safe Only' to ensure only safe areas are ticked for now. Once done, click the 'Scan Now' button and wait while the scan is performed.

4 RESULTS OVERVIEW

Don't be alarmed at the hundreds or even thousands of 'errors' it finds – many of these can be left safely in place without any impact on your computer's stability or performance. The results divide these into their parent categories; again, don't worry about the levels of severity assigned to each section – remember that most of these errors have no detrimental effect [**Image B**].



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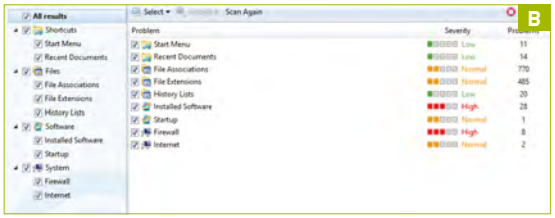

B

5 EXPLORE IN DEPTH

Use the annotation opposite to help identify problem entries. Most entries should yield some clue to their origin. Look for references to a specific program, or click the 'Google it' button to perform a search using that Registry key or value, which may throw up people with similar problems and – if you're really lucky – potential solutions to try.

6 SELECT ALL AND REPAIR

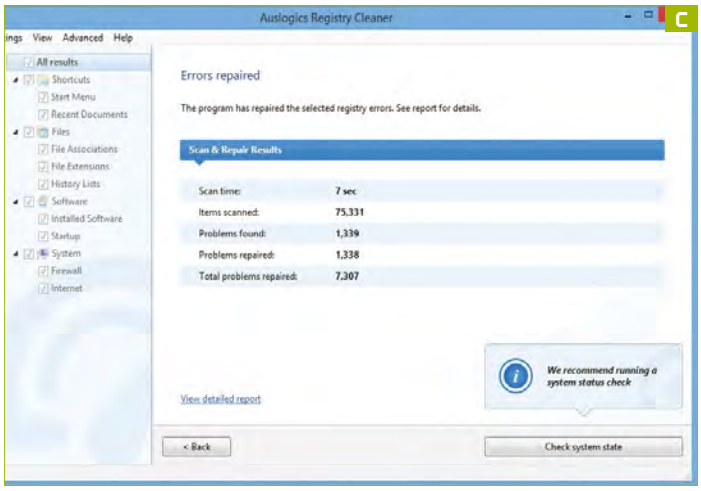
By default, all problems are selected – clicking 'Repair' removes them all. If you're unable to identify a specific Registry entry that you believe is causing your problem you could – with some risk – try removing them all [**Image C**]. Click 'Repair', then reboot and analyse to see if the problem has gone. If it hasn't, or other problems emerge, jump to step nine to restore the backup.

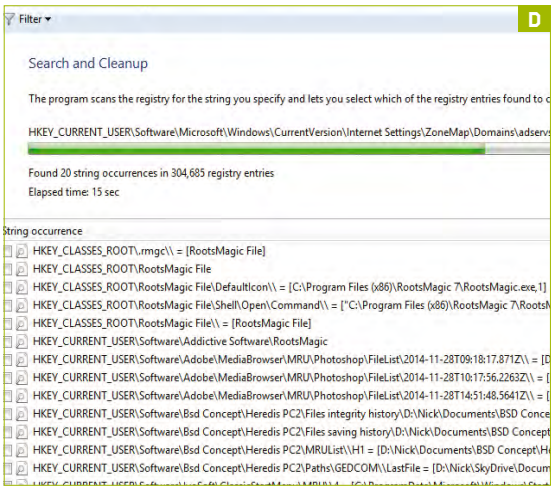
7 BE SELECTIVE

Alternatively, right-click 'All results' and choose 'Uncheck all' to select nothing by default. Now manually place a tick next to the entries you wish to remove. When you're done, verify 'Back Up Changes' is ticked, then click 'Repair' to remove only those entries you've selected. After the repair completes, click 'View detailed report' to see exactly what was deleted, if necessary.

8 SEARCH FOR REGISTRY KEYS

Select 'View → Find Registry Keys' to perform a manual examination of the Registry for keys to examine and potentially delete. Use the 'Filter' button before clicking 'Search' to restrict your search. Note that Auslogics Registry Cleaner provides no indication of





whether a key is a problem or not; it simply returns all results [**Image D**]. Manually select entries to delete, then 'Clean up'.

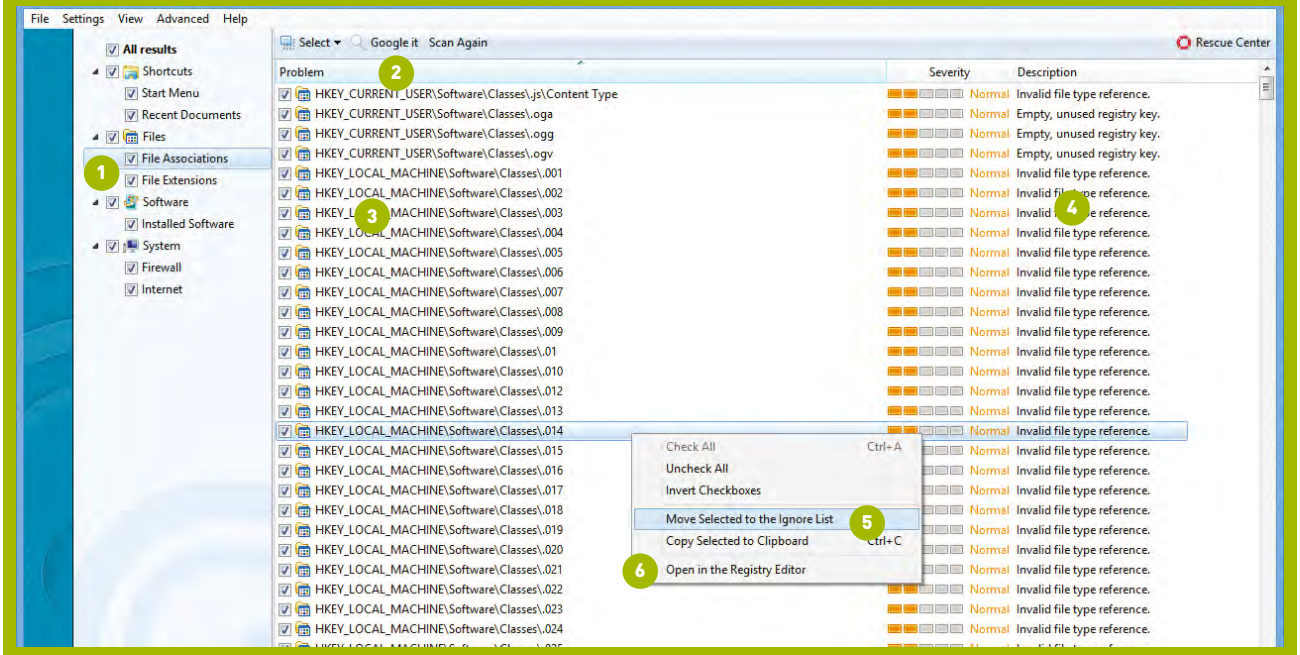
9 RESTORE KEYS

Should you run into new problems, select 'File → Rescue Center' to browse available backups and Restore points. Start by right-clicking your most recent backup and choosing 'Restore' – click 'Yes' to restore all deleted entries from that backup (you can't choose single entries). If this doesn't work, select 'Restore Points' and your System Restore file.

10 REGISTRY CLEANING MADE EASY

Armed with these tips, you should now be able to safely remove Registry entries on your PC whenever the need arises. Advanced users have the option to go even further and include potentially more 'dangerous' sections of the Registry, including 'Missing Software' and 'Shared DLLs', when scanning for any problems. Note, however, that indiscriminately cleaning these sections could cause major problems on your PC, so proceed with plenty of caution. ■

SPRING CLEAN



1. CATEGORIES
Auslogics Registry Cleaner divides up the Registry into more meaningful categories to help you focus your searches.

2. GOOGLE IT
Use this to search the web for any references to the selected Registry entry – this could help identify it or reveal a known problem.

3. PROBLEM
This lists either the allegedly problematic Registry entry (key or value) or a file or folder path referred to in the Registry.

4. DESCRIPTION
This field highlights why Auslogics Registry Cleaner thinks the selected value, key or path is a problem that needs to be removed.

5. ADD TO IGNORE
Choose 'Select → Move Selected to the Ignore List' to protect Registry entries you know should be left alone.

6. OPEN IN REGISTRY EDITOR
This option lets you view the selected entry in Registry Editor – you can see related values and keys that may help identify it.

Make Your Own Stop-Motion Movie

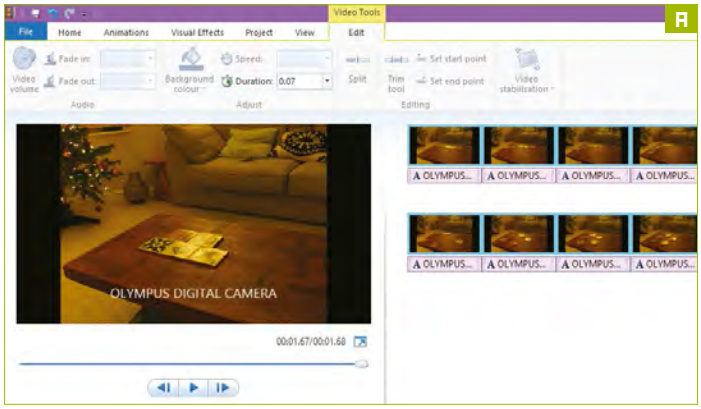
YOU'LL NEED THIS

MOVIE MAKER
The editing software is part of Windows Essentials 2012. Get it at http://bit.ly/1BwQJmg.

CAMERA AND TRIPOD
Steady, consistent snapping will create the best results.

SINBAD AND THE EYE OF THE TIGER, *Jason and the Argonauts*, *Robocop*, *The Evil Dead* – all these movies had something in common: stop-motion, a type of animation technique that originated as early as the late 19th century. As the name implies, it's literally a case of stopping motion by breaking it down into a series of discrete steps. By making small incremental movements to an object and taking a picture from the same position each time, you create frames which can later be stitched together in movie-making software.

Once you've joined the frames, it'll look like the object is moving – the more frames you add, the smoother the movement. Creating a stop-motion movie isn't that difficult, but it requires a touch of patience to see one through. It's worth doing, though, because you can create some brilliant effects. –NICHOLAS ODANTZIS



1 SNAP YOUR PHOTOS

You first need to capture the object or thing you're planning to animate. Decide what you want your animation to achieve, then get your camera into position (you'll need a tripod) and each time you move the object a little, take a photo. Once you've finished, upload the photos to your PC.

2 OPEN YOUR FRAMES

Find where you saved your photos, and either [Shift] + left-click the first and last photo you want to use, or use [Ctrl] + [A] to select all the photos in the folder. Now, open Movie Maker – the software you'll be using to make your animation. Download it from http://bit.ly/1BwQJmg and install it. Drag and drop the selected photos into Movie Maker.

3 CHANGE FRAME RATE

The photo frames will have a fixed duration between them, the default being much too slow to make your animation work – it'll look like a slideshow. To change it, select all your frames and click 'Edit' in the top menu. In the box next to 'Duration', highlight the time and change it to about 0.07 seconds [**Image A**].

4 KEEP EXPERIMENTING

What happens in the movie is up to you, so experiment with the settings. Click the first frame in your video to go to the very beginning of your movie and tap the play button underneath. Movie Maker will show you how your stop-motion video looks with the settings you've used. If you're not happy with what you see, go back to the 'Edit' menu and carry on experimenting.

5 SWAP FRAMES

If some of your frames were mixed up in the importing process, you can easily swap them around. Simply left-click a frame and drag and drop it to a new location within the frames already opened. You can also delete multiple frames or add new ones by dragging them onto your project at any time. If you make a mistake at any point, just use [Ctrl] + [Z].

6 REMOVE WATERMARKING

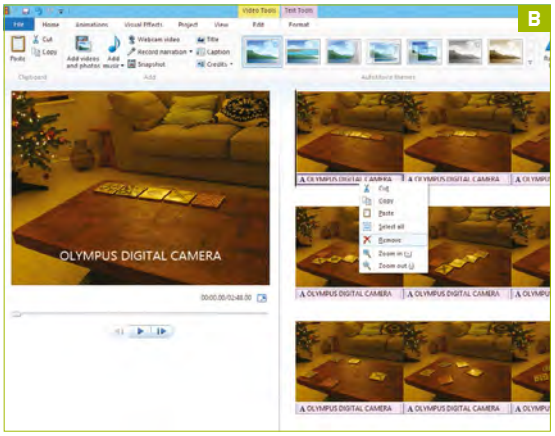
If you opened your frames to find they contain the camera's watermark, don't worry, these can easily be removed. Select all the frames and underneath a single frame you'll see a text box which displays the make and model of your camera. Right-click here and select 'Remove' from the menu that appears [**Image B**].

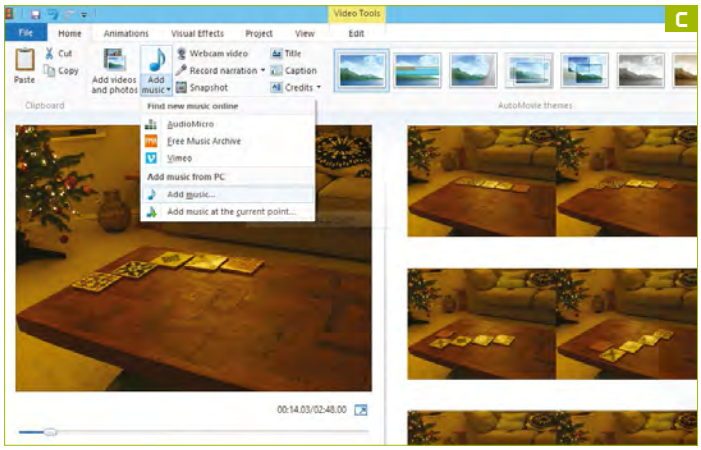
7 MAKE IT DRAMATIC

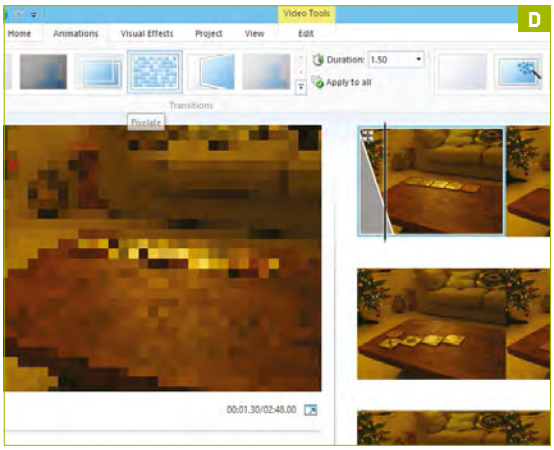
No movie would be complete without a background score, so go ahead and add one. Click 'Home' and select 'Add music' [**Image C**]. Find the file you want to open and double-click it. Use the 'Music Tools' tab to set the start and end point, add a fade in and out, and more. You can add more audio files after the current one is finished.

8 SPRINKLE SOME MAGIC

To give your movie a little polish, you can add a variety of effects. Click the 'Visual Effects' tab to change the actual look of each frame, or select them all







to apply it wholesale. If you want to change the way your frames behave, click the 'Animations' tab – you can add a selection of transitions or use panning and zooming settings [**Image D**].

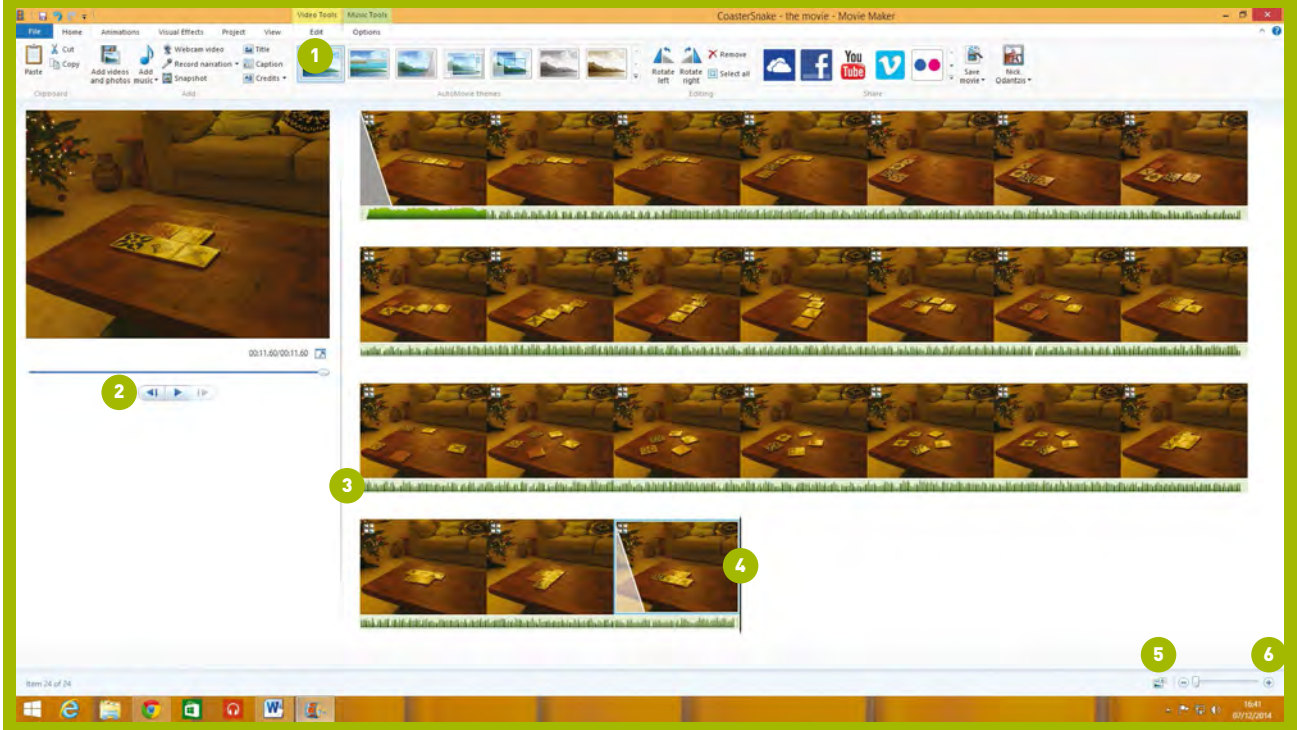
9 WIDE NOT?

If you took the photos on a camera, instead of a phone, the orientation of each image will probably be in the 4:3 format. Movie Maker, however, uses the 16:9 widescreen by default, meaning your photos with be left with black bars on the top and bottom. But don't worry, you can change this as well. Click the 'Project' tab and choose 'Standard (4:3)' from the Aspect ratio setting. Now your movie will play full-screen.

10 ADMIRE YOUR WORK

That's it, you've made a stop-motion video! To save your animation. Click 'File → Save Project', give it a name and hit 'Save'. If you want to create a movie file that can be played back, go to 'File → Save Movie' and choose an option that suits. You can make a movie optimised for Android phones, HD displays and more. ■

LIGHTS, CAMERA, ACTION!



1. EDIT
This tab gives you access to most of the frame editing options, enabling you to change the transition time.

2. PLAYBACK
You can watch a preview of your animation at any point during the creation process by hitting the play button.

3. AUDIO
The green bar represents audio you've added to your video. You can click and drag this to wherever you want it to play.

4. FRAMES
When you import your photos, they appear as frames. You can move them around and change how they appear.

5. THUMBNAILS
If you're working with a lot of frames, you can change their size to see them all at once, or you can zoom in.

6. TIMELINE SCALE
When you want to view your project in more detail, use the timeline slider to adjust the level of zoom.

ASK LUIS

BY LUIS VILLAZON

All The Stuff You Didn't Know About

Pull up a stool and settle in at the troubleshooting tech bar

SPONTANEOUS BREAKAGE

ACER DETECTIVE

My Acer laptop died recently. I'm pretty sure it's the hard disk and I've taken the case apart to have a quick look. It looks quite easy to remove and Amazon seems to have the same model of drive for sale. Surely it can't be that easy though? You're always telling us that repairing laptops isn't worth the trouble. What's the catch I'm missing?
Andrew Kirkwall

Acer laptops, particularly the Aspire series, are quite simple to dismantle – no fiddly plastic catches that snap off; just a bunch of little screws. And the hard disk isn't tucked underneath the motherboard or anything awkward. The catch is that your replacement disk is going to be blank. Unless you've backed up a complete image of the previous disk, you'll need a new copy of Windows.

Nowadays, operating systems aren't really a thing you *own*. They're more like the gift of fire. As long as you can keep the flame alive, it's yours forever. But should it ever be snuffed out, even for a moment, you'll need to spend hours and hours patiently banging flints together, or hope for a providential lightning strike. Laptops have a recovery partition that can restore Windows if the primary partition gets corrupted, but if the disk dies, it takes all its secrets to the grave.

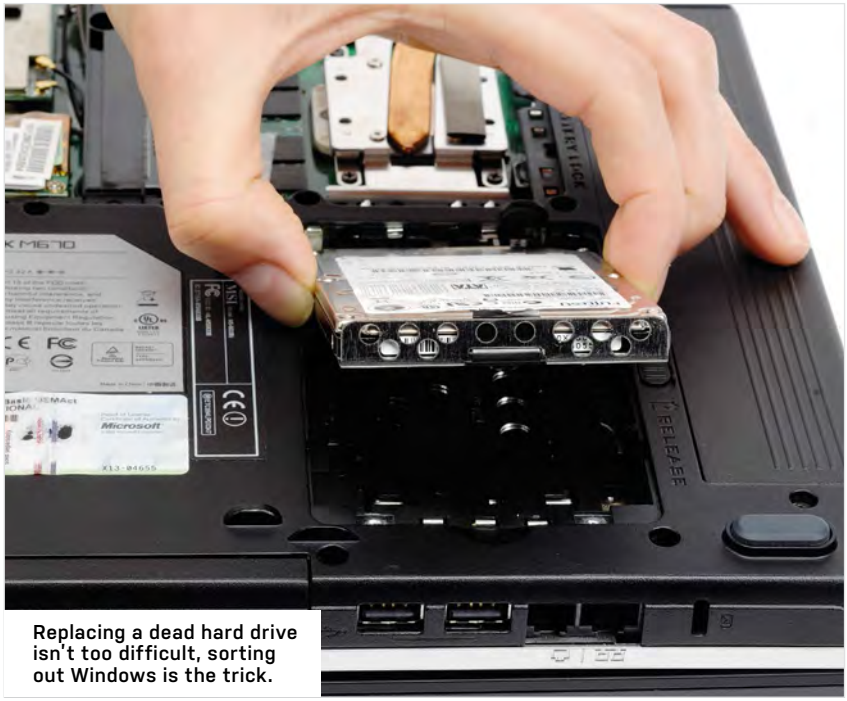
Windows isn't cheap. You can buy a download licence key for Win 8.1 for £41, but that's just the key to let you activate Windows on multiple computers. You can't use it to install Windows, because you need to be running Windows in order to download it in the first place. A full version with installation discs costs £84. The in-between option is to get the OEM recovery media from Acer. If you call them on 0371 760 1000 and quote your serial number they will sell you this for £54. The downside is that it takes a week or two for them to deliver, but since you've waited this long to read your answer in the magazine, what's another couple of weeks?

CREEPING BADNESS

BOOTS 'N' ALL

I've been trying to find out how hard disk lifespan is determined. I've read on several websites that it depends on the number of times the PC is booted. Does this mean turned off and on? Or does restarting from the Start menu count as well? Is it better to leave the PC on all the time and only reboot when something crashes or for updates?
Mark Ogbourne

I'm not sure which websites these are but you need to update your bookmarks because this is – well, not *wrong* exactly – but somewhere between an oversimplification and a misunderstanding. The SMART health monitoring software on your hard disk does track the number of reboots, but this is just part of the way that it estimates wear and tear on the drive. There is no predetermined lifebar for your hard disk that shrinks by a fixed amount every time you reboot. And



Replacing a dead hard drive isn't too difficult, sorting out Windows is the trick.

FREE TECHNICAL SUPPORT

Email Luis for guaranteed insults and possibly even some technical help as well.
pcfhelpline@futurenet.com
PCF Helpline, Quay House, The Ambury, Bath BA1 1UA

The six categories of all human misery

REPRODUCIBLE CALAMITY
Things that break predictably.

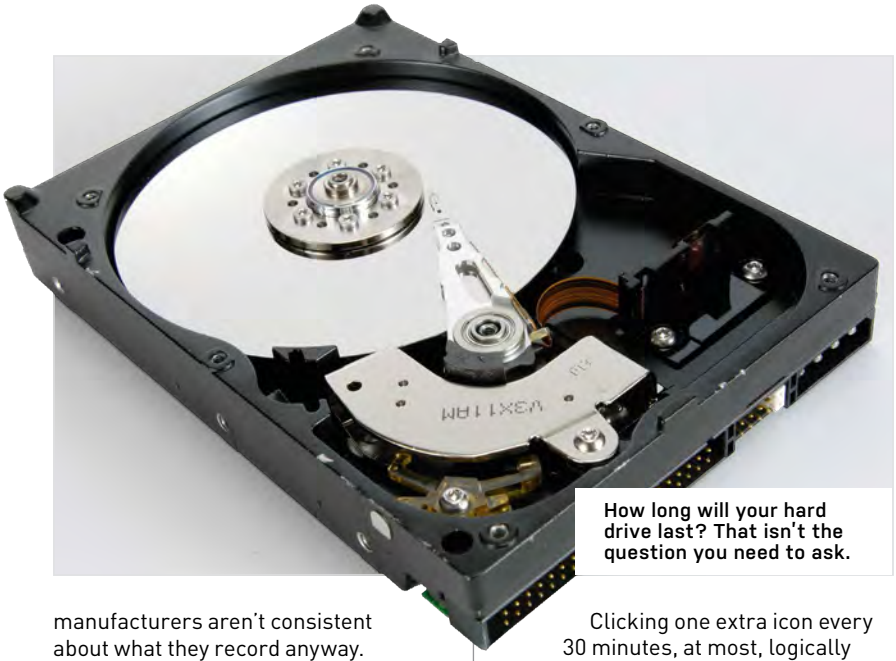
RANDOM WEIRDNESS
Things that break unpredictably.

CREEPING BADNESS
Things that just get worse.

OMINOUS PORTENTS
Things that might be a problem.

SPONTANEOUS BREAKAGE
Things that definitely are.

RAINBOW CHASING
Things that could be so much better.



How long will your hard drive last? That isn't the question you need to ask.

manufacturers aren't consistent about what they record anyway. Some count each soft boot, others only count the power on/off cycles.

Whether you turn off your PC at night depends on your own particular cocktail of neuroses. Some people find the idea of wasting a few watts of standby electricity totally unbearable. Others are brought to a rolling boil by the extra seconds it takes to power on a PC, compared with waking it from sleep.

Both of these problems are pretty much rendered trivial by switching from a hard disk to an SSD, because these don't need to use electricity spinning themselves up and down, and reduce boot times to just a few seconds. Ironically SSDs are completely different to hard disks in the way that they measure their lifespan, but exactly the same as hard disks in as much as you don't need to worry about it either. You protect your hard disk by backing it up, not by using it less.

Clicking one extra icon every 30 minutes, at most, logically ought to be something we could laugh off – it's roughly the same amount of energy as you will expend today digging interesting crusty bits out of your ear, or opening the microwave door a second early, so you don't have to listen to all the beeps. But what is so maddening is not the effort involved, it's the pointlessness of it. This seems like such a simple problem to solve. The PC *knows* which network you normally connect to; why doesn't it just reconnect automatically without being asked?

Well, if you think that's infuriating, take a deep breath. This fault is actually a bug in many Intel Wi-Fi drivers, and it's caused *precisely* by the efforts you've been taking to prevent it happening. By clearing the checkbox in Device Manager that says 'Allow the computer to turn off the device to save power' for your Wi-Fi adaptor, you've been stopping the driver from spotting that the power was cut anyway when the whole laptop went into standby mode, so it doesn't restore your connection when the power comes back on. So if you tell it not to turn off, it does. If you do let it turn off, however, it will silently reconnect fast enough that it feels as if it actually stays on all the time!

"OPERATING SYSTEMS AREN'T REALLY A THING YOU *OWN*. THEY'RE THE GIFT OF FIRE."

REPRODUCIBLE CALAMITY

GROGGY ON RISING

I've a Windows 7 laptop that normally goes into standby after half an hour. Whenever I wake it up, whether it's after several hours or straight away, it's lost the Wi-Fi connection. I have to right-click the Wi-Fi icon and reconnect manually – if I leave it alone it will never reconnect by itself. This is extremely annoying. I can obviously disable standby mode altogether, but it kills my battery in very short order. I've been through all the power management settings and made sure they're all on 'Maximum Performance' but this has made no difference at all.
Jean Gearies

RAINBOW CHASING

AUTOFILL ANARCHY

I'm a big fan of Google Chrome and greatly prefer it to all the other browsers but there is one thing that is driving me mad: where is 'autofill' data, such as addresses and credit card numbers stored? I've downloaded DB browser for SQLite and gone through all the likely-looking files in /Appdata/

YOU ASKED!

FAQ

Skype Translator

How is this any different from Google Translate?
It talks! Skype Translator is built directly into Skype and works like the human translators at UN conferences. You say something in English, Skype repeats it in Spanish. And vice versa.

How fast is it?
When you speak, Skype first breaks the sound into separate words and phrases. Then it removes your "ums" and "ahs" and any minor stutters and converts this into text. Next it translates the English text into Spanish text and finally it reads the Spanish text back. That's a lot of processing but the delay is still only what you'd normally get from asking Siri a question.

Just Spanish?
For the moment, yes. Skype will give you the text translation for lots of other languages, but it only reads out the translated text if it's in English or Spanish. Presumably these were chosen because English is very popular and Spanish is relatively easy.

Is this anything new?
All the component parts have been around for several years, but this is the first time they have been combined so seamlessly into a single product. The accuracy of both the speech recognition and the translation also seems to have crossed the threshold of being genuinely useful, rather than just a technology demo.

Is it useful for anything else?
The fact Skype Translator also displays the transcript makes this useful for journalists conducting interviews or students using Skype for distance learning. Potentially it might be helpful for deaf people.

Where can I get it?
It's currently invitation-only, but you can register your interest at translator.skype.com.

Local/Google/Chrome/User Data/Default but so far I've come up empty! Is this data actually stored in the cloud?
Jonathan Btembi

You do believe in making things difficult for yourself, don't you? I think the folder you mention has been used in the past for Chrome autofill data, but there is no requirement for Google to preserve backwards compatibility in this regard. Certainly there doesn't seem to be anything there on my installation now. Google could easily have moved this into the cloud by now, and it would probably be safer if it did. But anyway, there is no reason for you to manually open each database file because Chrome has a user interface option that does exactly this. Open Settings, scroll to the bottom and click 'Show advanced settings...' Under 'Passwords and forms' you can click 'Manage Autofill settings' or 'Manage passwords'.

"PERHAPS YOUR BOSS IS GETTING HIS OWN BACK FOR THE CHRISTMAS PARTY."

SPONTANEOUS BREAKAGE
A VAIN HOPE

My laptop (an HP Pavillion) recently refused to boot. I tried the Windows Startup Repair and when that didn't work I also tried System Restore. That didn't work either. I've taken the drive out and put it in a USB drive caddy to run some diagnostics from my desktop PC. This gives me a clean bill of health except for one error: 'Raw Read Error Rate: Threshold value 51, Current value 1, Worst value 1.' I've done some reading up and this seems to come from the SMART monitoring software. Is there some way I can reset this error count or increase the threshold to get the drive working again? I can put up with one or two read errors if it means I get the rest of my data back.
JP

It's not going to happen. Imagine I'm a fireman hosing down the embers of your recently ablaze house. Asking me if I could take the battery out of your smoke alarm isn't really tackling the heart of the problem, is it? SMART stands for Self-Monitoring, Analysis and Reporting Technology. It doesn't disable your hard disk, it just tries to tell you what is wrong with it before it fails altogether. And in your case it has not even managed to do that, because your hard disk has already failed. That read error is well below the warning threshold, which means that something else broke – and broke so quickly that SMART didn't have time to warn you about it.

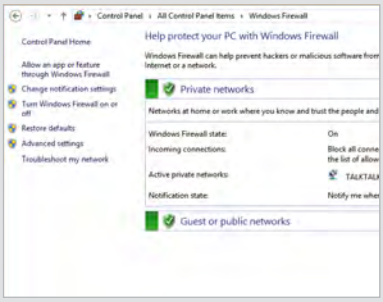
SMART may well be jolly clever, but I've never known anyone who has had their data saved by it. Most people aren't warned in time or ignore the warning when it comes. The few that are cautious enough to listen, already make regular backups and so don't need it.

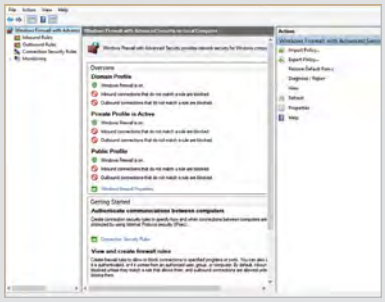
RAINBOW CHASING
A CASE OF THE MONDAYS

At work I've been lumbered with the task of copying data from some tables in MS Word documents and pasting them into Excel spreadsheets. The data is automatically generated from some report tool run by another department and there can be hundreds of these every month. At the moment I have to open the Word document, [Ctrl] + [A], [Ctrl] + [C] to copy the data, open Excel, [Ctrl] + [V] to paste it and then [Ctrl] + [S] to save it. This is already tedious enough but the save window in Excel insists on using the default save location each time and I have to waste more precious seconds navigating to the right folder each time. Is there a way to make Excel remember the file location from the previous time? I'm tearing my hair out here!
Marley Sinise

The most efficient way to address this would be to automate it entirely. If your company got IT services to knock up an Excel macro, they could cut you out of the loop altogether. Or even better, tweak these reports so that they save in a comma-separated format that Word and Excel can both open from the start. But maybe your company isn't big enough to have its own IT department.

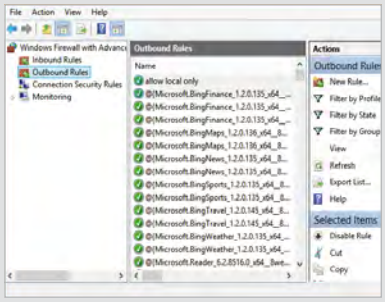
Customise Windows Firewall
Control who can connect to the internet





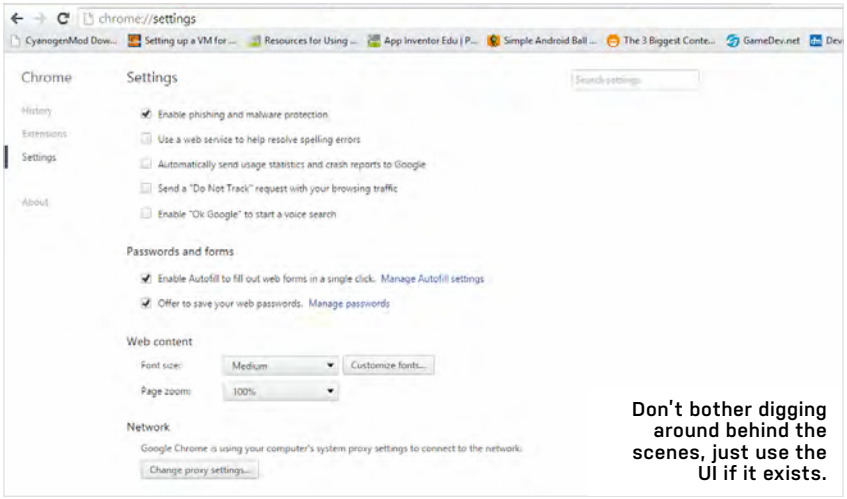
1 Control Panel
The default settings for Windows Firewall are designed to keep the bad guys out. But suppose you want to restrict a specific computer on your home network so it can't send any traffic beyond your home network? You can do that using the Windows Firewall applet in Control Panel.

2 Block
First, disable all outgoing traffic by default. Click the top item in the sidebar on the left and click 'Windows Firewall Properties' in the Overview section. Set Outbound connections to 'Block' in the Domain, Private and Public profile tabs, then click 'apply'.



3 Wizard
Now create an exception for each device that you want to be able to access the network. Click 'Outbound Rules', then 'New Rule'. Choose 'Custom' as the rule type, then 'All programs' and 'Protocol type: Any'. Enter the IP addresses or IP range of the PCs on your LAN.

4 Unblock
Finish the wizard by choosing 'Allow the connection', then leave Domain, Private and Public all ticked and enter a name for your rule. If you ever need to temporarily lift this restriction, you can leave the rule in place and just change the Outbound connections from Step 2, to 'Allow'.



Don't bother digging around behind the scenes, just use the UI if it exists.

Or maybe your time is way cheaper than the IT technicians'. Or perhaps your boss is getting his own back for that incident with the photocopier at the Christmas party. It doesn't matter, there are still things you can do to reduce the grind.

Changing the default file location at 'File → Option → Save' is the most obvious. If you aren't allowed to do this, you could create a shortcut in the default file location and have this point to the folder where you actually want to save. This cuts your navigation down to just one double-click each time. Or else you could just let the files all pile up in the default folder temporarily. Then sort the folder by file creation date and drag all them to the correct folder in one go, when you're finished.

RAINBOW CHASING

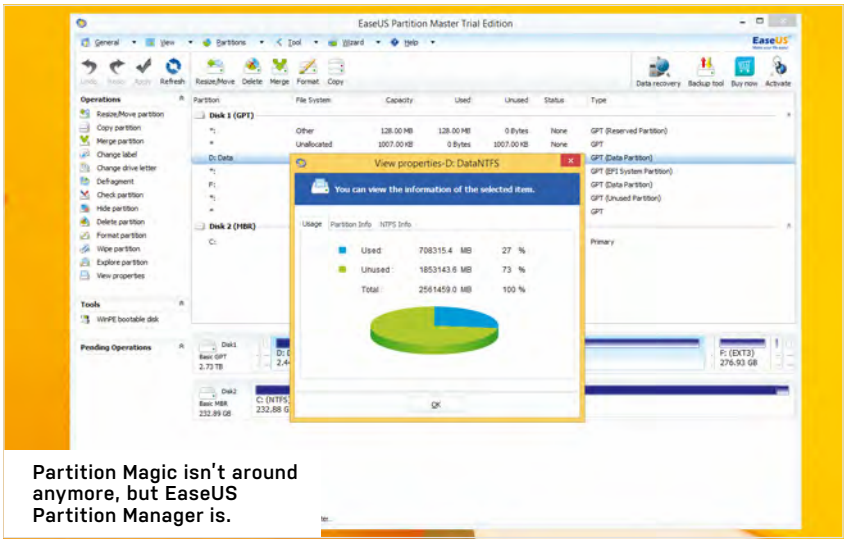
RAISE THE DRAWBRIDGE

Is there a way to prevent access to the internet through my router at certain times, but still retain a local connection? I would want this to be for certain devices only.

Lesley Ellis

You're being rather cryptic. What is this restriction for? Are you trying to limit your children's access to the internet at certain times? Many ISPs have options you can enable on your account page at their website. TalkTalk for example, has a Homework Time option that locks out social networking and gaming sites at certain times but allows the wider internet so they can still research stuff. You can combine this with the Kids Safe filter to block sites related to suicide, drugs, weapons and pornography at all times. Both of these filters apply to any devices connecting through the home router though, which might be inconvenient if Mum and Dad want access to something racier after the kids are in bed.

You can use Windows firewall to create extra restrictions on specific computers (see "Customise Windows Firewall", opposite). But against sufficiently determined children this will be a delaying tactic at best. Smart kids will figure out how to undo the firewall changes, and even ordinary kids will eventually realise they can tether their laptop through their mobile phone and get their porn that way, albeit slightly slower. And if you aren't trying to protect your children, do please write back and tell me what you do want to achieve. I can no more think of valid reasons for cutting some devices off the internet than I can for bricking up the windows of some of the rooms in my house.



Partition Magic isn't around anymore, but EaseUS Partition Manager is.

FLASHBACK

What Luis Said...

5 years ago *(PCF237)*

About keeping old PCs

Laptops are family. The very marvel of their portability means we forgive specifications that would've spelled a death sentence for a desktop years ago. I still have a Compaq with a monochrome screen, a 486 processor and two *megabytes* of RAM. I can't bear to throw it away so it's mounted on my kitchen wall as a piece of Nineties sculpture. That still boots up Windows 3.1.

10 years ago *(PCF171)*

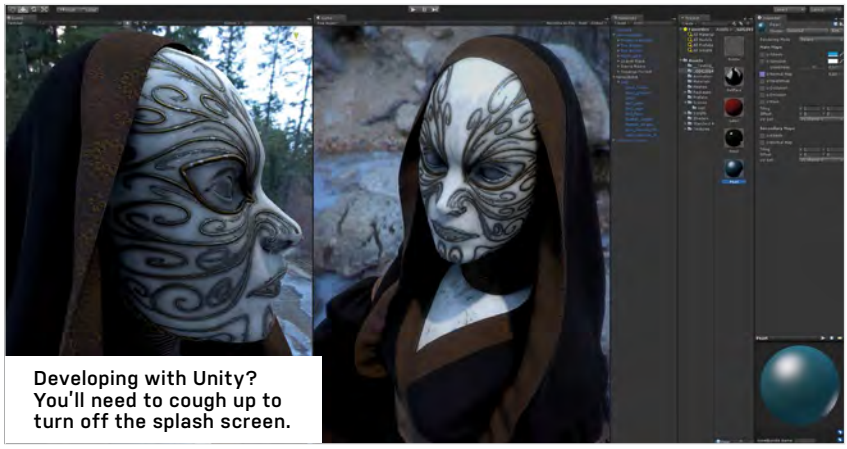
About getting rid of old PCs

Before everyone writes in about how I don't understand the financial difficulties of bringing up five kids in a former tied cottage in rural Cornwall, let me say I am just *not* listening. I had to crawl in the dust to find the only PC in the house that might've been old enough to get stuck in 16-colour mode. Even *that* monstrosity, bought in 1995, runs in 32,000 colours and won't drop below 256 without a gun held to its VGA port.

15 years ago *(PCF106)*

About the Y2K bug

All bugs are the result of laziness and programmers are the laziest people on the planet (I used to be one). But lazy people are responsible for progress – they're always looking for easier ways to get the same job done. So don't be too hard on them if every now and again they get it wrong and cost the global economy 600 billion dollars.



Developing with Unity? You'll need to cough up to turn off the splash screen.

OMINOUS PORTENTS

NO WAY BACK

I tried Win8 for a bit and didn't like it, so I removed it and went back to Win7 64-bit. I used Partition Magic to completely wipe the partitions and reinstalled from the DVD. This seemed to go okay but now I can't read any DVDs or music CDs. Even putting the Win7 DVD back in doesn't work, so it definitely isn't the discs! It just says it cannot find the hardware device and Device Manager has an exclamation point next to the drive.
Tolley Menton

This is known as the UpperFilters corruption and it can happen to Win7 or Win8. You can sometimes fix it just by using the CD/DVD troubleshooter, or the Hardware and Devices troubleshooter. But if you want to roll up your sleeves and get some grease on your nose, open Regedit and navigate to HKLM\SYSTEM\CurrentControlSet\Control\Class\{4D36E965-E325-11CE-BFC1-08002BE10318}. Select 'UpperFilters' on the right-hand side and click 'Edit → Delete' on the menu. Do this for 'LowerFilters' as well, then quit Regedit and reboot.

REPRODUCIBLE CALAMITY

SPLASH DOWN

I'm making a mobile app for Android using the Unity 4 game engine. When the app starts it always displays the Unity splash screen first, before the splash screen for my app has a chance to load. Is there a way to replace the Unity splash screen with mine? I've never seen the Unity splash screen on other commercial apps. Is that because they've found the secret? Or have they just abandoned Unity in disgust.
James Harker

Neither. They're just using Unity Pro. The free version of Unity doesn't let you use a custom splash screen. The licence agreement explicitly forbids you from modifying any of the existing Unity files or assets. But the Pro version has a custom option built in. It costs $1,500 (£960) to buy, is the only problem. But you can rent a licence for £48 a month.

OMINOUS PORTENTS

TOO COOL

I'm going skiing in March with my school and I'm planning to take my tablet. This will mostly be for Facebook and Snapchat and movies but I'd also like to use it on the slopes to check GoPro footage. Will this be okay? The small print says the operating range is -15º to 50ºC. What happens if it's colder? Will I damage my tablet just by carrying it in my backpack? Or only if I try and actually use it at those temperatures?
Liam Crossfield

Extreme cold is bad for electronics in lots of ways. Most Lithium batteries will provide only half their charge at -18ºC and will stop working altogether below -20ºC. Electrolytic capacitors also increase their capacitance, oscillators run at the wrong frequency and transistors exhibit lower gain. Everything is more brittle too – from the plastic case, to the connector cables to the solder on the circuit board.

Minus 15ºC is very cold for European ski resorts in March, so you would be unlucky to go out of the warranted range. But I still wouldn't take it on the slopes. Cracking the screen when you wipeout, getting it wet and getting it stolen are bigger risks. And checking camera footage on the slopes isn't very useful. Just take a big memory card, record everything and dump it to the tablet when you're back in the hotel.

RANDOM WEIRDNESS

CROCODILE TEARS

I've just started experimenting with the Raspberry Pi. I'm comfortable with the programming side but the electronics aspect is all new to me. I'm not sure how much I need to worry about static electricity. If I want to test a part like an LED, is it okay to just wind the wire around the output pins on the Pi, or do I need to a set of crocodile clips.
Mark Crewkerne

Provided you're careful not to short out any of the adjacent pins, wrapping wire around a pin, or just holding the legs of the LED directly to the Raspberry Pi pins won't damage anything. Static can be a problem in a carpeted room, unless you're wearing an earthed wrist strap. But sat at the kitchen table you'll be completely fine.

But wrapping wire around pins is a terrible idea for a completely different reason. It's a really unreliable way to make a connection. As soon as your circuit gets more complicated than battery → resistor → LED → pin, you'll spend all your time wiggling joints to make sure they really are connected. If you are used to the deterministic nature of programming bugs, this sort of intermittent error will drive you potty. Get a breadboard and some jumper leads from Amazon and use mini crocodile clip test leads to connect from your breadboard to the Pi. You can get cheap sets of 10 for £2, so it's hardly much of an investment. ■

STATS KNOW-IT-ALL?

Quiz

1. Which of these is not a cryptocurrency?
a) Bitcoin
b) Ripple
c) XRP
d) Litecoin

2. How is XRP different from Bitcoin?
a) No new XRP can ever be created
b) XRP uses unbreakable encryption
c) XRP cannot be used for illegal trades
d) XRP is run by Google

3. What happens to the transaction fee with XRP trades?
a) The seller keeps it
b) The buyer keeps it
c) The network operator keeps it
d) It is destroyed

4. How many XRP were originally created?
a) 100 million
b) 100 billion
c) 100 trillion
d) None. It's mined by users

5. How many Bitcoins can you buy with 1 XRP?
a) 8,000
b) 80
c) 0.08
d) 0.00008

Answers: 1b 2a 3d 4b 5d

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PC Format PERFORMANCE GEAR & GAMING

ISSUE 303 ON SALE
12 March 2015

Month in numbers...

55%

The amount of PCs still running Microsoft's Windows 7 operating system. Mainstream support for the best version of Windows officially ended in January, but Microsoft will give it extended support until 2020, by which time we'll all be part of a cybernetic hive mind anyway.

15 million

The number of subscribers Spotify claims to have, with 2.5 million joining during the Christmas period alone. However, the BPI estimates streaming services returned just £175 million to the UK music industry, which is about enough to cover Harry Styles' haircut bill.

42.5%

Apple's share of the smartphone sector in the UK according to Kantar Worldpanel ComTech. That's a growth of 12.2 per cent year-on-year. Android's grip is slipping, tumbling from 56.4 per cent to 49.7 per cent. We won't mention the Windows Phone figures because, well, they're frankly embarrassing.

998,000

The maximum number of people concurrently playing *Minecraft*, according to developer Nathan Adams. It's a world record – the closest any other game has come to those figures is *Dota 2*, which peaked at 913,625.

$1 million

The total prize fund available for pro manshooters in Major League Gaming's *Call of Duty* championships. It's not a patch on *Dota 2*'s $10 million fund, and it actually makes us feel sorry for those impoverished *CoD* pros.

ILLUSTRATION: KEVIN FEBRUARY

THE VOICE OF REASON

The Dumbphone Revolution

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...**

AFTER YEARS OF WORSHIPPING TECHNOLOGY, there seems to be a feeling that having lots of gadgets and gizmos might not necessarily be a good thing after all. Everyone spends far too much time looking at a screen, whether it's a tiny smartphone or an epic monitor. As a result, we're losing age-old skills like making a decent cup of tea, communicating with other people face-to-face, and not looking at disturbing hardcore porn every five minutes.

There is a digital rebellion coming, with people switching from smartphones to dumb ones, picking up a paperback instead of cradling a Kindle, or versifying via vinyl rather than emphasising on MP3. Going digital-free – or digital-lite – is the way the rest of this decade is shaping up.

With this in mind, my New Year's resolution was to embrace the digital-minimal revolution. And so, to put my newly found analogue lifestyle into practice, I decided to catch a train to the wilds of the North York Moors with little more than an Ordnance Survey map, my keen nose for directions and a palpable sense of adventure. Plus a poo bag.

The day started well – a skylark chirped happily, invisible at its great height among the teal-blue skies, while the frosted ground beneath me gave a satisfying crunch as I trod upon it. This, I thought to myself, is exactly what dropping digital products is all about – exploring the world beyond the screen. It was delightful.

After a little walking I decided it was time to return home for a cup of Lapsang souchong and a scone. The landscape swept away from me like a tsunami of earth frozen in time. Clouds drew in and a heavy, impenetrable mist descended. I had the sudden, horrific realisation that I was completely and totally lost.

I pulled out my map and realised I'd actually purchased one for the Zimbabwe Parks and Wildlife Estate instead of Yorkshire. My keen nose for directions was now shrivelled and walnut-like. I felt my palpable sense of adventure seep out of my leaky boots.

If only I had a smartphone with me, I thought to myself. I would be able to open a map app, find my exact location, wander to the nearest road and find my way from there. If I was still lost I could call the emergency services. And if there was no signal I would at least have been able to wile away the grim onset of hypothermia with a game of *Peggle*. Instead, my options were more limited. I decided my best course of action would be to simply stand and scream in the vain hope that someone, anyone, would hear my wails and send help.

"Excuse me, sir," said an unexpected voice next to me. "Please stop screaming and get out of the train station car park. You're disturbing the others." And with that I walked back to the platform, caught a train home and solemnly vowed never to leave the comfort of my tech-nest again. ■

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