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Welcome

Custom PC Issue 179

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86 Build an 8-core 2nd Gen Ryzen PC

AMD has already mounted its bazooka and fired the first shots of the 2018 CPU war, with its excellent 2nd Gen Ryzen CPUs. It's made significant headway all round, with better lightly threaded performance, and its 8-core chips have also extended their lead over Intel's 6-core CPUs in heavily multi-threaded tasks.

Building a 2nd Gen Ryzen system needs some careful forethought to get the most out of it, though, as Ryzen CPUs benefit from good cooling and fast memory. What's more, the Ryzen 7 2700X can be quicker when it's left at stock speed. This month, we've selected the best gear to create an awesome, well-balanced and super-quiet PC based around AMD's Ryzen 7 2700X 8-core CPU, and we'll show you how to put it all together and set it up too.

COVER STORY
P86



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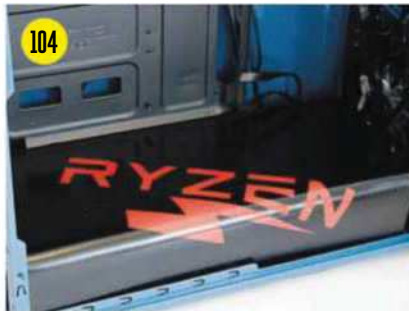
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BEN HARDWIDGE / FROM THE EDITOR

THE END OF OVERCLOCKING?

AMD's new boosting algorithms have effectively made overclocking redundant for Ben Hardwidge, and he's not sure how he feels about it

I've just committed a cardinal journalism sin by putting a question mark at the end of this column's title. As Betteridge's law states, any headline with a question mark at the end can be answered with a 'no'. Incidentally, Ian Betteridge, who coined this law, has regularly written for *Custom PC*, so I'm hoping he doesn't see this one while flicking through the mag in WH Smith. Anyway, let's get that obvious answer out of the way – no, technically there's still a point to overclocking your CPU for some tasks. For most people, though, I think we've now reached the end of that road.

I'm going to upgrade my water-cooled X370 rig to a Ryzen 7 2700X this month, and I'm not going to overclock it – I'll run it at stock speed, and run the fans and pump at low speeds for low-noise operation instead. There's simply no point in me overclocking it – AMD's new boosting algorithms will give separate CPU cores a decent clock speed boost when required, without any tweaking needed. In fact, in many tasks, an all-core overclock will now make your CPU slower rather than faster.

Boosting algorithms aren't a new idea, of course, they've been around for years. The difference is that, with 2nd Gen Ryzen, they're so effective that they've made overclocking redundant for most people. Even Scan, with its team of expert overclockers, decided against overclocking its Ryzen 7 2700X machine on p64.

Plus, while we've shown you how to overclock our 2nd Gen Ryzen build on p86, we decided against overclocking it for the benchmarks. With the exception of Cinebench and Handbrake, it's generally faster without overclocking. It's a situation that's made a mess of the benchmark graphs for our X470 motherboard

Labs (see p51), with us having to reverse the stock speed and overclocked bars on a fair few tests, as the boards were quicker with the CPU at stock speed. Also, as Antony has established on p102, you'll need a serious cooling system if you want to run all your CPU cores overclocked permanently.

There's still a point to overclocking a low-end quad-core CPU such as Intel's Core i3-8350K to give you fast performance in games at a low price, or overclocking a non-X-series Ryzen CPU, although the smaller price gap means it's hardly worth it now.

Professional overclockers will also want to squeeze as much clock speed as possible out of each chip – people who want to break benchmark records and have serious cooling gear.

If you're going to regularly run seriously multi-threaded workloads then there's a point to an all-core overclock too. That said, you'll be better off with a Threadripper or Core i9 if that's the case, rather than overclocking a sub-£300 CPU.

For the rest of us, the everyday enthusiasts who might be considering a 6-core or 8-core X-series Ryzen CPU for all-purpose use, there's simply no point to overclocking it, and I'm not entirely sure how I feel about that. I've always taken some satisfaction in using my skills and knowledge to push my CPU beyond its official spec, and it's a bit of an anticlimax for the CPU to be clever enough to do that job itself.

There's still a need for all sorts of tweaking skills and knowledge if you want to build a high-end PC, particularly if it's water-cooled, it's just that overclocking may not be a major part of that process now. Do you still want to overclock your CPU? Let me know at letters@custompcmag.org.uk **GPC**

It's a bit of an anticlimax for the CPU to be clever enough to do that job itself



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RICHARD SWINBURNE / VIEW FROM TAIWAN

HITTING THE WALL

Delaying its moves to smaller transistors could make Intel uncompetitive over the next couple of years, argues Richard Swinburne

Way back in Issue 145 (mid-2015), I discussed how Intel's 'tick-tock' strategy had become 'tick-flop', as the company moved away from ten years of its 'process then architecture' CPU upgrade cycle, onto a new 'process, architecture then improvement' cycle. At the time, Intel was having trouble with its 14nm process, and it needed an extra year to get 14nm manufacturing back on track before 10nm transistors arrived. Unfortunately, 10nm has become an even more troublesome child, with Intel now claiming that big volume production has been pushed back to '2019'.

Given that we're already halfway through 2018, Intel's ambiguity over the date is leading some analysts to read that as 'not the early part of 2019,' because we're still lacking any defined roadmaps. Current Coffee Lake (8th Gen) Intel processors are already the *second* 'improvement' part of Intel's 14nm cycle after Broadwell, Skylake and Kaby Lake, so Intel will likely have to make yet another round of 14nm products based on the Skylake architecture again. This next line-up will effectively be the fourth generation of Skylake-based products, and the fifth 14nm generation.

Intel is shipping *some* 10nm products, but to my knowledge, they only consist of a single, low-power and low-clocked dual-core CPU without integrated graphics (dubbed 'Cannon Lake'). There's a tiny, low-power FPGA evaluation board for embedded product development. These two commercial products are very limited in capacity, so Intel is clearly having trouble with 10nm manufacturing when it comes to chip size, features and speed.

Meanwhile, Intel's foundry competitors already have 7nm chips in production. TSMC is producing 7nm chips in big volume today (used to make new GPUs), with 7+ chips due next year. The 7+ process uses a new type of production technique called EUV

(extreme ultra-violet) technology. By the time Intel is embracing EUV itself, TSMC is due to have a 12-18-month expertise lead. GlobalFoundries also has its 7nm process kicking off in the second half of 2018, with big volume for Zen 2 set for 2019.

It's not all bad for Intel though. Eagle-eyed folks have spotted new product leaks from Intel's new documentation, suggesting that Intel is preparing an 8-core chip to replace the Core i7-8700K, along with a new Z390 chipset. There's also a refreshed X399 chipset for to replace Intel's high-end X299 chipset. While there's been no confirmation of their respective features, it's possible that both chipsets will be brought up to at least the spec of recent H370 and B360 products, with added Wi-Fi and USB 3.1 Gen 2 (10Gbps). Whether the new Z390 chipset is required to run the new 8-core desktop chip remains to be seen, however.

Intel has also continued its hiring spree of ex-AMD staff. Following Raja Koduri (ATI/AMD Radeon and Apple GPU expert) late last year, Intel has also recently hired chip design legend Jim Keller (AMD Athlon 64 & Zen, Tesla in-car chips, Apple A-series SoCs) and Chris Hook (ex-ATI and AMD Radeon marketing) to lead its discrete graphics marketing efforts. And let's face it, Intel needs to work on its gaming credibility as much as delivering a capable product.

Koduri and Hook are specifically working on Intel's discrete graphics products with an eye on a ~2020 time frame, while Keller is apparently working on a wider remit across Intel's platforms. These staff hires are a part of ongoing reorganisations within Intel to shake up the firm and reinvigorate its competitiveness. Whether it works for the 100,000+ strong company remains to be seen, but it's likely to have a rough 2018 and an uncompetitive 2019 before the seeds planted now start to sprout in 2020. **CPC**

Leaks suggest Intel is preparing an 8-core chip to replace the Core i7-8700K

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan @Bindibadgi

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TRACY KING / SCEPTICAL ANALYSIS

CHILD SAFETY

We must look at the evidence before limiting young people's screen time and regulating the Internet, argues Tracy King

In last month's column I talked about government regulation of in-game purchases such as loot crates, which falls under the general umbrella of 'protecting vulnerable people'. Gambling addiction can ruin adult lives, and kids are particularly ill-equipped when it comes to recognising the risks and repercussions of behaviour.

Regulating these transactions would bring loot crates in line with existing regulation – simply a case of deciding whether they're gambling or not – rather than introducing new laws. Whether the British government decides to regulate microtransactions remains to be seen, but in the meantime, a different and more troubling spectre looms over the online and gaming population.

Various politicians (and therefore various newspapers) have decided that screen time is ruining an entire generation. Secretary of State for Digital, Culture, Media and Sport, Matt Hancock, suggested in March that he might be in favour of limiting online access by age, following frankly ignorant comments by Health Secretary Jeremy Hunt that social media could be as harmful as smoking or obesity.

Obviously the government has to draw legal lines, but they *must* be evidence-based. While there is little evidence regarding addiction to games, there is plenty of evidence around addiction to gambling, where there is real world money to be made (often because the winnings are used to feed other addictions such as alcohol or drugs, as several studies show).

The (hopefully) good news is that, rather than just taking Hunt or Hancock's word for it, the government is instead taking written evidence before making a decision. The first chunk of that evidence is now available online, and I've read it, so you don't have to.

The report is clear from the beginning that the Internet is, in fact, either good or neutral here

There are several reports, but I want to focus on the one from Hancock's own department, because that's the one that will have the most influence over the government's actions. The report is clear from the beginning that, despite what the boss says, the Internet is, in fact, either good or neutral here:

'A systematic review of the literature on the impact of social media on children and young people's mental health reported a mixture of positive effects (30 per cent), mixed/no effects (44 per cent) and risks/negative effects (26 per cent).' Overall, access to the Internet is a net positive for young people.

The report also claims that 'Gaming Disorder' has been added to The World Health Organisation's diagnostic manual, which I've discussed in previous columns, but it's clear the report is less concerned with gaming, and more concerned with mental health and gambling. And that's where it gets interesting.

The report states there's no evidence of a significant increase in gambling addiction (which you would expect to see as online gambling proliferates), and no evidence that online advertising for gambling has any effect on young people. It could just be down to a lack of studies, but it also might be the case that concerns around young people and online gambling are overblown.

Why does this matter to us though? We're all responsible people, right? It really matters, I promise. Previous government attempts to limit Internet access in the name of child safety have resulted in ISPs blocking perfectly innocent websites (The Open Rights Group keeps a list of them) – everything from chess sites to gardening tips to sexual health advice and, ironically, gambling addiction help organisations. To limit the Internet by age will also require all of us to prove who we are, resulting in a privacy and human rights nightmare. **GPC**

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdot](#)

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Incoming

We take a look at the latest newly announced products



Nvidia GPU prices approach normality

After a few months of ludicrous graphics card prices, it looks as though the demand for GPUs for cryptocurrency mining is starting to abate, and supplies are starting to fill the shelves again. We're not quite at pre-boom prices yet, and AMD GPUs are still demanding a hefty premium, but the prices of Nvidia GPUs are now approaching sensible levels again.

GeForce GTX 1060 3GB cards have dropped from a minimum of £290 inc VAT in January to £195 inc VAT on www.scan.co.uk, while 6GB GTX 1069 cards have dropped from £360 to £245 inc VAT over the same period at the same retailer. Even the GeForce GTX 1080 Ti is starting to look reasonably priced again, with Zotac Mini's version (pictured) now going for £720 inc VAT.

Steam goes mobile

It looks as though you'll soon be able to play some of your Steam games catalogue on mobile devices, as Valve has announced plans for a new Steam Link app. The app effectively streams the visuals for your game from your host PC, using your tablet or phone as the screen.

The app will support both Android and iOS, on various phones, tablets and TV devices, and will also support Valve's Steam Controller and MFI controllers, so you're not limited to your mobile device's touch-screen. The app should be available by the time you read this, although the Android version will initially be only offered in beta. PC gaming in bed, anyone?





Razer gives mouse underglow

Razer has announced its first mouse to feature an underglow light, which the company says 'reflects off the gaming surface being used', making the mouse look a little like it's hovering above your mouse pad. The Razer Abyssus Essential has an ambidextrous design, and also features a 7,200dpi optical sensor.

The company describes the mouse as a 'no-frills' model, and it doesn't have masses of extra buttons, but it's fully compatible with Razer's Chroma RGB lighting system. The Razer Abyssus Essential is available to purchase now from www.razer.com/gb-en for £50 inc VAT.

SSDs get RGB lighting

Proving that no component is now safe from the current RGB lighting trend, Team Group has now launched a new line-up of solid state drives featuring RGB LEDs. The company says that its new T-Force Delta RGB (Magnificent Version) SSDs offer the largest RGB illuminated area in the industry, with a 5:3 aspect ratio. They're 2.5in SATA SSDs, so they're not going to be super-fast, but they will look good. Black and white models are available in 250GB, 500GB and 1TB capacities, and the drives will have a physical height of 9.5mm.



Meanwhile, the lighting system has a palette of 16.8 million colours, which can be hooked up to a 5V RGB header on your motherboard. It's also compatible with Asus, Gigabyte and MSI's lighting control systems, so you can synchronise the SSD lighting with the rest of the build.

Noctua unleashes super-quiet fan

Airflow specialist Noctua has revealed a new cooling fan, which it says will offer 'an unprecedented level of quiet cooling performance'. According to the company's chief technology officer, Lars Strömbäck, the new NF-A12x25 is the result of 4.5 years of research and development, which he describes as 'easily the most thorny, intricate development project we've completed so far'.

The blades have a miniscule clearance of just 0.5mm between the frame and the tips of the blades, and the firm says the design helps to work more efficiently against 'back pressure', such as when the fans are mounted on radiators or heatsinks. An NA-SFMA1 adaptor will also be available to mount the fans on radiators with 140mm fan mounts.

Several flavours will be available, including a standard 4-pin PWM model and a 3-pin model with voltage adaptors to adjust the speed. A 3-pin Ultra Low Noise (ULN) model will also be available. Prices start at £26 inc VAT, with the fans available to buy from www.amazon.co.uk now.

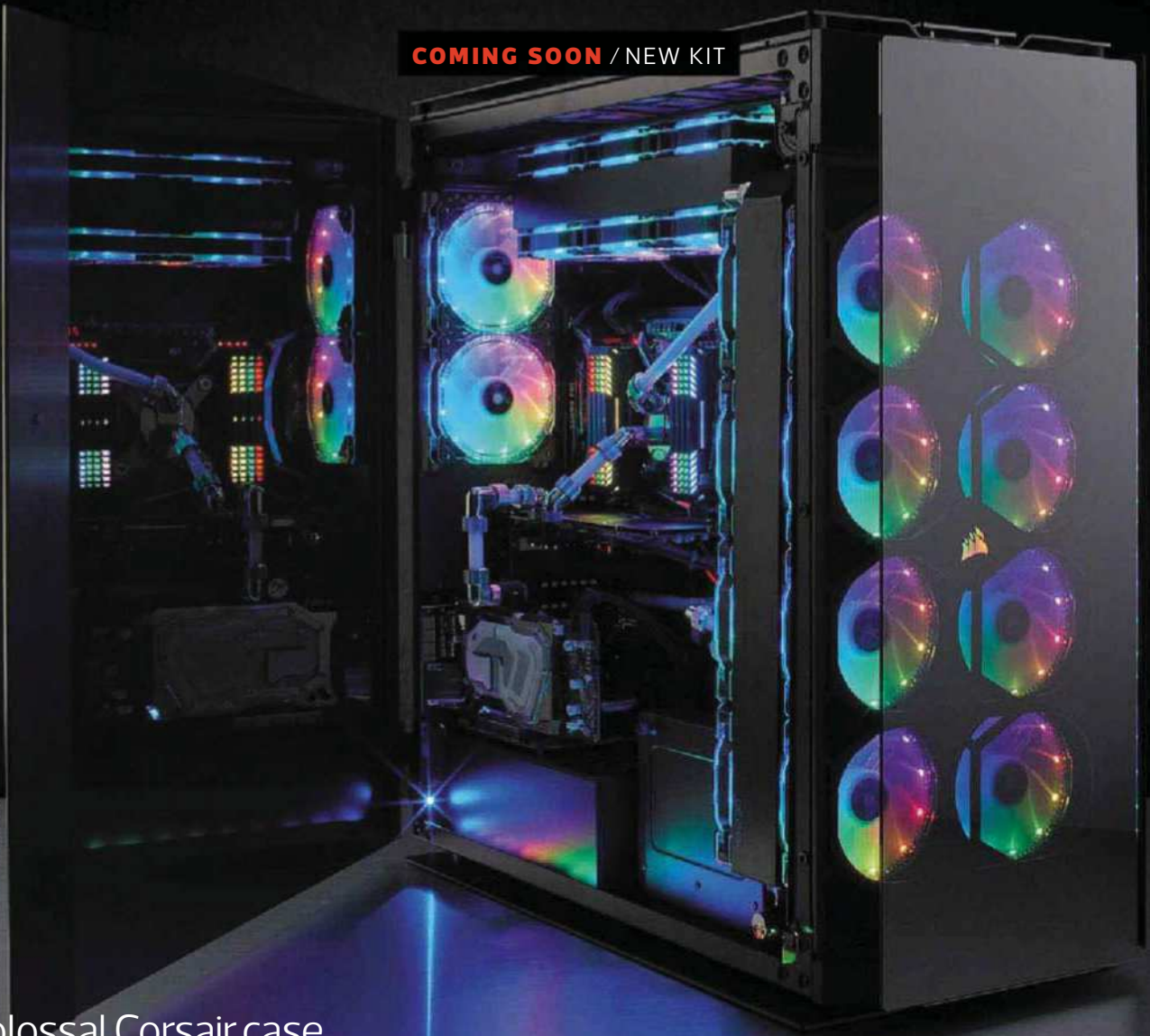


Cooler Master launches sub-£50 case

Cooler Master has launched a new chassis for PC enthusiasts on a tight budget. The company's new MasterBox MB510L case sports many features usually found on more expensive chassis. For a start, it has an edge-to-edge-transparent panel, which isn't made from tempered glass, but will show off your PC building skills. There's also a PSU cover to help hide messy cables.

Meanwhile, the front ventilation panels come in a choice of different colours, and there's room for up to six fans, with plenty of space for water-cooling gear. There's 400mm of graphics card clearance too. The MasterBox MB510L is scheduled to be available in June this year, at a cost of £49.99 inc VAT.

COMING SOON / NEW KIT



Colossal Corsair case

Corsair has announced a new case that's big enough to house two PCs. The Obsidian 1000D features four smoked tempered glass panels and can house both an E-ATX system and a mini-ITX rig, along with both an SFX and an ATX PSU. The case also offers 13 fan mounts and 11 drive bays. Corsair envisages the case being used to house 'the most powerful, ambitious and jaw-dropping PCs on the planet'.

You can install an E-ATX motherboard on what Corsair calls a 'raised motherboard island', which is accompanied by cable-routing

holes, with a rear compartment behind it for cable routing. The mini-ITX rig then sits on top of the ATX PSU mount. Corsair suggests using the second PC 'as a file server, streaming capture system, or second gaming PC for player two'.

The case also offers a rotatable graphics card mounting plate, and a load of pump and reservoir mounting points for water-cooling gear. Not surprisingly, though, it isn't cheap, with the Obsidian 1000D currently going for £449 inc VAT from www.scan.co.uk

Nvidia abandons GeForce Partner Program

Following strong online criticism about anti-competitive practice, Nvidia has pulled the plug on its GeForce Partner Program (GPP). The scheme was originally billed as a way to ensure that gamers knew exactly which brand of GPU they were buying, but some digging by Kyle Bennett at IHJardOCP suggested that firms who made cards with both Nvidia and AMD GPUs would have to differentiate their branding, and not use the same brand for both Radeon and GeForce GPUs.

That's fine for some firms, but it's not ideal if you have an overarching brand across all your products, such as Asus' Strix brand, or Gigabyte's Aorus brand – to be clear, neither Asus nor Gigabyte has spoken out publicly about the scheme, however. According to Bennett's anonymous sources from board partners, there was an implication that GPU supply would be withheld from companies that didn't comply. Following a bit of an online backlash, though, the company has now abandoned the scheme.

In an online statement, Nvidia's director of partner marketing, John Teeple, described the allegations as 'rumors, conjecture and mistruths'.



Teeple says the firm decided against 'battling information' and instead just decided to cancel the scheme. However, Teeple remains defensive of Nvidia's intentions. 'With GPP, we asked our partners to brand their products in a way that would be crystal clear,' he said, adding that 'the GPU brand should be clearly transparent – no substitute GPUs hidden behind a pile of techno-jargon' and that 'most partners agreed'. **GPC**



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Letters

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Yes to massive monitors

I was amazed at the response from Ben this month. Is it really true that Ben can't imagine a home user would want a big screen? Has he ever used one?! I've got two 37in screens on my twin-SLI GTX1080 rig. Why would I not? Surely your readership is made up of exactly the kind of people who love tech. What would be the point in having all that graphics power if I didn't use it to run some screens?!

I hope you're learning that we're interested, and I hope to see a 'massive screens' megatest in the near future. There must be a lot to consider, because some of the truly massive screens actually have very low resolutions.

Other slightly smaller screens have a very high resolution. I would love to see them compared.

JAKE LIDDELL

Ben: This wasn't the only response we had about bigger monitors this month – consider me schooled. We'll look into it.



Cache for questions

I've had a bit of a funny incident, where my system just crashed but behaved as if the graphics card had died. The screen looked like the old Commodore 64 loading screen with pretty rainbow colours. I looked at the event viewer when I restarted my system, and I noticed a particularly worrying entry, saying there was a cache hierarchy error in the processor core.

I'm running an AMD FX-9590 at stock speed, (I've never overclocked it, as it works perfectly, hitting 5.052 GHz with the turbo clock). The vcore



AMD's FX-9590 can get very hot with its 220W TDP

goes to around a max of 1.5V when it hits 5GHz and has done since I built the system. Lately it seems to have been running a little warmer than usual – perhaps it's the games I play, but at idle, it sits at around 33°C and when it's under load, it can get anywhere up to 84°C – I'm using a Corsair H110i GTX cooler.

Is my CPU getting so hot to the point where it's causing errors in the cache? Should I have replaced the TIM compound years ago, and on a regular basis? I've seen on a lot of debate on forums about renewing vs not renewing your TIM. Also, is my cooler getting worn? I believe they have a finite life span.

The error has occurred seven times, but the last time was the first time my system actually locked on me. Please can you tell me what you make of this error, as I'm at a loss. I would hate for my CPU to be going bad due to an overheating issue that can be fixed for a couple of hundred pounds.

CHRIS BURDEN

Ben: While that peak load temperature is very hot for a stock-speed CPU, it isn't in the danger zone – that's a chip with a 220W TDP, so it's always going to get hot at peak load, even with a decent cooler. Speaking of which, all-in-one liquid coolers do generally have a limited lifespan, but it looks as though yours is working – if the cooler isn't making proper contact, the CPU temperature rockets well beyond the danger zone at full load and you end up with throttling – yours isn't doing that. Your CPU is running hot, but it should still be functional.

Just to be sure, though, try removing all the TIM on your CPU and cooler with a solution such as ArctiClean and a lint-free cloth, then reapply some new TIM (apply a cross shape from corner to corner, then press the Corsair waterblock onto the CPU). Also, try increasing the speeds of your case fans and CPU cooler fans. Finally, see if a friend can lend you an equivalent CPU to try in your system – one with the same or very similar spec. If the latter makes the errors disappear, you've probably got a faulty CPU.



New RealBench?

Has the new version of RealBench been released so that newer systems can upload their results?

WILL

Ben: I'm afraid not, Will, which is why we removed the leaderboard from the magazine a few months ago. Asus' RealBench team has sent us a couple of revisions that were intended to enable newer systems to upload their results, but they sadly introduced other issues that stopped the suite completing on some systems. **GPC**

WHEN'S THE NEXT MAG COMING OUT?

Issue 180 of Custom PC will be on sale on Thursday, 12 July, with subscribers receiving it a few days beforehand.



Send your feedback and correspondence to letters@custompcmag.org.uk



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x
1440

1ms

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Reviews

Our in-depth analysis of the latest PC hardware



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AMD SOCKET AM4 CPU

AMD Ryzen 5 2600 / £161 inc VAT

SUPPLIER www.overclockers.co.uk



Hot on the heels of the X-series Ryzen chips we saw last month, the new Ryzen 5 2600 looks like a veritable bargain. While the Ryzen 72700 only shaves 12 per cent off the price of the Ryzen 7 2700X (see Issue 178, p22), the Ryzen 5 2600 costs a more substantial 22 per cent less than the Ryzen 5 2600X (see Issue 178, p23).

While this difference only equates to a £30–40 saving in both cases, it's a much bigger deal at this end of the budget spectrum, and amazingly, it retails for £40 less than its predecessor's launch price too. That's particularly exciting, as the Ryzen 5 1600 was our favourite CPU in AMD's previous line-up. It was a great all-rounder, trouncing Intel's quad-core CPUs in heavily multi-threaded benchmarks for a lot less cash, while overclocking to match the more expensive Ryzen 5 1600X.

Again, AMD's cheapest 6-core CPU is a bargain

This time around, with the 12nm Pinnacle Ridge core, clock speeds are higher, with a 200MHz bump to the base frequency and 300MHz added to the maximum boost frequency. The CPU also sports lower latencies and AMD's new boosting algorithms, which will hopefully improve the lacklustre single-threaded performance of its predecessor, as well as increasing its lead in multi-threaded applications compared with Intel's competitors. The cache amounts are the same as those of its predecessor, with 3MB of L2 cache and 16MB of L3 cache. The TDP of 65W is also the same, but this figure sits 30W under the Ryzen 5 2600X's TDP and is well within range of the capabilities of its included Wraith Stealth cooler, at least at stock speed.

Performance was vastly improved compared with the Ryzen 5 1600, but lacking compared with the Ryzen 5 2600X, with image editing scores of 51,754 and 56,195 respectively, giving the more expensive CPU a reasonable lead. Video editing was no different, with the score of 382,404 paling compared to the 2600X's 425,937. The system scores of 154,693 and 169,556 show that, on average, there's around a 10 per cent performance difference between the two Ryzen 5 6-core 2nd Gen Ryzen CPUs.

The Ryzen 5 2600 also sports a slightly higher base frequency than the Ryzen 72700, which might explain the quicker 64fps minimum frame rate in Deus Ex: Mankind Divided. This figure was 2fps behind the Ryzen 5 2600X with a similar deficit in Ashes of the Singularity: Escalation.

The highest clock speed we could reach with our maximum safe vcore of 1.425V was 4.15GHz, which is over 200MHz higher than we managed with the Ryzen 5 1600 and only 50MHz lower than the top figure we achieved with the Ryzen 5 2600X.

This overclock saw the minimum frame rate in Deus Ex rise from 64fps to 67fps, while the Ryzen 5 1600 could only muster 60fps and 63fps when overclocked. The system score also rose from 154,693 to 171,803, sitting only just behind the Intel Core i5-8600K, which costs £40 more.

Conclusion

Once again, AMD's cheapest 6-core CPU is a bargain, offering excellent value for money as well as a noticeable performance boost over its predecessor. Even though the latter CPU has received numerous price cuts and now costs under £150 inc VAT, the Ryzen 5 2600 is a much better buy in all regards. If you're game for some overclocking, it offers better bang per buck than the Ryzen 5 2600X as well. Intel still has a lead in some games, but when coupled with fast memory, the Ryzen 5 2600 will be snapping at the heels of the much more expensive core i5-8600K too.

ANTONY LEATHER

/SPECIFICATIONS

Base frequency 3.4GHz

Max boost frequency 3.9GHz

Core Zen

Manufacturing process 12nm

Number of cores 6 x physical (12 threads)

Simultaneous Multithreading (SMT) Yes

Cache 16MB L3 cache, 3MB L2 cache

Memory controller Dual-channel DDR4, up to 2933MHz

Packaging AMD Socket AM4

Thermal design power (TDP) 65W

Features Precision Boost 2, XFR2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

PERFORMANCE **42/50**

FEATURES **15/15**

VALUE **34/35**

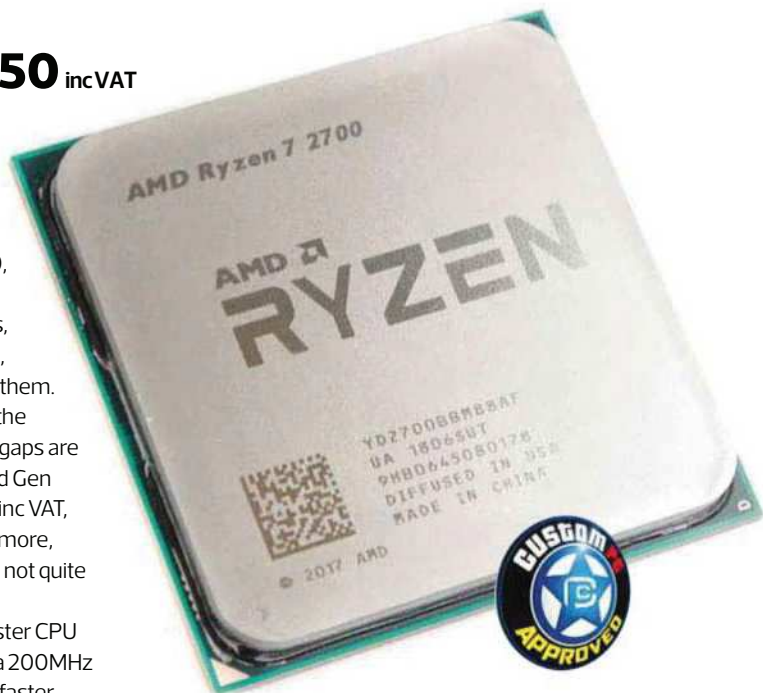
OVERALL SCORE
91%

VERDICT
A worthy successor to the excellent Ryzen 5 1600 with a spectacularly low price.

AMD SOCKET AM4 CPU

AMD Ryzen 7 2700 / £250 inc VAT

SUPPLIER www.overclockers.co.uk



While AMD's original non-X-edition Ryzen CPUs, such as the Ryzen 7 1700, weren't officially speed-binned for better overclocking performance, in many cases, they overclocked similarly to the Ryzen 7 1800X, making bargains for anyone willing to overclock them. There was also a huge £170 price gap between the Ryzen 7 1800X and the Ryzen 7 1700, but these gaps are much smaller between AMD's new, cheaper 2nd Gen Ryzen CPUs. The Ryzen 7 2700 costs just £250 inc VAT, but the fantastic Ryzen 7 2700X costs only £30 more, potentially making the Ryzen 7 2700 not quite as big a bargain as its predecessor.

It has an extremely low TDP for an 8-core CPU

Its specifications reveal a much faster CPU than the Ryzen 7 1700, though, with a 200MHz faster base frequency and 400MHz faster maximum boost frequency. While the total cache is the same at 19MB, the new 12nm CPU also sports the same lower latencies as other 2nd Gen Ryzen CPUs. These specifications should mean it's noticeably quicker across the

board in both lightly threaded and multi-threaded applications. However, the clock speeds also pale in comparison with the Ryzen 7 2700X, with a 200MHz deficit in maximum boost frequency and a sizeable 500MHz drop in base frequency.

The Ryzen 7 2700, like its predecessor, not only sports an unlocked multiplier, but also has an extremely low TDP for an 8-core, multi-threaded CPU, at just 65W. As such, it's an ideal candidate for a tiny PC limited to low-profile coolers or simply an inconspicuous content creation rig.

The CPU also comes equipped with AMD's new Wraith Spire RGB cooler, which is more than up to the task of dealing with this 65W CPU at stock speed. It's a tempting package compared with Intel's similarly priced CPUs too, with the Core i7-8700K costing £30 more and lacking a heatsink.

At stock speed, our system drew just 126W from the wall with the Ryzen 7 2700 at load, compared to 220W for the Ryzen 7 2700X, and it was a performance match for the Ryzen 7 1800X too. Not surprisingly, it was a lot slower than the Ryzen 7 2700X, though, scoring 49,424 compared to 56,507 in the image editing test and 467,186 compared to 535,250 in the video encoding test.

We also spotted that the all-core boost of the Ryzen 7 2700 only reached 3.4GHz, while the X-edition CPU regularly topped 4GHz, which accounts for the much slower multi-threaded performance. The system score of 176,374 was 14 per cent slower than the 201,613 scored by the Ryzen 7 2700X too. Games also took a hit

compared with the 2700X, with the Deus Ex: Mankind Divided minimum frame rate falling from 67fps to 61fps.

However, we managed to overclock the CPU to 4.1GHz using a vcore of 1.425V, which is 150MHz shy of what we managed with the Ryzen 7 2700X, resulting in huge improvements across the board. The system score rose by 15 per cent to 202,593 and the minimum frame rate in Deus Ex increased to 68fps, matching the overclocked frame rate of the Ryzen 7 2700X.

Conclusion

The Ryzen 7 2700 is significantly quicker than its predecessor, but lacks grunt at stock speed, where the Ryzen 7 2700X is a better buy for just £30 more. However, once overclocked, the cheaper CPU is faster than the stock speed X-edition model and the slightly lower overclock didn't amount to a significant deficit in our benchmarks. If you want decent multi-threading performance for a mini PC, a stock speed Ryzen 7 2700 makes sense, but for a standard desktop rig, the Ryzen 7 2700X is the better chip, given that it's much faster at stock speed and has the promise of a higher all-core overclock for just £30 more.

ANTONY LEATHER

/SPECIFICATIONS

- Base frequency** 3.2GHz
- Max boost frequency** 4.1GHz
- Core Zen**
- Manufacturing process** 12nm
- Number of cores** 8 x physical (16 threads)
- Simultaneous Multithreading (SMT)** Yes
- Cache** 16MB L3 cache, 4MB L2 cache
- Memory controller** Dual-channel DDR4, up to 2933MHz
- Packaging** AMD Socket AM4
- Thermal design power (TDP)** 65W
- Features** Precision Boost 2, XFR2, FMA3, F16C, SHA, BMI / BMI1 + BMI2, AVX-512, AVX2, AVX, AES, SSE4a, SSE4, SSSE3, SSE3, SSE2, SSE, MMX

PERFORMANCE
44/50

FEATURES
15/15

VALUE
31/35

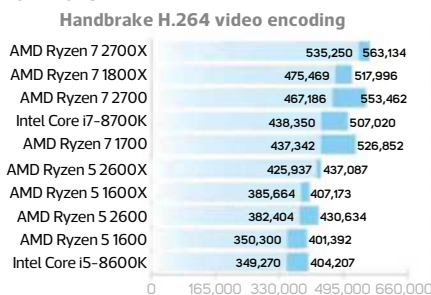
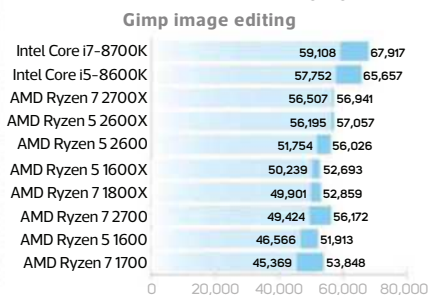
OVERALL SCORE
90%

VERDICT

Decent speed for the price, and a low TDP. The Ryzen 7 2700 lacks grunt at stock speed, but performs similarly to the Ryzen 7 2700X once it's overclocked.

AMD 2nd Gen Ryzen results

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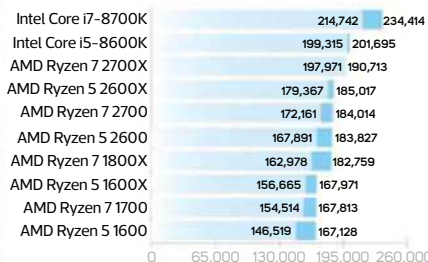


STOCK SPEED DEUS EX: MANKIND DIVIDED (FPS)

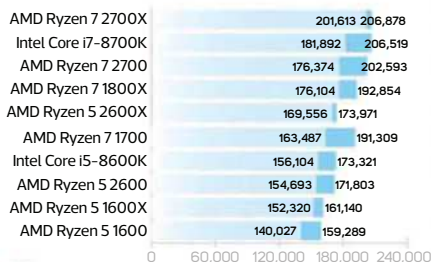
1,920 x 1,080, Very High settings, DX12



Heavy multi-tasking

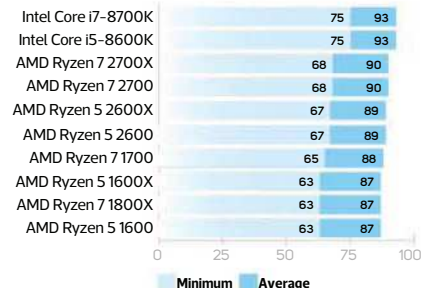


System score

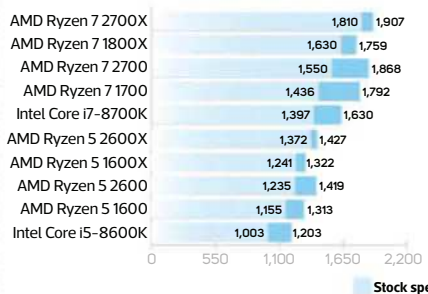


OVERCLOCKED DEUS EX: MANKIND DIVIDED (FPS)

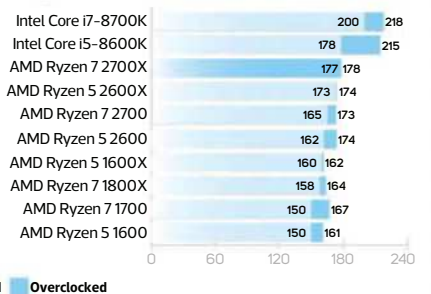
1,920 x 1,080, Very High settings, DX12



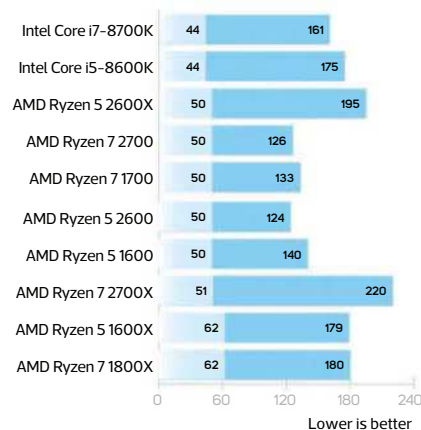
CINEBENCH R15 MULTI-CORE



CINEBENCH R15 SINGLE-CORE

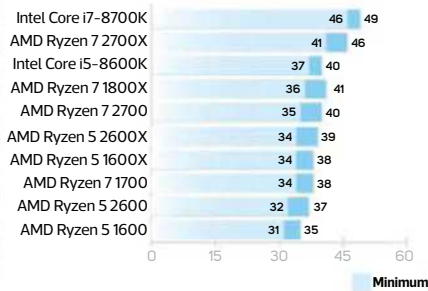


STOCK SPEED TOTAL SYSTEM POWER CONSUMPTION (WATTS)



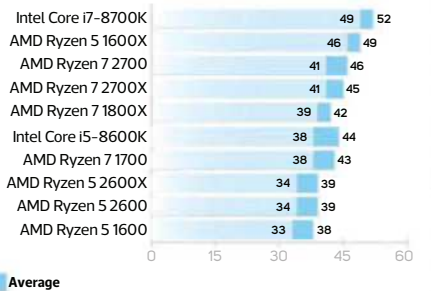
STOCK SPEED ASHES OF THE SINGULARITY: ESCALATION (FPS)

1,920 x 1,080, High settings, DX12, CPU test



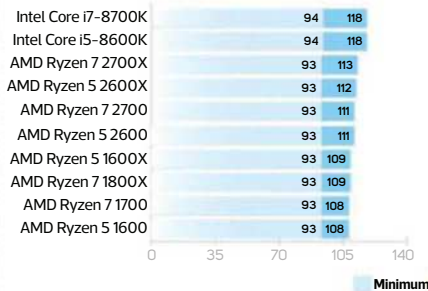
OVERCLOCKED ASHES OF THE SINGULARITY: ESCALATION (FPS)

1,920 x 1,080, High settings, DX12, CPU test



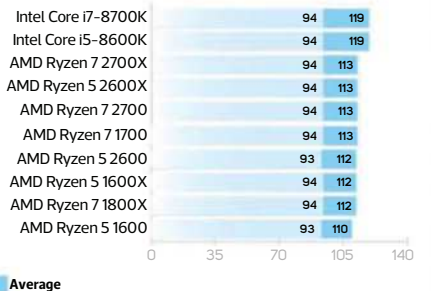
STOCK SPEED FALLOUT 4 (FPS)

1,920 x 1,080, Ultra settings

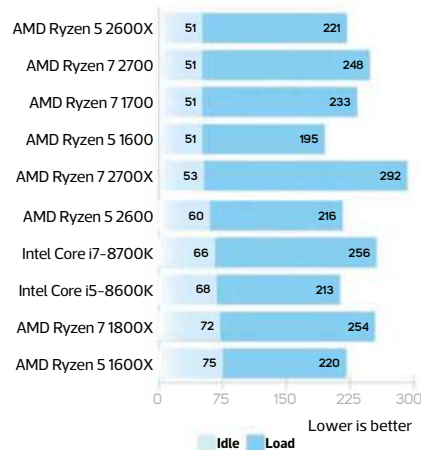


OVERCLOCKED FALLOUT 4 (FPS)

1,920 x 1,080, Ultra settings



OVERCLOCKED TOTAL SYSTEM POWER CONSUMPTION (WATTS)





SOLID STATE DRIVES

Samsung 970 Evo 500GB / **£189** incVAT

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Samsung 970 Pro 1TB / **£546** incVAT

SUPPLIER www.cclonline.com

Samsung has dominated the SSD market recently, thanks to a slew of high-performance and cost-effective drives, both in the lower-end SATA segment and the high-end M.2 NVMe space. It's in the latter space that the Samsung 960 Evo and Pro made a huge splash in 2016. Although they weren't cheap, they weren't extortionate either, and they blitzed the competition.

Nearly two years on, Samsung is back with a replacement for the 960 drives – the aptly named 970 range. As you'd expect, performance has again improved, but not by nearly as much as before, and moreover, the rest of the market has changed too. Now the latest drives from Western Digital, in particular, offer meaningful competition.

Let's first take a look at what the new drives offer. The headline number is that both new drives claim a sequential read speed of up to 3,500MB/sec. It's not actually an improvement as far as the 960 Pro goes, but the 960 Evo maxed out at 3,200MB/sec, meaning both product ranges are the fastest consumer SSDs on the market in this regard.

Sequential write speeds have jumped forward for both drives too. The 500GB Evo, for instance, has gone from 1,800MB/sec to 2,300MB/sec, while the 1TB Pro has gone from 2,100MB/sec to 2,700MB/sec. Random read and write performance has also improved, with the 500GB 970 Evo claiming 370K IOPS read and 450K IOPS write, compared to 330K IOPS read and write from the 960 Evo. Similarly, the 1TB 960 Pro has moved from 440K IOPS read and 360K IOPS write to a flat 500K IOPS across the board.

They're mighty impressive numbers and the only other drives that really come close are the new WD Black M.2 models, with claimed sequential read and write speeds of 3,400MB/sec and 2,500MB/sec respectively for the 500GB drive, with the write speed increasing to 2,800MB/sec for the 1TB model.

One area that hasn't improved with these new drives, though, is capacity. The 960 Pro topped out at 2TB and the 960 Evo was limited to 1TB. This time around, the 970 Pro peaks at 1TB and the 970 Evo is available in up to 2TB. Yes, for some reason, Samsung has swapped around the capacities. This immediately calls into question the appeal of the Pro line, as its larger capacity was the main appeal for home users – the extra write speed and endurance is only useful in extremely niche cases.

At the heart of these new drives is a range of new tech from Samsung, starting with its latest 3D NAND. Being first to market with 3D NAND has been key to Samsung's success over recent years and its latest version continues to keep it at the forefront.

Each NAND die has now increased from 48 layers to 64 layers, allowing for even higher data densities. Not that each die here has a greater capacity though. Most of the 960 drives used 256Gb dies, as do most of the 970 range, with only the 2TB model going up to 512Gb.

Just as important is the controller used to access them, and here we see Samsung move from its Polaris controller to its new Phoenix controller. Samsung hasn't released

many details about the controller other than confirming that it has five CPU cores, one of which is dedicated to host-side communications.

Meanwhile, the main difference between the 970 Pro and 970 Evo is that one uses 2-bit MLC (multi-level cell) NAND, while the other uses 3-bit MLC (TLC) NAND. The use of TLC NAND allows for greater density, allowing for cheaper, larger capacity drives.

The downside to TLC NAND is that it makes for slower write operations and a shorter lifespan. To get over the slower write speed, the 970 Evo converts some of its NAND for use as an SLC (1-bit) cache to boost performance. For the 500GB drive, that's 4GB, with up to 18GB of dynamic cache also available if the drive has enough spare capacity. In practical terms, most users won't exceed the write cache often, if ever. Once full, the drive's write speed drops to between 300MB/sec and 1,250MB/sec depending on capacity (600MB/sec for the 500GB model).

When it comes to the endurance, the Pro models have double the write endurance for the same capacity. Realistically, though, most users won't ever come close to exceeding the write limit of the Evo drives, and certainly not within their five-year warranty.

Samsung has stuck with its fetching matt black styling for both drives, and each drive is single-sided, with a couple of die packages and the controller squeezed together under the information sticker. The backs also retain the copper-backed sticker introduced with the 960 Pro, which helps to distribute heat, and Samsung has added a nickel top to the controller chip too.

Performance

We tested the 500GB 970 Evo and the 1TB 970 Pro and it immediately became evident that all of Samsung's

performance claims were true. In CrystalDiskMark, both drives hit their claimed 3500MB/sec read speed, as well as their respective write speeds, putting them at the top of the charts for drives we've tested.

Meanwhile, Iometer largely showed those impressive random read and write IOPS figures to be realistic, although the Evo's random read performance was lower than expected and the Pro's random write performance was lower too.

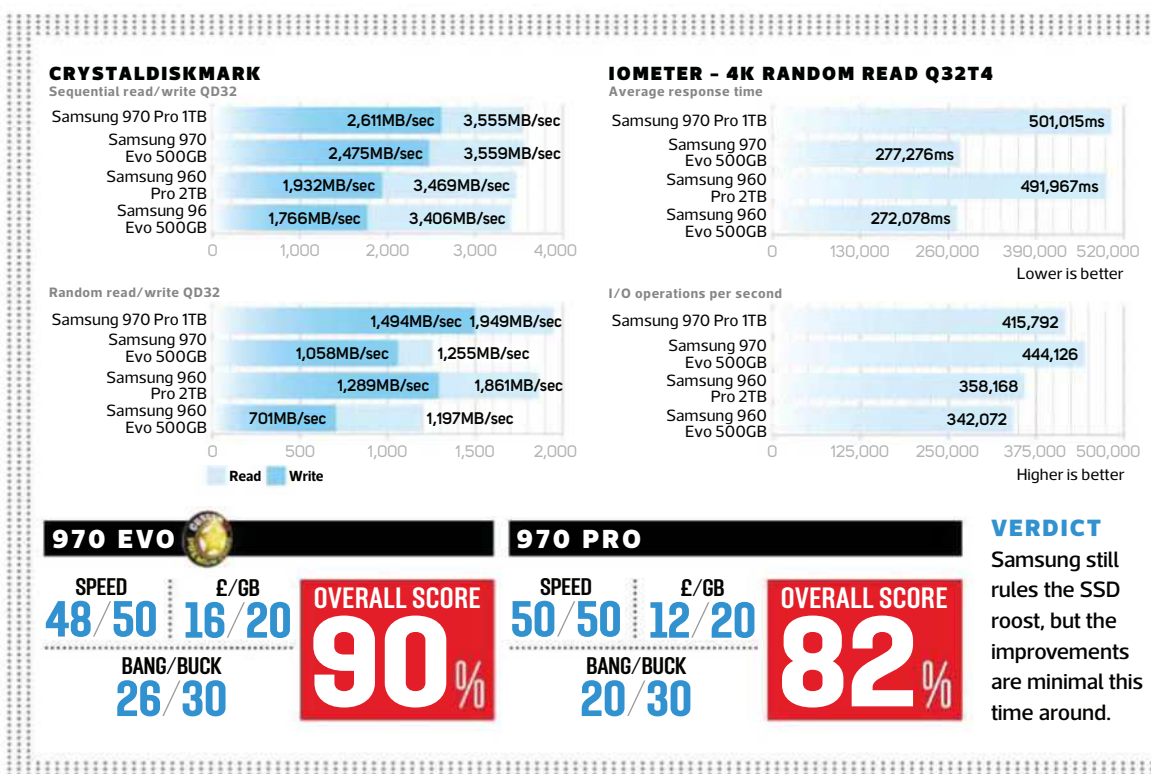
As for the real-world relevance, the difference these drives make to Windows boot speed is so small compared with other fast drives that it's irrelevant. Even compared with SATA SSDs, you're only saving a second or two, and that's largely true for games too. It's a similar story in many applications. For most users, the 960 Evo was already overkill, and the 970 drives just hammer that point home. The benchmarks are amazing, but we're talking diminishing returns unless you're using specific IO-heavy workloads.

Each NAND die has now increased from 48 layers to 64 layers

Conclusion

Both the Samsung 970 Evo and 970 Pro drives impress with their sheer speed, making them both highly desirable. However, with only minor improvements over their predecessors, and stiff competition from the likes of the latest WD Black SSDs, they're not quite the runaway success of the previous 960 models. Moreover, the case for any consumer spending the extra money on the 970 Pro is very weak, especially now that the 960 Evo has the larger 2TB maximum capacity.

EDWARD CHESTER





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CPC78

MICRO-ATX X399 MOTHERBOARD

ASRock X399M Taichi / £310 incVAT

SUPPLIER www.overclockers.co.uk



Due to the colossal size of AMD's TR4 CPU socket, we never imagined Threadripper motherboards would dip below the ATX form factor, but ASRock has worked its mini magic once again, as we also saw with its epic X299E-ITX/ac mini-ITX X299 motherboard. The X399M Taichi doesn't quite shrink to mini-ITX, but fitting the massive TR4 socket onto a micro-ATX PCB is still quite a feat.

Thankfully, ASRock has done a superb job with the X399M Taichi too. It looks absolutely stunning, with huge, gunmetal grey heatsinks for the CPU power circuitry linked by a heatpipe. These heatsinks are flanked by an I/O panel shroud that hides the unsightly ports underneath.

Despite its small size, the X399M Taichi can even comfortably house a pair of dual-slot graphics cards, thanks to the fact that all of the three 16x PCI-E slots on the board can supply the full 16 lanes of bandwidth. Using the first and third slots provides a large gap between graphics cards, while other micro-ATX boards end up sandwiching them together, blocking the top card's airflow.

The X399M Taichi uses an 11-phase power design, and it caters well for extreme overclockers with an additional 4-pin CPU power connector. Some space has also been gained by ditching four DIMM slots, reducing the total count to four. However, the board still supports quad-channel memory, you're just limited to a 64GB maximum, rather than 128GB.

There's a reasonable count of five fan headers on the PCB too, and ASRock's EFI allows you to switch between the CPU and motherboard as temperature inputs for fan speeds, as well as enabling you to switch off fans below a specific temperature, which is handy for case fans. All but two fan headers are limited to 12W, with the 'CPU optional' and 'water pump' headers able to dish out up to 18W.

ASRock has squeezed three 4x PCI-E 3 horizontal M.2 SSD mounts onto the PCB too, although none of them has heatsinks and only one supports SATA M.2 SSDs. These slots are in addition to eight SATA 6Gbps ports plus a U.2 port.

Meanwhile, USB 3.1 headers were a rarity on the initial batch of X399 boards and ASRock hasn't seen fit to include one here either. However, you do get USB 3.1 Type-A and Type-C ports on the I/O panel, as well as eight USB 3 ports, so even the most USB port-dependent setups shouldn't be left wanting. You get a decent

array of networking features too, including 802.11ac Wi-Fi that supports speeds up to 433Mb/sec, plus dual Intel Gigabit LAN ports.

The PCB offers almost every feature you need from an overclocking and testing point of view as well, with a POST code LED display, clear-CMOS button, power and reset buttons, and USB BIOS flashback button too, which allows you to flash the BIOS without a CPU or memory being installed. The latter might come in handy if you fancy pairing the X399M Taichi with a 2nd Gen Threadripper CPU later this year.

ASRock has never been really into laying on masses of RGB lighting, and the X399M Taichi is also colour-neutral, but it makes a rare exception here with several RGB LEDs dotted around the PCH heatsink and a 4-pin RGB LED header on the PCB. Meanwhile, the audio system benefits from a 120dBA SNR DAC, a premium headset amplifier and individual PCB layers for right and left channels, as well as Nichicon gold series audio capacitors. Audio performance was excellent too, with a recorded dynamic range of 114.5dBA and noise level of -109.6dBA.

Performance

It's fairly easy to work with ASRock's EFI, although the usual overclocking settings are spread around more than in Asus or MSI's EFIs. ASRock's Windows software also works well, mimicking many of the EFI options, including overclocking and fan control, which provides a more convenient way to fine-tune your system.

We managed to boot first time using 3200MHz Hynix A-die memory too, which just required setting the XMP profile in the EFI – the board then applied the correct frequency, voltage and timings. We also managed to overclock this memory to 3466MHz, so quad-channel 3466MHz memory kits should also work fine. We then tried overclocking our Threadripper 1920X test CPU, and managed to hit 4.05GHz using a vcore of 1.3875V, which



Despite its size, it can comfortably house two dual-slot graphics cards

/SPECIFICATIONS

Chipset AMD X399

CPU socket AMD Socket TR4

Memory support 4 slots: max 64GB DDR3 (up to 3600MHz)

Expansion slots Three 16x PCI-E 3

Audio Realtek ALC1220

Networking 2 x Intel Gigabit LAN, 802.11ac Wi-Fi

Overclocking Base clock N/A, max CPU multiplier 63x; max voltages: CPU 1.6V, RAM 1.8V

Ports 8 x SATA 6Gbps (X399), 3 x M.2, 1 x USB 3.1 Gen 2 Type-A, 1 x USB 3.1 Gen 2 Type-C, 8 x USB 3, 2 x LAN, 5 x surround audio out, optical/S/PDIF out

Dimensions (mm) 244 x 244

- 1** All the PCI-E slots get the full 16 lanes of bandwidth – ideal for dual graphics
- 2** Somehow, ASRock has shoehorned a TR4 socket onto a micro-ATX board
- 3** There are three M.2 slots, all with horizontal mounting

matches the frequency we achieved with this board's ATX sibling, the X399 Tachi, and it's also 50MHz higher than many other X399 boards we've tried.

The newer board and up-to-date BIOS appeared to have a big impact in some benchmarks too, with the image editing test result being several thousand points ahead of the competition, despite us using identical test hardware. The video encoding test was also a little quicker, while a slower multi-tasking result meant that, overall, the X399M Taichi was on a par with other X399 boards we've tested.

Not surprisingly, the X399M Taichi also had some of the most power-frugal figures on test, drawing just 91W at idle and 252W under load at stock speed. The load power draw was higher than average when overclocked thanks to a higher overclock frequency though. When overclocked, the system score rose from 229,630 to 252,041, while the minimum frame rate in Ashes of the Singularity rose 2fps, matching the best X399 results we've seen.

Conclusion

While there are cheaper X399 boards available, the ASRock X399M Taichi isn't aimed at budget users. It has a huge set of features, and as long as you won't be using more than two graphics cards, it has all you need to power a monstrous Threadripper system in a compact, micro-ATX form factor.

It overclocks particularly well and was happy with 3466MHz memory too. The only downsides are lack of M.2



heatsinks, although you can cheaply buy third-party ones anyway, and the lack of a USB 3.1 header for Type-C port compatible cases. It's otherwise an awesome motherboard that trumps many ATX X399 motherboards in terms of features too.

ANTONY LEATHER

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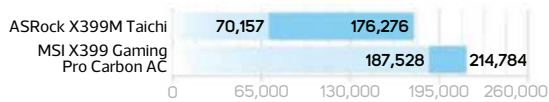
GIMP IMAGE EDITING



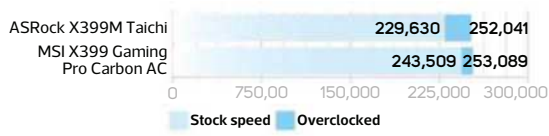
HANDBRAKE H.264 VIDEO ENCODING



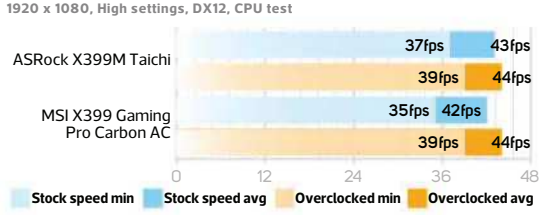
HEAVY MULTI-TASKING



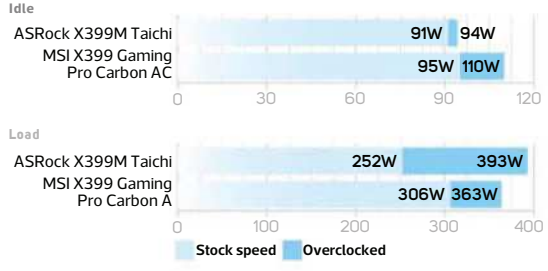
SYSTEM SCORE



ASHES OF THE SINGULARITY: ESCALATION



TOTAL SYSTEM POWER CONSUMPTION



PERFORMANCE: 34/35
 FEATURES: 32/35
 VALUE: 25/30

OVERALL SCORE
91%

VERDICT
 Powerful, overclockable and perfect for building a monstrous micro-ATX Threadripper PC.

240MM AIO LIQUID COOLER

Cooler Master MasterLiquid ML240R RGB / £102 inc VAT

SUPPLIER www.cclonline.com

Last month saw Cooler Master's ML120L RGB pick up our Approved award, thanks to a low price, good cooling and low noise. The MasterLiquid ML240R RGB is quite a different beast though. It's not only twice as large, with a 240mm radiator that's 27mm thick, but it also costs more than twice as much at £102 inc VAT.

There's more RGB lighting here, with a large controller powered by either a USB header or SATA connector. It can control RGB LEDs in the fans and pump, all of which sport several individually controllable LEDs, allowing rainbow and other multi-LED lighting effects.

The lighting is bright and punchy, although the pump section appeared to be much brighter than the fans. You also have to deal with a mass of six cables dealing with the lighting and power. One issue is also that the ML240R uses 3-pin RGB connectors instead of the standard 4-pin ones, so despite Cooler Master's claim of Asus Aura compatibility, you will need a motherboard with a 3-pin addressable RGB LED header, as the standard 4-pin ones won't work. Thankfully, the included controller can handle most tasks.

The individually addressable LEDs offer great effects

Mounting on an AM4 socket requires using two rather basic and fiddly clips, while the Intel mounts are a little more involved than the usual Asetek contraptions from Corsair and NZXT, with more bits. However, it's all straightforward and the only real issues are tidying the masses of cables and the fact that there are only enough screws for the included fans; if you want to use a push-pull setup with two extra fans, you'll need more screws.

All three CPU sockets saw vast improvements compared with all the 120mm radiator coolers in last month's Labs test, all thanks to the extra cooling capacity, and the cooling results are great, particularly on our AM4 rig. That said, the cooling capacity isn't out of the ordinary for a 240mm AIO liquid cooler, and similar cooling capacity can be had for much less money elsewhere. Meanwhile, the fans are certainly audible at full speed, but the noise isn't unpleasant when next to you, and the pump was inaudible over the fans too.

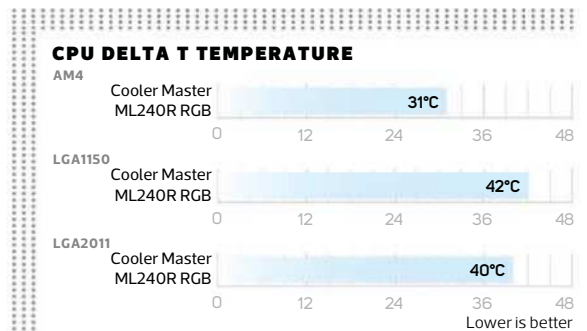
Conclusion

Stepping up to a 240mm radiator clearly gives you a massive benefit over a 120mm model, and the ML240R's funky lighting and individually addressable LEDs offer some great lighting effects. However, there's a messy collection of cables, and you pay a hefty premium for the lighting. Similar cooling can be found for much less money, even in Cooler



Master's own line-up. If you want some of the best RGB lighting on a capable and reasonably quiet AIO cooler, though, the MasterLiquid ML240R RGB is great.

ANTONY LEATHER



LGA2011

COOLING	FEATURES	DESIGN	OVERALL SCORE 84%
37/40	17/20	16/20	
VALUE	FITTING		
14/20	EASY		

LGA115x

COOLING	FEATURES	DESIGN	OVERALL SCORE 85%
37/40	17/20	17/20	
VALUE	FITTING		
14/20	EASY		

AM4

COOLING	FEATURES	DESIGN	OVERALL SCORE 84%
38/40	17/20	14/20	
VALUE	FITTING		
15/20	EASY		

VERDICT

Great cooling and funky addressable RGB lighting, but it demands a hefty premium.

/SPECIFICATIONS

Compatibility Intel: LGA775, LGA2011x, LGA2066, LGA115x, LGA1366; AMD: Socket AM4, AM3/+, AM2/+, FM2/+, FM1

Radiator size with fans (mm) 120 x 277 x 52 (W x D x H)

Fans 2 x 120mm

Stated noise Up to 30dBA

GAMING HEADSET

SteelSeries Arctis Pro + GameDAC / £250 inc VAT

SUPPLIER www.scan.co.uk

Achieving the utmost in audio quality is the aim of SteelSeries' new Arctis Pro range, thanks to a new driver design that more than doubles the existing Arctis range's frequency response range. Most headphones and headsets have a frequency response range of 20-20,000Hz, while the standard Arctis series ups this range to 20-22,000Hz. The Arctis Pro, though, stretches the range to 10-40,000Hz. That's the sort of level of fidelity normally only claimed by serious audiophile headphones.

At this point some of you may be wondering if there's a benefit to such a range, given that human hearing can't stretch much beyond 20-20,000Hz. Well, the answer is twofold. For one, the extended range is perceived by some people to be felt rather than heard, especially for powerful low frequencies from speakers. More importantly, the extra frequency range means manufacturers can ensure a more accurate, linear response in the frequencies we can hear.

Aside from its fancy new drivers, there's no obvious difference between the Pro and the rest of the Arctis range. The overall styling is all but identical, with the same subtle stretched-circle earcup design, simple metal headband and elasticated strap. Instead, the differences are in the colouring. While the normal Arctis range has a variety of patterns on the elasticated bands and a prominent silver SteelSeries logo, here it's just black, black and more black. The Arctis range was already good-looking, but the new all-black livery elevates its style even further.

Build quality is excellent too, with all the pieces and joints feeling solid and robust, and all the buttons and dials feeling well made. The elasticated band works wonders for distributing the weight of the headset over the top of your head too, and SteelSeries has slightly deepened the padding on the earcups, making the Pro more comfortable to wear than the standard Arctis.

The Arctis Pro isn't wanting for features either. It includes a retractable microphone, a microphone mute button, a volume dial, the main proprietary audio input and a conventional jack input that means you can use this headset as a conventional passive pair of headphones.

Then there's the optional GameDAC. This mini-USB sound interface includes a volume/control knob and OLED display, and can control some of the headset's features. As well as the main USB input that goes to your PC and the output for the headset, it also includes an optical input, a line-out jack and a line-in jack. It's a really well-made little unit, plus it appears as two audio outputs in Windows, so you can assign chat to one input and in-game sound to another one, then mix the levels using the control knob.

It also includes a quality digital-to-analogue converter (DAC) with native 24-bit/96KHz audio support, enabling SteelSeries to slap the Hi-Res Audio label on this headset.



However, this feature only works with virtual DTS surround sound turned off and without support for chat/game audio mixing, rendering it rather pointless in games.

Finally, we come to that all-important sound quality, and the Arctis Pro delivers on its promise, even without Hi-Res Audio. Comparing it with the already-good Arctis 7, the difference is like night and day, with a leap in clarity. The sound signature is also reasonably flat, so there's no over-the-top bass muddying the sound, making for an accurate presentation in music and games. The DTS virtual surround works well too, and it's handy that you can switch between surround and stereo at the touch of the GameDAC's button.

Conclusion

The SteelSeries Arctis Pro is a fine gaming headset. It boasts clarity that far surpasses most alternatives, it looks great, is reasonably comfortable to wear and is packed with useful features. The GameDAC also makes for a great addition, although it certainly isn't an essential. It might be expensive, but the Arctis Pro delivers on all fronts.

EDWARD CHESTER

SOUND
38/40DESIGN
18/20VALUE
32/30OVERALL SCORE
88%

VERDICT

A mighty pricey but mighty fine gaming headset that offers clarity far above the immediate competition.

GAMING LAPTOP

Scan 3XS LG15 Vengeance Pro / **£1,400** incVAT

SUPPLIER www.scan.co.uk

Scan's latest 3XS LG15 Vengeance Pro laptop makes an impact in numerous ways. It's one of few gaming laptops we've seen with a mechanical keyboard, and Scan reckons it's slimmer and lighter than any rival too. It's also the first Coffee Lake laptop we've seen, with the Core i7-8750H offering six Hyper-Threaded cores, and its base speed of 2.2GHz can boost to 3.9GHz on all six cores and to 4.1GHz across one or two cores. Previously,

the quad-core Core i7-7700HQ was the usual gaming mobile CPU of choice, as found in the £1,349 Dell Inspiron 15 7000 Gaming (see Issue 177, p32), which has a maximum turbo speed of 3.8GHz.

The Scan doesn't have any new components elsewhere, but its internals remain impressive. The full-fat variant of the GTX 1060 is used, unlike the Dell's Max-Q

variant. That means the Scan's GPU runs at 1404MHz rather than 1063MHz. There's also 16GB of dual-channel memory, which is an improvement on the Dell's single-channel DDR 4 setup, and storage is divided between a 250GB Samsung 960 Evo SSD and a 1TB hard drive.

Scan has packed all of this hardware into a chassis that's 19.9mm thick and weighs 2kg. Comparatively, the Dell was 0.5cm thicker and 0.5kg heavier. The Scan also has

reasonable build quality, despite its comparatively small size. The keyboard and the base panel are strong, although the lid is slim and feels a little creaky – we'd advise carrying the Scan in a padded bag.

There aren't many visual flourishes. The lid has some slashes and a 3XS logo, and the rear has small air vents. There's also a strip of RGB lighting at the front, and dramatic slashes around the power button. Elsewhere, it's just dark, brushed aluminium. That's fine if you prefer subtlety to all-out 'gamer' design, and it can be made more discreet by turning off the backlighting. That's achieved using Scan's Gaming Center app, which can also be used to customise the keyboard and deactivate the RGB light bar.

There's a reasonable port selection, including USB 3.1 Type-C and two mini-DisplayPort outputs, and Internet access comes via the usual Gigabit Ethernet port and dual-band 802.11ac Wi-Fi. You can get full access to the interior too, and a second M.2 slot is free to add more storage.



The new Coffee Lake Core i7-8750H CPU offers six cores

Meanwhile, the aforementioned mechanical key switches sit beneath conventional, chiclet-style buttons. The action is faster than any chiclet-based rival we've used, which helps during gaming – it's easier to get up to speed in fast-paced titles. They have a solid base, but don't have the softer typing action of conventional laptops – instead, they bottom out with a rigid click, giving you proper tactile feedback. They're far louder than usual laptop keys, too. The layout is good as well, with a numeric keypad and full-sized keys, and the touchpad is reasonable. The buttons are a bit soft in action, but you'll want a proper USB mouse for gaming anyway.

As ever, Scan's machine can be customised too, with alternative memory and storage options. Finally, the Scan has a two year parts and labour warranty, with a collect and return service for the first year. That's better than the one year RTB deals that we often see from big-brand rivals.

Performance

The Coffee Lake processor is superb. The huge turbo speed helped the Scan to deliver an image editing score of 51,004, which is almost 15,000 points beyond the Core i7-7700HQ. It's no multi-threaded slouch either. Its Handbrake result of 357,370 is also nearly 150,000 points ahead of the older Core i7. Single-threaded software will run with speed on the Scan, and the CPU won't have any trouble with difficult, multi-threaded applications or tough games either. The SSD bolsters the Scan's performance with read and write speeds of 3,230MB/sec and 1,464MB/sec.

Meanwhile, the full-fat GTX 1060 beat the Dell's Max-Q chip, with Fallout 4 and Deus Ex minimums of 49fps and 40fps being 5-10fps quicker. Those are demanding tests at high settings, and the Scan has no trouble coping with them at its screen's native 1,920 x 1,080 resolution.

When running less intensive tasks and mid-tier games, the Scan made hardly any noise; but when running tougher games, the fans spun up, modulating between two levels. It's a normal level of noise, unlike the Asus ROG Strix GL702ZC (see Issue 178, p38), which is a solid achievement

/SPECIFICATIONS

CPU 2.2GHz Intel Core i7-8750H

Memory 16GB 2400MHz DDR4

Graphics Nvidia GeForce GTX 1060 6GB

Screen 15.6in 1,920 x 1,080 IPS 60Hz

Storage 250GB Samsung 960 Evo M.2 SSD, 1TB hard disk

Networking Gigabit Ethernet, dual-band 802.11ac Wi-Fi

Ports 3 x USB 3, 1 x USB 3.1 Type-C, 1 x USB 2, 2 x audio jack, HDMI, 2 x mini-DisplayPort, SD card reader

Dimensions (mm) 359 x 236 x 19.9 (W x D x H)

Weight 2kg

Operating system Windows 10 Home 64-bit

Warranty Two years parts and labour, first year collect and return, second year return to base

- 1 The Samsung 960 Evo provides super-fast NVMe solid state storage
- 2 It's good to see proper dual-channel memory in a laptop
- 3 Two fans linked by heatpipes keep the 6-core CPU and GTX 1060 GPU cool



considering the Scan's powerful internals and slim size. The temperatures are fine too – the CPU peaked at a 64°C delta T with each core running at 2.7GHz, while the GPU topped out at 58°C and ran at around 1550MHz.

The 60Hz IPS panel doesn't have any active sync technology, but it does deliver decent image quality. Its brightness level of 367cd/m² is huge, and the black level of 0.27cd/m² is good. Those figures deliver a contrast of 1,359:1, which means ample versatility; colours are vibrant, there's enough brightness for outdoor gaming, and dark areas look inky. Those results are all better than the aforementioned Asus and Dell machines. The Scan's average delta E of 2.64 is better than the competition too, and the colour temperature of 6,687K is close to the 6,500K ideal. Its sRGB coverage level of 81.7 per cent is better than the Dell and almost on a par with the Asus, and its backlight only varied by 6.5 per cent – a superb figure.

The speakers are reasonable too, with a good mid-range and a high end that just avoids being tinny. There's not much volume, though, and bass is weak, which is no surprise on such a small machine. The middling battery life is no shock

either. The Scan lasted for around 80 minutes in a gaming test – miles behind the Dell. Make sure you pack the charger.

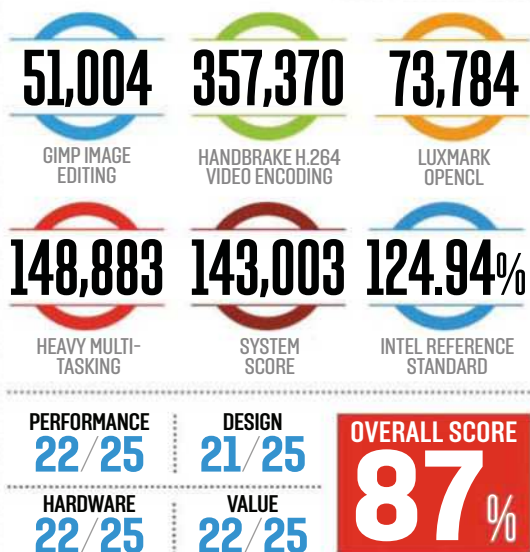
Conclusion

The 3XS LG15 Vengeance Pro is excellent. The Coffee Lake processor delivers a huge performance boost compared with Kaby Lake predecessors, and the CPU is bolstered by a fine SSD and 16GB of dual-channel memory. Meanwhile, the full-fat GTX 1060 outpaces Max-Q rivals and handles 1080p gaming without a struggle.

Scan has also crammed the components into a slim, light chassis with a great screen. It has a mechanical keyboard that's better than conventional hardware, and the warranty is excellent. Problems are minor. The battery is mediocre, the touchpad is a little soft and the speakers are weedy. Those are tiny issues, though, especially if you'll be mainly using your laptop plugged into the mains with a USB mouse and headset. The Scan is slimmer, lighter and faster than the competition, and it's priced reasonably too, meaning there's every reason to make it your next gaming laptop.

MIKE JENNINGS

CPC REALBENCH 2015



FALLOUT 4

1,920 x 1,080, Ultra Detail, TAA



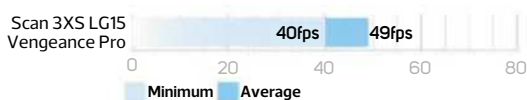
THE WITCHER 3: WILD HUNT

1,920 x 1,080, High Detail, Nvidia HairWorks off



DEUS EX: MANKIND DIVIDED

1,920 x 1,080, Very High detail, DX12



VERDICT

Great performance and an excellent screen in a chassis that's slim, light and sturdy.

27IN 5K MONITOR

Iiyama ProLite XB2779QQS / £744 inc VAT

SUPPLIER www.scan.co.uk



Apple's iMac has been quite the style icon over the years, and Iiyama's latest 27in monitor, the ProLite XB2779QQS, borrows a lot from the latest iMac design, including the glorious 5K resolution, its large black bezels and the silver strip along the bottom. It looks great, although those bezels mean it takes up more space than necessary - a three-sided borderless design would be preferable.

At £744 inc VAT, the XB2779QQS isn't exactly cheap either, but it comfortably undercuts its 5K competitors. Dell's UP2715K currently retails for just under a grand, while LG's UltraFine 5K Display comes in at a steep £1,179 inc VAT. The Iiyama also has a fully adjustable stand that allows for a full 360-degree rotation, offering pivot, tilt and height adjustment. Alternatively, there's a 100 x 100mm VESA mount if you want to mount it elsewhere.

The brightness of 500cd/m² is dazzling even in bright sunlight

The OSD is accessed through a set of touch-sensitive buttons at the bottom right-hand corner. These buttons aren't ideal, as they give no positive feedback and they're easy to tap by accident. Still, the OSD provides a good range of settings - the only notable missing

features are RGB gain and preset gamma profiles.

Around the back, you get two DisplayPort 1.4 inputs, each capable of supporting the full 5,120 x 2,880 resolution at 60Hz. That's neater than the Philips 275P4VYKEB, which needs dual-DisplayPort inputs to drive its native 5K resolution - just make sure your graphics card has a DisplayPort 1.4 output. In addition, three HDMI ports each support resolutions up to 3,840 x 2,160 at 60Hz. There's also a pair of built-in 2.5W speakers, which aren't exactly audiophile-quality but are fine for Windows notifications.

The Iiyama ProLite XB2779QQS is built around an 8-bit (6bit + Hi-FRC) IPS panel. The glossy front supposedly helps the contrast ratio and makes colours look more vibrant. However, it can result in unwanted glare in rooms with bright ambient light. That said, the XB2779QQS can easily outshine most reflections. Our X-Rite iDisplay Pro measured a maximum brightness of 500cd/m², which is dazzling even in a bright, sunlit room.

Colour coverage is very good too. The XB2779QQS reproduced 99 per cent of the sRGB gamut and 85 per cent of the Adobe RGB range. With a 1,196:1 contrast ratio, it all looks beautifully rich and vibrant. The panel does have one weakness, and that's colour accuracy. With an average delta E of 3.34, and a maximum of 6.22, you can't rely on the Iiyama for colour-critical photo or video workflows. To be clear, though, this colour accuracy won't be a concern if you chiefly intend on watching movies or playing games.

On that note, even though this monitor isn't aimed at gamers, its gaming performance is remarkably good. The panel's 4ms response time may not sound exceptional, but its perceived input lag is minimal, and it responds well with Overdrive set to +2, with minimal inverse ghosting. It's not 144Hz gaming, but the XB2779QQS works well. Also, not many graphics cards can pump out the full 5,120 x 2,880 pixels at 60Hz. Even our Nvidia GeForce GTX 1080 test card could only manage a 100fps frame rate at this resolution in Counter-Strike: Global Offensive with medium-to-low settings, and that's hardly a graphically intense game.

Conclusion

The ProLite XB2779QQS' poor colour accuracy makes it unsuitable for photo or video editors, but it's otherwise a great 5K monitor for the money. The design looks gorgeous, and overall performance is very impressive. If you're looking to dip a toe into the waters of 5K, the Iiyama is a bright, good-looking display for a surprisingly low price.

CHRISTOPHER MINASIAN

IMAGE 42/50	FEATURES 15/20	VALUE 23/30
OVERALL SCORE 80%		VERDICT A low price for a surprisingly capable and very bright 5K monitor, as long as you don't need it for colour-critical work.

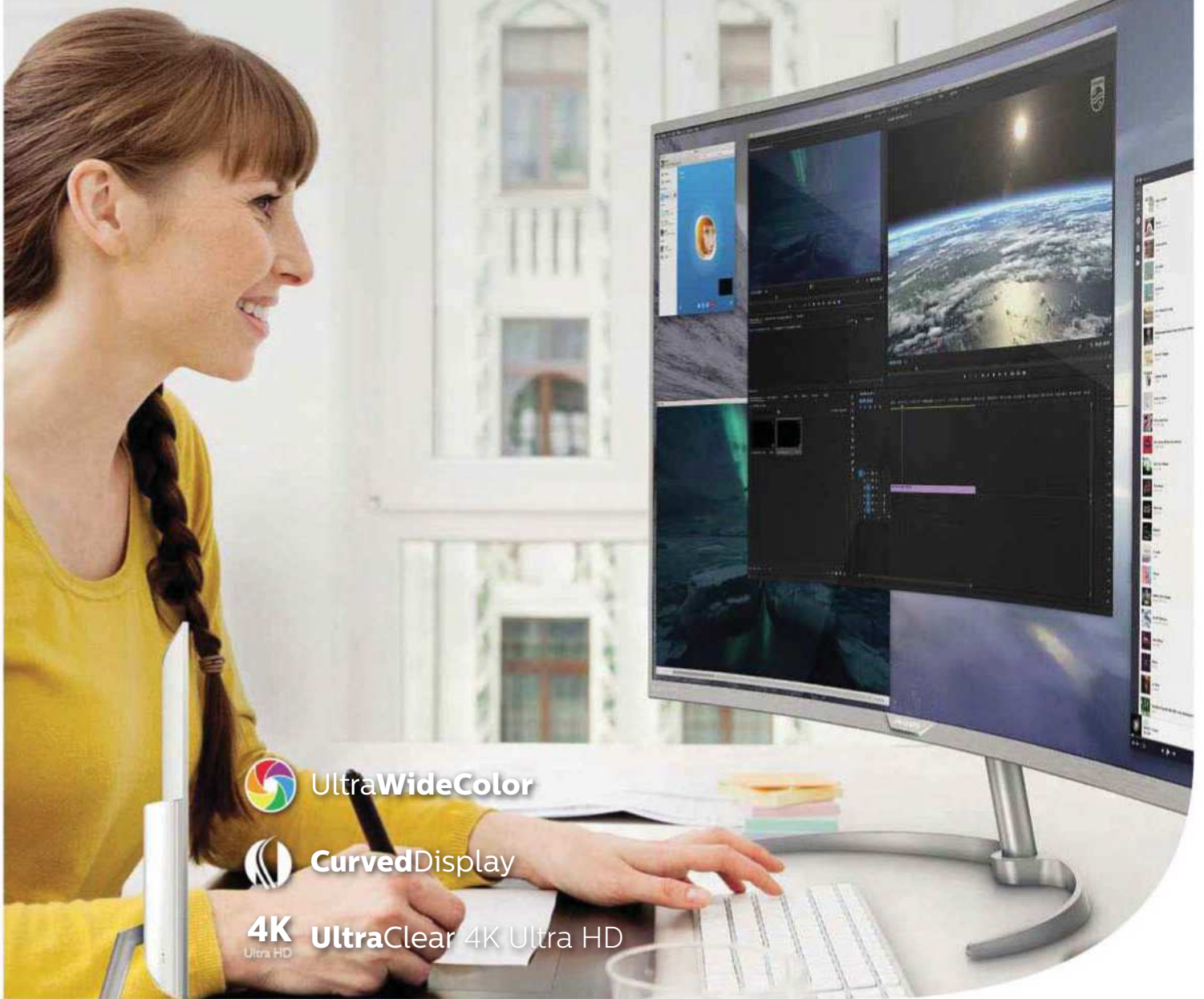


Ultra Wide-Color

with 4K in an immersive design


Colours like you've never seen before. This brilliant 4K UHD resolution display with Ultra Wide-Color offers the richest and most vivid colours wrapped in an immersive curved design for a your best creations yet.

innovation ✨ you



 UltraWideColor

 CurvedDisplay

 4K Ultra HD UltraClear 4K Ultra HD

40" 4K curved display
(BDM4037U)

MISCO
a Systemax Division
ebuyer.com

amazon.co.uk

BT Business Direct

PHILIPS

Custom Kit

Phil Hartup checks out the latest gadgets, gizmos and geek toys

ISelector 6 Way Outlet / £25.99 inc VAT

The ISelector attempts to cater for various tech power needs, with six plug sockets in two inwardly facing rows, and five USB charging ports out of the other end. It also offers surge protection and a maximum of 2.4A for each USB port, although the total current for all five USB ports used together is only 8A.

The net result, however, is a bit of a cable explosion, as all the wires attached to it are invariably sent off in one of three directions. Having the sockets so close together keeps the size of the ISelector down, but it also means bulkier transformer plugs will take the corresponding socket on the opposite side out of play. It's hard to recommend the ISelector for a conventional setup where you'd want to keep all your cables tidy and together, but it does offer a decent power hub if it's hidden away and you're aware of its limitations.



SUPPLIER www.amazon.co.uk



Fancii Personal USB Fan / £15.99 inc VAT

The Fancii Personal USB Fan is, as the name suggests, a USB fan. Or, to be exact, it's a double 80mm fan inside a cylinder, with plastic gratings at each end to prevent anything from poking inside it and getting whacked by the blades. There are two speed settings, which are accessed by pressing the speed control on the top. Weirdly, this control isn't a visible button – you just tap the casing – but it works well enough. Fancii claims the fan is 'whisper quiet', and at low speed, the fans are indeed quiet, but at the high setting, you can easily hear it over a standard air-cooled PC. Even so, it's a surprisingly capable USB desk fan if you just want to cool yourself at your desk.



SUPPLIER www.amazon.co.uk

Cmhoo XXL Gaming Mouse Pad / £8.99 inc VAT

A massive mousepad with a neat map of the world on it – what's not to like? The shape and size of the Cmhoo pad is good if you want your pad to cover your whole gaming area. You can put a keyboard on it and still have room for a mouse. Indeed, that's the best way to go with it; if you wanted to use it purely as a mouse pad for low-sensitivity gaming, you'd need a telescopic arm to reach the far end. The surface is made from fabric and fine for optical mice, and the underside has some grip to it – not much, but there's enough for it to stay put. It's big, comfy, costs under a tenner and, as mouse pad patterns go, a world map isn't the worst idea – it's a decent mouse pad if you want to cover a large area without spending too much cash.



SUPPLIER www.amazon.co.uk



Enhance GX-B1 Mouse Bungee / £17.79 inc VAT

Adding LEDs to a mouse bungee is one thing, but the Enhance GX-B1 goes all-in on the extra features and includes a four-port USB hub. On one level, it's not always a bad idea to have a few more USB 2 ports, as you never know when you might need one. However, on a more practical level, if your intention with a mouse bungee is to keep your mouse cable elevated and away from all the other wires and clutter on your desk, then maybe your bungee acting as a hub for extra wires isn't the best plan.

As a mouse bungee, the Enhance GX-B1 is decent enough, using a flexible rubbery arm that can be attached to any one of three points on the base, allowing some flexibility for how you use the USB ports. Visually, it looks like your standard neon blue cheesy tech gadget, but in its favour, you can also make it look a bit like a scorpion.



SUPPLIER www.amazon.co.uk



Urbanista Tokyo / £119 inc VAT

On initial inspection, the Urbanista Tokyo Bluetooth earphones feel like they get just about everything right. They're comfortable, the sound quality is good and they have a handy box to store them (and charge them), so they don't get lost. They even feature a rudimentary control interface – you tap the earphone to pause or play, which is more convenient than taking them out if somebody is talking to you.

There's a problem, though, and that's down to the limitations of the Tokyo's Bluetooth signal. If your phone is too far from the earphones, you get interference and a broken signal.

Your mileage may vary, but an HTC 10 in a trouser pocket couldn't reach the earphones in our tests.

If you have a use in mind that bypasses the range limit – for example, using them with a VR headset – they're great, but the Bluetooth flakiness is otherwise painful at this price.



SUPPLIER www.urbanista.com



HaWacha 7 Port USB 3.0 Hub / £69.99 inc VAT

The HaWacha is a very small, minimalist seven-port USB 3 hub. You get your ports, a power switch for each one and a little blue light to indicate if the switch is on or off. The data transfer speed is also what you'd expect for USB 3. However, there's no external power for the HaWacha, which means that all the gear you hook up to it is going to draw all its power from one USB port on your PC. This might not necessarily be a problem, depending on what you've connected to the hub, but it's going to be an issue if you want to charge multiple devices from it. For the massive price of the HaWacha, a mains power connection is a significant omission – you can buy a powered hub for half that price elsewhere.




SUPPLIER www.amazon.co.uk

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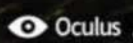
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How we test

PROCESSORS

INTEL LGA1151-V2

Intel LGA1151-V2 CPU + Asus ROG Strix Z370-E Gaming + 16GB Corsair Vengeance LED 3000MHz DDR4 + 480GB Crucial MX500 + Zotac GeForce GTX 1080 AMP! Edition

INTEL LGA2066

Intel LGA2066 CPU + Asus ROG Strix X299-E Gaming + 32GB Corsair Vengeance LED 3000MHz DDR4 + 256GB Crucial MX100 + Zotac GeForce GTX 1080 AMP! Edition

AMD AM4

AMD AM4 CPU + MSI X470 Gaming M7 AC + 16GB Corsair Vengeance LED 3000MHz DDR4 + 256GB Crucial MX100 + Zotac GeForce GTX 1080 AMP! Edition

AMD AM4 (APU)

AMD APU + MSI B350I Pro AC + 16GB Corsair Vengeance LED 3000MHz DDR4 + 256GB Crucial MX100 + Radeon RX Vega integrated GPU

AMD TR4

AMD TR4 CPU + Asus ROG Zenith Extreme + 32GB Corsair 3000MHz Vengeance LED DDR4 + 256GB Crucial MX100 + Zotac GeForce GTX 1080 AMP! Edition

TESTS: We use Custom PC RealBench 2015, Cinebench and Ashes of the Singularity: Escalation, installed on Windows 10 Home 64-bit, and record the power draw of the test PC. These tests cover a broad range of performance characteristics, including image editing, gaming, video encoding and 3D rendering. We run all tests at stock speed and at the CPU's highest overclocked frequency.

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.

4.4GHz Intel Core i5-6600K + 16GB Corsair Vengeance LED 3000MHz DDR4 + Asus Maximus VIII Hero + Windows 10 64-bit + The graphics card we're reviewing = SCORES

CUSTOM PC REALBENCH 2015

INTEL REFERENCE



Intel Core i7-4790K 16GB of Corsair 2400MHz DDR3 240GB OCZ 150 Asus Maximus Gene VII Nvidia GeForce GTX 780 3GB =100%

AMD REFERENCE



AMD A10-7850K 8GB of Corsair 2133MHz DDR3 256GB Plextor M5 Pro Asus A88X-Pro =100%

Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

MOTHERBOARDS

INTEL LGA1151-V2



Intel Core i7-8700K Motherboard on test 16GB Corsair Vengeance LED 3000MHz DDR4 500GB Samsung SSD 960 Evo Zotac GeForce GTX 1080 AMP! Edition

INTEL LGA2066



Intel Core i9-7900X Motherboard on test 32GB Corsair Vengeance LED 3000MHz DDR4 256GB Crucial MX100 SSD 500GB Samsung SSD 960 Evo 2 x Asus Strix Radeon RX 480 8GB

AMD AM4



AMD Ryzen 7 2700X Motherboard on test 16GB Corsair Vengeance LED 3000MHz DDR4 500GB Samsung SSD 960 Evo Zotac GeForce GTX 1080 AMP! Edition

AMD TR4



AMD Threadripper 1920X Motherboard on test 32GB Corsair 3000MHz Vengeance LED DDR4 500GB Samsung SSD 960 Evo 2 x Asus Strix Radeon RX 480 8GB

TESTS: We use Custom PC RealBench 2015 and Ashes of the Singularity installed on Windows 10 Home 64-bit, and also test the board's SATA and M.2 ports. We try to overclock every motherboard by overclocking our test CPU to its maximum air-cooled level.

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overkill earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test Deus Ex: Mankind Divided, Doom, Crysis 3, Fallout 4 and The Witcher 3: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.

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LABS TEST

X470 motherboards

Antony Leather takes a look at six of the latest Socket AM4 motherboards with X470 chipset motherboards, in search of the best foundations for AMD's 2nd Gen Ryzen CPUs

Contents

Asus ROG Crosshair VII Hero /p45	Gigabyte X470 Aorus Gaming 7 WiFi /p47	MSI X470 Gaming M7 AC /p49
Asus TUF X470-Plus Gaming /p46	Gigabyte X470 Aorus Ultra Gaming /p48	MSI X470 Gaming Pro Carbon AC /p50
Results graphs /p51		

How we test

To make the most of AMD's 2nd Gen Ryzen CPUs you'll need a motherboard with AMD's new X470 chipset. While ATX boards make up most of the X470 line-up at launch, smaller models will soon be available. Of course, the rest of AMD's 2nd Gen Ryzen CPUs and low-end chipsets will also be released soon, but in the meantime we've tested six ATX X470 boards, with prices ranging from £130 and £250 inc VAT, to see which ones are worth your cash.

Our test kit includes 16GB of 3000MHz Corsair Vengeance LED DDR4 RAM, a 512GB Crucial MX100 SSD with Windows 10 installed, a Cooler Master ML120L RGB all-in-one liquid cooler and a Zotac GeForce GTX 1080 AMP! Edition graphics card.

We also use a Samsung 960 Evo SSDs to gauge performance for the M.2 ports and we tap into the SSD's internal temperature sensor to see how well any M.2 heatsinks perform under load, via back-to-back runs of CrystalDiskMark's entire battery of tests.

We use RightMark's Audio Analyzer software to measure the dynamic range, noise level and total harmonic distortion of the on-board audio.

Other tests include our RealBench suite of benchmarks to gauge application performance, and Ashes of the Singularity: Escalation for gaming performance. Finally, we measure total system power consumption when idle at the Windows desktop, and at load running Prime95's smallfft test.

Asus ROG Crosshair VII Hero WiFi / £250 inc VAT

SUPPLIER www.box.co.uk

A little over a year ago, we were battling with some gremlins with various X370 boards, one of which was the Asus Crosshair VI Hero, until Asus released a spate of EFIs (as did other manufacturers) to improve memory support and stability. Fast forward to 2018, though, and its successor, the ROG Crosshair VII Hero WiFi, is solid as a rock and bristling with features too. You'd expect nothing less, though, as it costs a whopping £250 inc VAT.

Providing plenty of power to AMD's new Ryzen CPUs is a key focus, with a lot of boards on test this month and the ROG Crosshair VII Hero WiFi has two huge heatpipe-linked VRM heatsinks, a 10+2 power phase design and an additional 4-pin power connector for the CPU too. The primary M.2 slot also sports a heatsink and, unlike many other boards on test, this heatsink can be swapped to the lower slot. The upper M.2 slot isn't placed under the graphics card either.

The M.2 SSD delta T of 29°C was the second lowest on test, only sitting behind the monstrous dual heatsink of the MSI X470 Gaming M7 AC (see p49).

Also, while the other boards on test are limited to two PCI-E lanes on one M.2 slot, the ROG Crosshair VII Hero WiFi can provide four PCI-E lanes on either slot. Using a PCI-E NVMe SSD in the lower slot will see the primary 16x PCI-E slot reduced to eight lanes, but this doesn't usually result in noticeable performance drops. You get the full complement of overclocking and testing tools and a trio of USB 3.1 ports too, comprising Type-A and Type-C ports on the I/O panel, and a Type-C header on the PCB for compatible cases.

Asus includes a pair of 4-pin standard RGB LED headers, as well as two 3-pin 5V addressable RGB LED headers, and there's plenty of RGB lighting on the board itself too. There's a total of nine fan headers, three of which are handily located next to the CPU socket, catering for pumps and coolers with two fans.

This board's integrated I/O shield looks great too, while also making board installation easier. The rear panel sports USB BIOS flashback and clear-CMOS buttons as well as an Intel-powered LAN port, 802.11ac Wi-Fi



You get the full complement of overclocking and testing tools

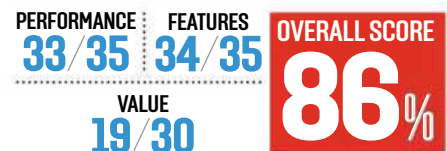
aerial ports and a total of 11 Type-A USB ports, nine of which support USB 3 or faster.

The ROG Crosshair VII Hero WiFi was a little slow at stock speed, but it was quicker once we'd overclocked our Ryzen 7 2700X. The EFI is excellent, although one niggle is that the ability to change a fan's temperature source isn't located in the main fan control section like other boards – that's our only criticism though. Using a vcore of 1.425V, the board reached the second highest frequency on test of 4.275GHz. This overclock saw the system score rise from 196,624 to 206,864, and the Crosshair had the best audio on test too, with a dynamic range of 113.1dBA and noise level of -113.6dBA.

Conclusion

Asus has nailed the Crosshair this time, producing a superb motherboard for AMD's Ryzen CPUs. It has one of the biggest feature sets on test, it overclocks well, it looks great and its EFI is comprehensive. Its only problem is its price in this highly competitive field. The

Gigabyte X470 Aorus Gaming 7 WiFi's better looks, similar features and £30 lower price make it the better buy, but only just.



VERDICT

Great looks and overclocking abilities, plus a huge feature set, make the Crosshair a cracking AM4 motherboard. It's just a little overpriced.

SPECIFICATIONS

Chipset AMD X470

CPU socket AMD Socket AM4

Memory support 4 slots: max 64GB DDR4 (up to 3600MHz)

Expansion slots Two 16x PCI-E 3, one 16x PCI-E 2, two 1x PCI-E 3

Sound 8-channel Realtek ALC1220

Networking Intel Gigabit LAN, 802.11ac Wi-Fi

Overclocking Base clock adjustment, max CPU multiplier 64x; max voltages: CPU 1.7V, RAM 2.15V

Ports 6 x SATA 6Gbps (X470), 2 x M.2, 1 x USB 3.1 Type-A, 1 x USB 3.1 Gen 2 Type-C, 8 x USB 3, 2 x USB 2, 1 x LAN, 5 x surround audio out, S/PDIF out

Dimensions (mm) 305 x 244

Asus TUF X470-Plus Gaming / £135 inc VAT

SUPPLIER www.cclonline.com

There are plenty of premium X470 boards around already but, as Asus and Gigabyte have shown this month, you can already pick up one for under £140 inc VAT too. The TUF X470-Plus Gaming is part of Asus' aim to reinvent the TUF brand, which used to include the likes of the Sabertooth and Gryphon series, but now focuses on the lower end of the market, albeit still with its own aesthetic flare.

The TUF X470-Plus Gaming feels noticeably lighter than the ROG Crosshair VII Hero, which might partly be down to the small cut-out in its PCB. This notch takes a leaf out of the ROG Maximus IX Apex's design book, but it looks snazzy, as does the subtle yellow lighting, and black and silver colour scheme. Asus also includes an I/O shroud that does a fantastic job of hiding those unsightly ports.

The price tag affects several areas, though, such as the CPU power circuitry, which has just six phases and two rather small heatsinks, both of which are trumped by the similarly priced Gigabyte X470 Aorus Ultra Gaming. It also lacks an additional CPU power connector, has no M.2 heatsinks, lacks a USB 3.1 Type-C header and its Type-C port is limited to USB 3 speeds too.

The TUF is also the only board on test to drop from Realtek's ALC 1220 audio codec to the less capable ALC 887, which sees the number of audio outputs drop to three on the rear I/O panel too. Meanwhile, the lack of an M.2 heatsink saw our Samsung 960 Evo SSD run 13°C warmer than the next best-performing board on test. On the plus side, while the second M.2 slot is limited to two PCI-E lanes, both M.2 slots can cater for SATA M.2 SSDs.

At stock speed, the TUF X470-Plus Gaming performed similarly to the rest of the field and even managed the second highest system score on test at 204,411. The lack of an SSD heatsink didn't seem to hinder the M.2 speed tests either, with read and write speeds of 3,377MB/sec and 1,871MB/sec respectively.

Being an Asus board, you also get all the usual extensive software perks and an excellent EFI, although one snag is that vcore adjustment is limited to offset figures up to 0.5V – you couldn't input a specific voltage, which made tweaking tricky.



The TUF is the only board on test to drop the audio codec to the less capable ALC 88

We managed to hit a top clock speed of 4.25GHz with our Ryzen 7 2700X CPU using a vcore of 1.425V, which matched some of the other boards on test, although a couple of boards hit higher frequencies using the same voltage. However, the system drew a massive 298W when overclocked, compared to just 268W for the ROG Crosshair VII Hero.

That said, the Gigabyte X470 Aorus Ultra Gaming drew more power still. Finally, the audio performance was, not surprisingly, poor compared with the rest of the field, with a dynamic range of 91.6dBA compared to 110dBA for the Gigabyte X470 Aorus Ultra Gaming.

Conclusion

You expect some sacrifices as you dip down below £150, and in many ways the TUF X470-Plus Gaming is a solid offering, with a great EFI and software package. However, it costs around £20 too much given that Gigabyte's X470 Aorus Ultra Gaming costs less money,

while still offering a stronger set of features and better audio performance. If you're after an X470 board with a tight budget, the Gigabyte is a better option.

PERFORMANCE	FEATURES	OVERALL SCORE
30/35	22/35	78%
VALUE		
26/30		

VERDICT

Cheap but not particularly cheerful in one or two areas, while the competition costs less and offers more.

/ SPECIFICATIONS

Chipset AMD X470

CPU socket AMD Socket AM4

Memory support 4 slots: max 64GB DDR4 (up to 3200MHz)

Expansion slots One 16x PCI-E 3, one 16x PCI-E 2, three 1x PCI-E 2

Sound 8-channel Realtek ALC 887

Networking Realtek Gigabit LAN

Overclocking No base clock adjustment; max CPU multiplier 64x; max voltages: CPU +0.5V, RAM 1.8V

Ports 6 x SATA 6Gbps (X470), 2 x M.2, 1 x HDMI, 1 x USB 3.1 Type-A, 1 x USB 3.1 Gen 2 Type-C, 2 x USB 3, 2 x USB 2, 1 x LAN, 3 x surround audio out

Dimensions (mm) 305 x 244

Gigabyte X470 Aorus Gaming 7 WiFi / £220 inc VAT

SUPPLIER www.novatech.co.uk

Of the three boards topping £200 this month, the X470 Aorus Gaming 7 WiFi is easily the best-looking. A lot of this aesthetic prowess comes down to the elaborate heatsinks for its extensive 12-phase power circuitry, ten of which are for the CPU vcore. Instead of being solid, the heatsinks comprise over 100 aluminium fins, which Gigabyte claims drops temperatures by up to 40 per cent compared with a solid heatsink. These fins are backed up by a heatpipe that makes direct contact with the hot spots on the PCB too.

The lighting, as we've come to expect from Gigabyte, is also the most extensive of any board on test. Practically every area is illuminated, including the PCI-E slots, DIMM slots and PCH heatsink. Gigabyte also now includes an illuminated strip in the I/O shroud, which has several individually controllable RGB LEDs that allow you to create rainbow and other effects. There are also headers for digital, RGBW and standard 4-pin RGB LED strips, with one of the latter located next to the CPU socket to control lighting on compatible coolers. Another aesthetic addition is an integrated I/O shield, which also saves your fingers from being mashed during installation.

There are eight 4-pin fan headers, each of which supports fans or pumps, providing a maximum output of 24W per connector. Gigabyte's fan control section in the EFI is excellent too, and provides the means to switch off fans at certain temperatures and switch the temperature input from the CPU to other areas on the motherboard, including two integrated ports for external temperature sensors or coolant probes. The rest of the EFI is a little clunky though.

The cooling-focused feature set continues with the M.2 ports – the Gigabyte is one of just two boards on test with heatsinks for both M.2 ports. Only the upper slot supports SATA M.2 SSDs, but the lower slot can offer the full four lanes of PCI-E 3 bandwidth should you wish to use both SATA and PCI-E M.2 SSDs to cut down on cable clutter.

The X470 Aorus Gaming 7 WiFi also includes a dual-BIOS system, with switches to toggle between them, while the only button it's missing is a reset button, with power and clear-CMOS buttons located on the rear I/O panel.

There are six USB 3 ports too, two of which offer USB audio DAC enhancements such as adjustable voltage, plus there are USB 3.1



The Gigabyte is one of just two boards on test with heatsinks for both M.2 ports

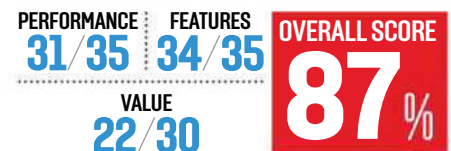
Type-A and Type-C ports, and a Type-C header on the PCB.

At stock speed, the Gaming 7 WiFi came fourth overall in our RealBench suite, but once we overlocked it to 4.25GHz, which was the maximum stable clock at 1.425V, it managed the best result of 208,148, despite not having the highest overclock. It did draw noticeably more power than both MSI boards at stock and when overlocked though. Meanwhile, audio performance was excellent and in line with other Realtek ALC 1220 codec results, and the M.2 SSD temperature was 13°C cooler with the included heatsinks attached.

Conclusion

The X470 Aorus Gaming 7 WiFi wasn't the best overclocker on test and didn't top all the performance graphs, but it looks fantastic, has an equally impressive set of features and costs less than the Asus ROG Crosshair VII Hero, despite offering a similar feature set. The latter is a worthy alternative if you'll be spending a lot of time in the EFI, while MSI's

X470 Gaming Pro Carbon AC costs £60 less and includes many, but not all, the same features. Overall, though, the X470 Aorus Gaming 7 WiFi offers the best balance of performance, features and value on test.



VERDICT

Amazing aesthetics and all the features you need to build a high-end Ryzen system, and at a reasonable price too.

SPECIFICATIONS

Chipset AMD X470
CPU socket AMD Socket AM4
Memory support 4 slots: max 64GB DDR4 (up to 3600MHz)
Expansion slots Two 16x PCI-E 3, one 16x PCI-E 2, two 1x PCI-E 2
Sound 8-channel Realtek 1220
Networking Intel Gigabit LAN, 802.11ac Wi-Fi
Overclocking Base clock overlocking, max CPU multiplier 63x; max voltages: CPU 1.7V, RAM 2V
Ports 4x SATA 6Gbps (X470), 2x M.2, 6x USB 3, 2x USB 2, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 1x LAN, 3x surround audio out
Dimensions (mm) 305 x 244

Gigabyte X470 Aorus Ultra Gaming / **£129** inc VATSUPPLIER www.box.co.uk

As the cheapest X470-chipset motherboard on test, and costing nearly half the price of the Asus ROG Crosshair VII Hero (see p45), you might expect the Gigabyte X470 Aorus Ultra Gaming to come with a bare PCB and a drastically trimmed feature set. However, it's a refreshingly solid board that covers all the essentials, despite its low price tag. You get an 11-phase power design, some reasonable-sized heatsinks and even an M.2 heatsink, although the latter can only be fitted to the top M.2 slot.

The audio circuitry and PCH heatsink also sport RGB lighting, plus you get 3-pin digital, 4-pin standard and 5-pin RGBW LED headers on the board. There's an impressive count of eight 4-pin fan headers too, all of which sport the same hybrid design as the Ultra Gaming's bigger sibling, the X470 Aorus Gaming 7 WiFi (see p47), supporting fans or pumps and dishing out up to 24W of power on each connector.

Unlike the Asus TUF X470-Plus Gaming (see p46), the X470 Aorus Ultra Gaming also includes full-fat Realtek ALC 1220 audio, and Gigabyte includes its twin USB DAC ports that can compensate for voltage drop (although this feature's usefulness is debatable). There's no on-board Wi-Fi, but Gigabyte has opted for an Intel-controlled Gigabit LAN port. Plus, courtesy of an ASMedia USB 3.1 Gen 2 controller and the X470 chipset, you also get USB 3.1 Type-A and Type-C ports, plus a Type-C header on the PCB for compatible cases. This brings the total of USB 3 or faster Type-A ports on the I/O panel to five, with two USB 2 ports included as well.

As we found with the X470 Aorus Gaming 7 WiFi, the EFI is a little dated-feeling compared with Asus and MSI's efforts. Also, like the Asus TUF X470-Plus Gaming, you can't input a specific CPU voltage – instead, you can only input an offset amount up to +0.3V, which can make overclocking a little trickier.

We managed to overclock our Ryzen 7 2700X to 4.25GHz using a 1.425V vcore within a few minutes though – the Ultra Gaming will let you get a decent overclock, even if it's not particularly flexible. That said, for serious overclocking sessions where you want to squeeze out every last inch of performance, we would instead opt for MSI's X470 Gaming Pro Carbon AC, which costs just £30 more.



There's an impressive count of eight 4-pin fan headers

The system score rose from 201,613 to 206,878 after overclocking, which was in line with other boards on test, and the audio performance was on a par with the more expensive boards too, which is a great result for a board costing under £130. However, our system did post the highest stock speed load power draw with the X470 Aorus Ultra Gaming installed at 221W, rising to a massive 305W when overclocked. Not surprisingly, the M.2 temperature was exactly the same under load as the X470 Aorus Gaming 7 WiFi, which has a similar heatsink, but this temperature was 13°C cooler than the heatsink-less Asus TUF X470-Plus Gaming managed.

Conclusion

It might lack the advanced power circuitry and extra features of the more expensive boards on test, but the Gigabyte X470 Aorus Ultra Gaming offers a solid base for a budget-conscious AM4 system. We'd recommend stepping up to MSI's X470 Gaming Pro Carbon AC if overclocking is a top priority, though, and the MSI has a better EFI too. However, the X470 Aorus Ultra Gaming has

particularly strong storage, audio and cooling credentials for the cash. If you only have around £130 to spend, it's a great buy.

PERFORMANCE	FEATURES	OVERALL SCORE
31/35	24/35	84%
VALUE	29/30	

VERDICT

A surprisingly well-featured board for the money, offering decent performance, great audio and a solid base for a budget-conscious AM4 system.

/ SPECIFICATIONS

Chipset AMD X470
CPU socket AMD Socket AM4
Memory support 4 slots: max 64GB DDR4 (up to 3200MHz)
Expansion slots Two 16x PCI-E 3, one 16x PCI-E 2, two 1x PCI-E 2
Sound 8-channel Realtek ALC 1220
Networking Intel Gigabit LAN
Overclocking Base clock overlocking, max CPU multiplier 63x; max voltages: CPU 1.7V, RAM 2V
Ports 6 x SATA 6Gbps (X470), 2 x M.2, 1 x HDMI, 4 x USB 3, 4 x USB 2, 1 x USB 3.1 Type-A, 1 x USB 3.1 Type-C, 1 x LAN, 3 x surround audio out
Dimensions (mm) 305 x 244

MSI X470 Gaming M7 AC / £215 inc VAT

SUPPLIER www.ebuyer.com

If you're worried about your M.2 SSD overheating, then you'll like the huge, weapon-like dual heatsink that occupies half the PCB of the MSI X470 Gaming M7 AC. This monstrous lump of metal flips out on a sprung hinge that's separate to the PCH heatsink, and is the largest M.2 heatsink on test. Unfortunately, you can't run both M.2 slots at 4x PCI-E 3 speed, though, with the lower slot's PCI-E 2 interface limiting it to around 1,600MB/sec instead of the speeds of over 3,000MB/sec you can see from many modern M.2 SSDs.

Thankfully, it's also compatible with SATA M.2 SSDs, so you could use one large SATA M.2 SSD for storage and a smaller PCI-E SSD in the top slot for your operating system and games.

The heatsink made a massive difference to temperatures too, with the M.2 delta T dropping to just 19°C, which is a whole 10°C lower than the next best result obtained by the Asus ROG Crosshair VII Hero (see p45).

MSI has gone into overkill mode with the power circuitry too, with the board sporting a 14+2 power phase design and two 8-pin CPU power connectors, plus a pair of large heatsinks. The PCB itself, meanwhile, is colour-neutral, with a mix of black, grey and chrome; only the I/O shroud has any kind of RGB lighting on the top side.

The rest of the lighting comprises a row of individually controllable RGB LEDs under the 24-pin ATX connector, while you also get a pair of 4-pin RGB LED headers and a 3-pin addressable RGB LED header. This lighting setup isn't quite as lavish as that of the flagship Asus and Gigabyte boards on test, but it's enough to kit out a large case with RGB lighting. It also includes a connector that's compatible with Corsair's RGB fan hub, allowing control of up to six Corsair RGB fans.

You get the full complement of overclocking and testing tools too, with power, reset and clear-CMOS buttons included, plus an LED POST code display and a USB BIOS flashback button on the rear I/O panel.

The number of fan headers is reasonable at six as well, although other boards on test this month include more headers, and Gigabyte's fan control is much more powerful, with the ability to select from a range of temperature inputs to control the fans, plus the ability to



The M.2 heatsink made a massive difference to temperatures

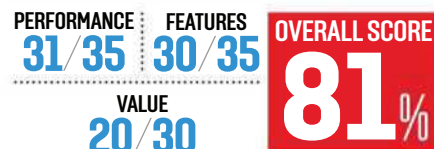
turn off fans under certain temperatures. The board lacks USB and SATA ports compared with other boards on test as well, with its sibling, the X470 Gaming Pro Carbon AC including two more SATA ports, while both the Asus ROG Crosshair VII Hero and Gigabyte X470 Aorus Gaming 7 WiFi have more USB ports. That said, you're unlikely to need more than six SATA ports these days anyway.

We can't fault the board's power circuitry, though, with supremely low load draws at stock and overclocked speeds. However, the MSI couldn't match the 4.3GHz maximum clock speed of the MSI X470 Gaming Pro Carbon AC, instead settling for 4.25GHz at the same 1.425V vcore, which saw the system score rise from 197,335 to 206,765.

Conclusion

The MSI X470 Gaming M7 AC has some tempting credentials for hardcore overclockers, plus a solid set of features and excellent power circuitry. However, Gigabyte's X470 Aorus Gaming 7 WiFi offers more features for just £5 more. Meanwhile, MSI's own X470 Gaming Pro Carbon AC overclocks

further, has more SATA ports and a much lower price tag, making it the better-value MSI board on test.



VERDICT

A great M.2 heatsink and an all-round decent board, but it can't quite compete with the Gigabyte X470 Aorus Gaming 7 in this price league.

SPECIFICATIONS

Chipset AMD X470
CPU socket AMD Socket AM4
Memory support 4 slots: max 64GB DDR4 (up to 3600MHz)
Expansion slots Two 16x PCI-E 3, one 16x PCI-E 2, three 1x PCI-E 2
Sound 8-channel Realtek ALC 1220
Networking Killer Gigabit LAN, 802.11ac Wi-Fi
Overclocking Base clock overclocking, max CPU multiplier 63x; max voltages: CPU 2V, RAM 2V
Ports 6 x SATA 6Gbps (X470), 2 x M.2, 4 x USB 3, 4 x USB 2, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 1x LAN, 3 x surround audio out
Dimensions (mm) 305 x 244

MSI X470 Gaming Pro Carbon AC / £160 inc VAT

SUPPLIER www.box.co.uk

The MSI X470 Gaming Pro Carbon AC has a fairly sizeable price league to itself this month, sitting between the two budget boards on test and the trio of £200+ premium offerings. However, it includes the best elements of many boards this month, and in the unlikely event that six SATA ports aren't enough for you then the X470 Gaming Pro Carbon AC includes eight of them, trumping all the other boards on test.

The board includes an 8+4 power phase design, which is one phase more than its predecessor. There's a pair of 8-pin CPU power connectors too, so the X470 Gaming Pro Carbon AC clearly means business when it comes to overclocking. Like the X470 Gaming M7 AC, it has a colour-neutral PCB, so adding some RGB lighting flare to colour-match the board to your case will be easy. The PCH heatsink, I/O shroud and underside of the right edge of PCB all sport different RGB lighting zones, plus you get standard 4-pin and addressable 3-pin RGB LED headers on the PCB.

The Carbon AC also gets one up on the two cheaper boards on test by including a clear-CMOS button, although it lacks any other overclocking and testing tools, such as power or reset buttons, which all three more expensive boards offer to some degree. It also misses out on a USB 3.1 Type-C header, although you do get Type-A and Type-C USB 3.1 ports on the rear I/O panel.

There's a useful count of seven Type-A ports in total, four of which are USB 3, while the rear I/O panel also plays host to display outputs for AMD's APUs such as the Ryzen 5 2400G. You also get on-board 802.11ac Wi-Fi, which is lacking on the two cheaper boards, although the Gigabyte X470 Aorus Ultra Gaming has a few more fan headers.

Only the lower M.2 slot supports SATA SSDs, but the top M.2 slot offers the full 4x PCI-E 3 bandwidth, and you get a heatsink, bringing our SSD delta T down to 33°C under load. That's was a match for the two Gigabyte boards, and 14°C cooler than using no heatsink, although the massive heatsink on the MSI X470 Gaming M7 AC performed better.



It overclocked further than all the pricier boards on test

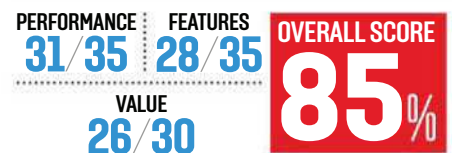
Despite being the third cheapest board on test, the Gaming Pro Carbon AC managed to push our Ryzen 7 2700X all the way to 4.3GHz using our usual vcore of 1.425V, which is the best result we've seen so far from an X470 board. This tweak helped the MSI to hit the highest Cinebench score and second highest image editing score on test, although other boards matched or beat it in other tests. Audio and storage results were on par with the rest of the field too, and despite having the highest overclock, the board drew the least power under load too.

Conclusion

The MSI X470 Gaming Pro Carbon AC deserves an award this month thanks to its solid set of features and the fact that, despite its low price, it managed to overclock further than all three of the most expensive boards on test, though not by much.

The Gigabyte X470 Aorus Gaming 7 Wi-Fi is still the best option this month, and the Gigabyte X470 Aorus Ultra Gaming offers the best value for money. However, if you want

Wi-Fi, good overclocking performance a great EFI and a solid set of features, but don't have £200 to spend, the X470 Gaming Pro Carbon AC is a great choice.



VERDICT

A good balance of price and features with excellent overclocking performance.

SPECIFICATIONS

Chipset AMD X470

CPU socket AMD Socket AM4

Memory support 4 slots: max 64GB DDR4 (up to 3600MHz)

Expansion slots Two 16x PCI-E 3, one 16x PCI-E 2, two 1x PCI-E 2

Sound 8-channel Realtek ALC 1220

Networking Intel Gigabit LAN, 802.11ac Wi-Fi

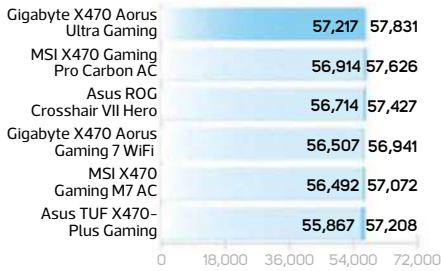
Overclocking No base clock overclocking, max CPU multiplier 64x; max voltages: CPU 1.7V; RAM 2V

Ports 8 x SATA 6Gbps (X470), 2 x M.2, 1 x DisplayPort, 1 x HDMI, 4 x USB 3, 2 x USB 2, 1 x USB 3.1 Type-A, 1 x USB 3.1 Type-C, 1 x LAN, 3 x surround audio out

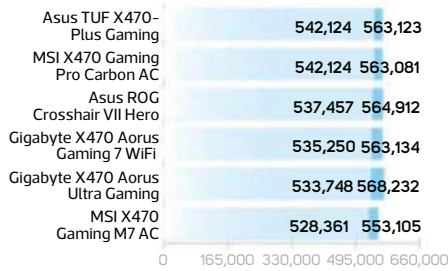
Dimensions (mm) 305 x 244

CPC REALBENCH 2015

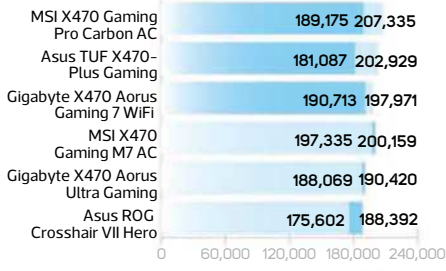
Gimp image editing



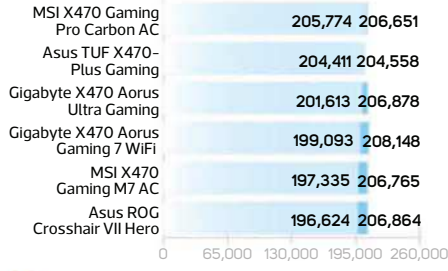
Handbrake H.264 video encoding



Heavy multi-tasking

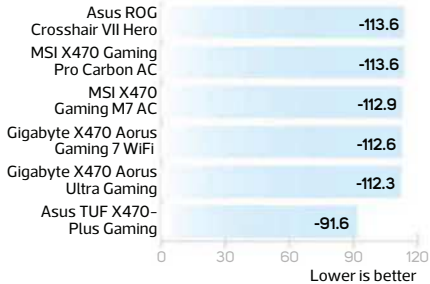


System score



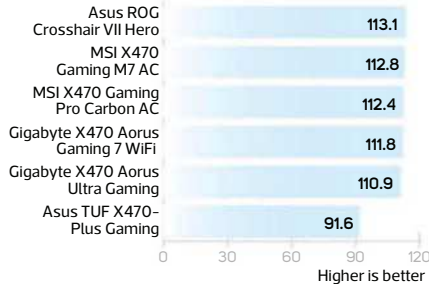
NOISE LEVEL (DBA)

RightMark Audio Analyzer 24-bit, 192KHz



DYNAMIC RANGE (DBA)

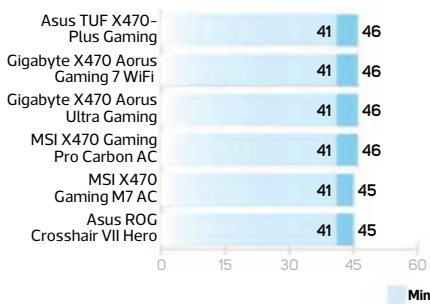
RightMark Audio Analyzer 24-bit, 192KHz



STOCK SPEED

ASHES OF THE SINGULARITY (FPS)

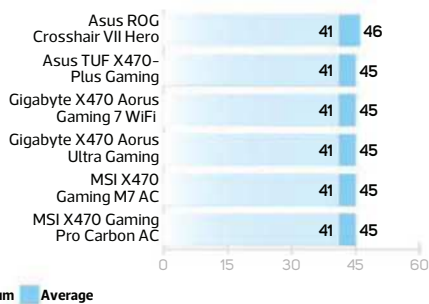
DX12 CPU Benchmark, 1,920 x 1,080, High settings



OVERCLOCKED SPEED

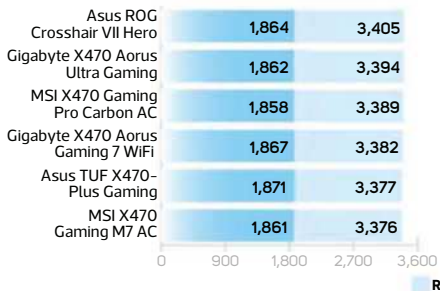
ASHES OF THE SINGULARITY (FPS)

DX12 CPU Benchmark, 1,920 x 1,080, High settings



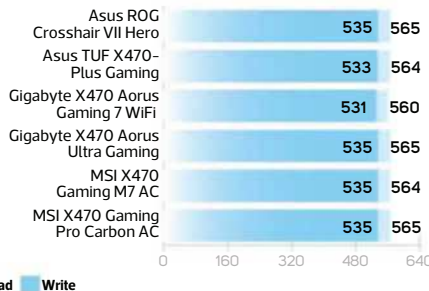
M.2 SPEED (MB/SEC)

CrysalDiskMark 32-queue depth



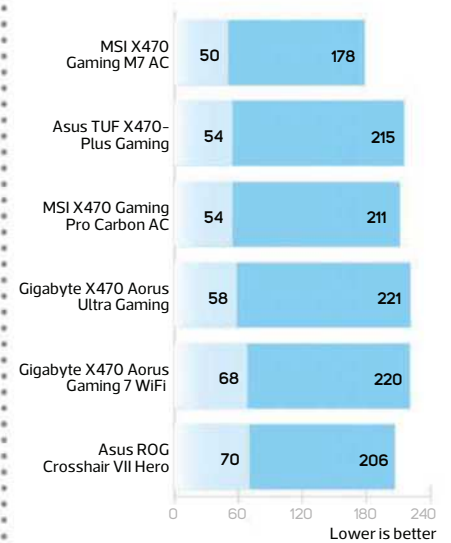
SATA 6GBPS SPEED (MB/SEC)

CrysalDiskMark 32-queue depth



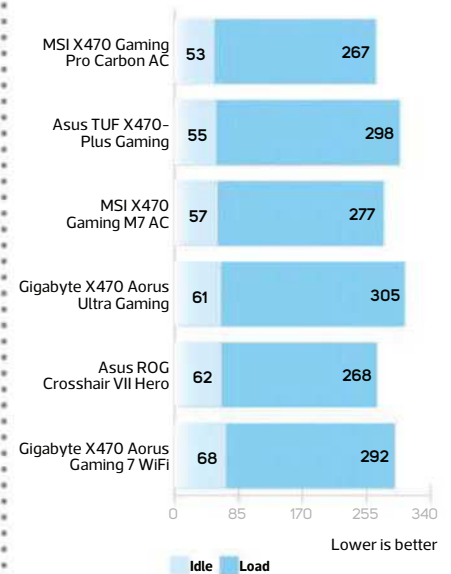
STOCK SPEED POWER CONSUMPTION (WATTS)

Windows Desktop / Prime95 smallfft

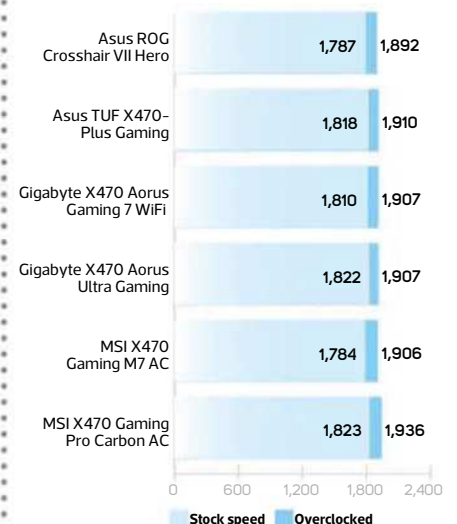


OVERCLOCKED POWER CONSUMPTION (WATTS)

Windows Desktop / Prime95 smallfft



CINEBENCH R15



Smart speakers

A voice-operated, digital home assistant is no longer the stuff of science-fiction, and it's no fad either. Darien Graham-Smith fully tests and interrogates nine speakers to help you choose the best digital companion

Contents

Amazon Echo / p53	Kitsound Voice 1 / p55	Libratone Zipp / Zipp Mini / p58
Amazon Echo Show / p54	Apple HomePod / p56	Sonos One / p58
JBL Link 20 / p54	Google Home / p57	Zolo Halo / p59

How we test

We consider a range of factors when reviewing smart speakers, including the general capabilities of the voice assistant, the specific design features, and the convenience and ergonomics of any physical controls.

Sound quality is also an important factor. We assess it by listening carefully to a variety of standard tracks on each unit – in both mono and stereo where supported –

paying attention to the depth, balance and overall tone of the sound, at both moderate listening volume and maximum volume. Multiple listeners were involved in this subjective test, with us accounting for personal impressions of each speaker's handling of classical and modern music at a typical indoor listening volume.

We also measure the maximum sound output of each speaker while playing a

standard piece of music, using a calibrated sound meter app on an iPad located 1m from the front of the speaker. While this gives you a guide to the relative volumes of different speaker models, be aware that tonal balance plays a big part too: a device with a deep bass response can create a bigger, more immersive sound than a little tinny speaker, even if both of them pump out the same nominal sound pressure.

Amazon Echo / £90 incVAT

SUPPLIER www.amazon.co.uk

The Amazon Echo is the undisputed king of the smart speaker market. When a third party wants to add voice control to a smart gadget, the sheer weight of numbers behind Alexa means the Echo is often the first platform considered. A huge range of household devices can connect to Alexa, from routers to cameras, phones and thermostats, allowing you to control them by barking commands from your sofa.

You can ask Alexa for news headlines, local weather reports and traffic warnings. You can check your calendar and set reminders. You can make two-way, hands-free voice calls to friends' Echo devices, or to other units in your home. You can, of course, stream playlists, radio stations and audiobooks over the Internet, and even order items from Amazon with a single command (although you'll need to confirm the purchase on your phone). You can also use Alexa to interact with a huge variety of online services, from Fitbit to Uber, using either installable 'skills' or freely available IFTTT applets.

It all works startlingly well, although the sound quality on this smaller, second-generation model is closer to a portable radio than a hi-fi system. There's a decent amount of bass, and it's surprisingly loud, hitting 78dBA at maximum volume. There's no snap or sparkle to higher frequencies, though, and it's only mono, all of which makes for a slightly flat, boxy sound. It certainly doesn't have the clarity and headroom of the Apple HomePod.

Still, a 3.5mm audio output socket lets you connect the Echo to a standalone stereo, or you can pair it wirelessly with a Bluetooth speaker, unlike Google Home devices. Besides, it's the Echo's input capabilities that really shine. Seven directional microphones dotted around its body do an astonishingly good job of detecting commands from near and far. Even when the Echo's blasting out music, it still impressively picks up instructions at normal speaking volume.

Amazon Prime Music and Spotify Premium are both natively supported, although multiple Echo devices can only play one song at once from a given source. Meanwhile, simple multi-room controls let you group devices together and play the same playlist in synchrony, although each unit can only be in one group.

The Echo is pleasingly available in five quite tasteful finishes too, although the plastic 'oak' and 'walnut' finishes look a little incongruous with the Echo's trademark blue LED ring



circling around the top. You can also buy replacement shells to spruce up your Echo, although they're overpriced at £30 a pop.

While the Echo is designed primarily for voice control, there are physical volume and power buttons on top, plus a mute button that shuts off the microphone. The volume controls aren't particularly tactile, but they're perfectly usable. When you tap the mute button, the whole LED ring also shines red, so you can see at a glance if it's muted.

For more in-depth controls there's the Alexa app for Android and iOS, with which you can create Routines – sequences of actions such as reading the news and turning off the lights – browse enabled 'skills', check your usage history and so on. It's slow and clunky, though, often taking several seconds to open and move between pages, and it's dauntingly overloaded with lists and buttons.

The Echo isn't always as capable as the Google Home either. Thanks to Google Assistant being deeply plumbed into Google, for example, it can do a better job of telling you travel times between two arbitrary points. Google Home can also distinguish between multiple registered voices: if you ask for your

next appointment, it will fetch the information from your calendar, whereas if your partner asks the same question, it's smart enough to check theirs. Alexa devices in the USA can do the same, but sadly not in the UK. Similarly, unlike UK Alexa devices, Google Home can directly call a landline.

Conclusion

The Echo isn't perfect, but with so much momentum behind it, you can expect Alexa to work with the widest range of devices and services. There's also the best range of companion devices, from the tiny Echo Dot to the Echo Show, not to mention plenty of third-party Alexa-powered speakers. Audiophiles could consider the pricier Sonos One (see p58), which partners Alexa with better sound, but for everyone else, the price and features of the Echo makes it the clear all-round winner.

SOUND	VOLUME	OVERALL SCORE
11/20	9/10	
FEATURES	VALUE	86%
37/40	29/30	

Amazon Echo Show / **£199** incVAT

SUPPLIER www.amazon.co.uk

The Echo Show's special feature is a 7in LCD touch-screen, which means Alexa can play videos as well as music. That might not sound very useful for a living-room device, but it's ideal for the kitchen, where you can stick on a sitcom while you're slaving over your Bolognese. It's not exactly a cinematic experience, but it's as sharp and colourful as you could reasonably demand.

However, browsing and selecting videos involves a lot of scrolling around with the touch-screen, so you lose some of that sense of effortlessness that comes with direct voice control. The range of content is disappointingly narrow too: Amazon Prime members have the Prime Video library, but there's no Netflix, YouTube or iPlayer.

When not streaming video, the screen provides information. For the most part, when you ask for the weather or a sports update, the display merely illustrates Alexa's spoken

response. Some third-party 'skills' take it further though: the Allrecipes 'skill', for example, gives you visual, step-by-step guides to creating thousands of culinary masterpieces, and the Uber 'skill' shows live updates, so you can see your ride's distance from you.

If you have a compatible camera, you can also tune into its feed at any time with a simple voice command. And since the Show has its own built-in camera, you can also use it for two-way video calls with other Echo Show or Spot devices, or to friends' smartphones running the Alexa app. Finally, when idle, the



JBL Link 20 / **£179** incVAT

SUPPLIER www.currys.co.uk

JBL makes a whole range of Bluetooth speakers, and at first glance the Link 20 doesn't look particularly different. Look closely, though, and you'll see the distinctive abstract logo of the Google Assistant on top of it. Indeed, as far as the software is concerned, the JBL might as well be a regular Google Home unit. The Link 20 integrates right into the Google Home app, and it can nearly match the smart capabilities of Google's own hardware, from music streaming to checking your calendar. The only major feature missing is the ability to make phone calls.

Although the Link 20 works just like a real Google Home, it's physically much less showy, with push-button controls on top and four pulsing white LEDs at the front, in place of the Home's swirling multi-coloured dots. It's probably fair to call the design 'inoffensive'.

Inside it sports a pair of 50mm drivers, just like the Home, but JBL's speaker has a much

brighter, airier tone than Google's. It can become a little harsh and resonant at high volumes, but there's an immediacy to it that makes the Google Home's restrained performance seem comparatively dull. It goes louder too: at maximum volume we measured it pumping out 78dBA, enough to properly annoy the neighbours. Like the Google Home, though, the Link 20 has just two microphones, and it can struggle to hear you in noisy environments.

JBL's speaker has a much brighter, airier tone than the one in the Google Home

The other factor that really sets the Link 20 apart from the Google Home is the ten-hour internal battery. While most smart speakers



Echo Show displays upcoming appointments from your calendar, news updates and so on. It's not very customisable – annoyingly you can't even tell it to use the 24-hour clock – but it's a positive addition to your work surface.

The Show's audio capabilities certainly deserve a mention too. Its twin 50mm speaker array is just as loud as an Echo Plus, and sounds noticeably more expansive and warmer. While it doesn't qualify as hi-fi, it's Amazon's best-sounding Echo device. The screen also shows track details and album art while music is playing, along with simple touch controls for play, pause and skip.

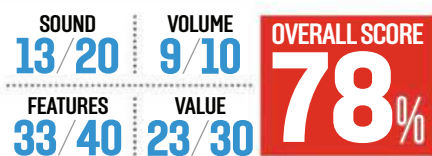
Indeed, the Echo Show is a solid all-round Alexa device. It's great to be able to check your calendar at a glance and watch video in the kitchen. The screen doesn't really transform Alexa's smart capabilities, though, and it's very limited as a video player, which makes it hard to justify paying more than twice the price of a regular Echo for it.



are tethered to the mains, you can simply yank out the power cable and carry the Link 20 to the bathroom, while your music happily plays on. It's waterproof too, so you don't have to worry about splashes from the shower.

You can even throw the Link 20 in a bag and take it on a picnic. The Assistant functions need Wi-Fi, however, and you can't simply use your phone as a portable hotspot, because you have to be on the same network as the speaker in order to switch its network settings in the Home app. You'll either have to use a second phone or make do with regular Bluetooth streaming.

Still, if the Link 20 isn't quite the perfect mobile music companion, it's certainly a more versatile speaker than the standard Google Home. If you're set on using Google Assistant, it's well worth paying the extra £30 for a speaker that can come out to play.



KitSound Voice One / **£90** inc VAT

SUPPLIER www.amazon.co.uk

The Alexa-powered Voice One is priced the same as a regular Amazon Echo, but it's

an interestingly different proposition with original design touches. For a start, the Voice One is relatively large: it's taller than an Echo Plus, with a footprint almost as big as that of the Apple HomePod. The LED ring on the front is surrounded by a volume dial, and flashes when you turn it, although there's no visual feedback to tell you which level is selected.

Above it there's a microphone mute button – the light ring turns red when the Voice One isn't listening – while below a source button lets you switch between Alexa, Bluetooth and 3.5mm line inputs. At the bottom sits a play/pause control, along with a KitSound logo that pulses in time to the beat.

In Wi-Fi mode, the Voice One can do most of the tasks expected from Alexa; you can stream music from Amazon and Spotify, and via the KitSound app, you can also access Tidal and Napster. That points to one of the big irritations with third-party Echo devices, though: settings and features are split between the official Alexa app and the manufacturer's own device-specific software.

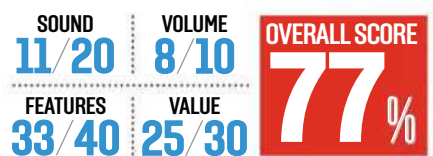
There are also a few notable features missing: you can't make calls to other Echo devices, nor can you change the wake word – for better or worse, you're stuck with 'Alexa'. On the upside, there's a graphic equaliser in the KitSound app, which you don't get with Amazon gear. Unusually, there's a remote control in the box too, which provides a civilised alternative to shouting, and lets you switch input sources and mute the microphone.

Most excitingly, if you own more than one Voice One speaker, you can set them up as a stereo pair. It takes a bit of fiddling in the app, but it's well worth it; in stereo, the sound no longer seems to emanate from



a single point and has more of an ambient quality. The Voice One speakers go pretty loud too, so they really can fill a room in more than one sense.

Sadly, the actual sound quality isn't all that great. The bass is quite weak and flappy, and there's a definite boxiness to the mid-range; it's hard to say that it sounds more enjoyable overall than the Echo, which is a disappointment considering the much bigger enclosure. The Voice One's remote control and stereo option are certainly appealing for the price, but it doesn't justify the trade-off of missing features and a fragmented app experience.



Apple HomePod / £319 inc VAT

SUPPLIER www.apple.com/uk

Apple is a late arrival in the smart speaker world, and to an extent it's playing catch-up with Amazon and Google. However, the HomePod is special enough to conceivably persuade a few Echo or Google Home devotees to switch. It doesn't look particularly assuming. Actually, it looks rather bland. A fabric mesh (in either white or 'Space Grey') covers the entire exterior, save for a black plastic blob on top.

Neither branding nor controls are visible; the only physical connector is the power cable. Address it with 'Hey, Siri!' though, and a familiar luminescent circle appears on the top to show it's listening. Touch-sensitive volume controls appear on the same surface as needed.

Not blown away? Start playing some music. On paper, its maximum volume level of 77dbA may look merely average, but unlike most smart speakers, it doesn't distort at all, even when pumped up to ten, making it feel much more powerful than its rivals.

What's really stunning, though, is how vibrant, arresting and perfectly controlled its sounds. Apple's custom speaker arrangement gives dance music an irresistible driving kick; rock grinds and roars as it should; the timpani in Verdi's Requiem have a palpable impact. Even at moderate volumes, the HomePod has a muscular musicality that easily outshines any other speaker on test this month.

What's more, the HomePod can listen to its own output, and automatically apply acoustic processing as needed to ensure you get the best sound, no matter where it's placed. If a nearby wall is producing nasty resonances in the mid-range, the HomePod will adjust those frequencies to compensate. Treble getting muffled by a nearby curtain? The HomePod will sort it out.

The upshot is that you can stick the HomePod carelessly on a shelf, or in a corner, without the slightest regard for acoustics, and get an effect that sounds like a high-end hi-fi system. All that's missing is a stereo sound stage, and Apple's working on adding that feature now. Once it's available, there will likely be no shortage of audio enthusiasts queueing up to buy HomePods by the pair.

For the rest of us, though, the HomePod isn't such a straightforward proposition. Firstly, £319 is a lot of money for a device that does the same basic job as the Amazon Echo. Sure, the difference in audio quality is night and day, but whether it's worth the gaping price gap will depend on your priorities, and your income.



Then there's the uncomfortable question of compatibility. Alexa and Google Assistant will both work with Android or iOS, and you can happily use either to access Spotify, Netflix and so on. The HomePod, by contrast, works only with iOS – Android users are shut out – and services such as Spotify get treated as second-class citizens. You can kick off Spotify playlists manually from your iPhone (using Apple's proprietary AirPlay transport) but if you're looking to stream music with voice control, you're limited to your own purchased iTunes songs, plus Apple Music and Beats 1 radio. There's not even a Bluetooth option to play tunes from a non-Apple phone or laptop.

There's one last consideration to bear in mind too. Compared with its established rivals, the HomePod is rather limited. As befits its design, it's at its strongest when performing musical functions. Siri does a superb job of picking out new music you'll like or assembling killer mixes within a given genre or era.

For general smart-speaker duties, though, the HomePod lags behind Amazon and Google. You'll look in vain for advanced features such as phone calls and multi-user voice recognition. It works with smart home devices only to the extent that Siri can control

them via HomeKit, and right now you can't even use it to control an Apple TV. Oddly, there's also no manual control to mute the microphone: you can tell Siri to stop listening, but then you have to use the Home app on your iPhone to enable it again.

Conclusion

If you're looking for a convenient voice hub that will work with your existing Android phone, Spotify account and mishmash of smart-home devices, the HomePod clearly isn't a good fit. It's almost insolent how pointedly it refuses to integrate with non-Apple services. If you're primarily a music fan who's already devoted to the Apple way, however, the HomePod will likely make you vastly, qualitatively happier than any of this month's rivals. It's not perfect, and it's not cheap, but you'll be loving the sound of it long after the expense is forgotten.

SOUND	VOLUME	OVERALL SCORE
20/20	9/10	
FEATURES	VALUE	75%
30/40	16/30	

Google Home / £129 inc VAT

SUPPLIER <https://store.google.com>

The Google Home's two-tone design and angled top make a statement next to the Amazon Echo's textured cylinder. What's more, where the Echo's ring of LEDs is clearly visible around its top edge, the Home conceals them beneath the top panel: when it's thinking, they shine through it, spinning in pastel colours. When it's dormant, it looks featureless again.

Unlike the Echo, though, the Home's light isn't clearly visible from all angles, and the physical controls aren't exactly tactile: to adjust the volume, you drag a finger around the unmarked upper panel, or tap to manually pause music or stop a timer. Wisely, Google has given the Home a physical mic-mute button, but it's hidden round the back, so hitting it can take some fumbling.

Still, when you address the Google Assistant with your voice, it responds promptly, with impressive intelligence and use of contextual information. You can more or less get into a conversation with it, to a greater extent than with Alexa. Where's my nearest pizza restaurant? What do the reviews say? Does it deliver? There are some niggles though. The wake phrase is either 'Okay Google' or 'Hey, Google' – prefix it to every statement a few times and it's clearly a clunkier address than 'Alexa', which flows neatly off the tongue. Unlike the Echo, you can't give it a different name either.

The Google Assistant is also comparatively inhuman. Ask its name and it says: 'I am the Google Assistant'; to wake it, you invoke the corporation that operates it. The speech sounds a bit stilted and artificial too, in contrast to the relative fluency of Alexa and Siri. Still, you get used to it, especially if you're usually issuing short, one-off commands, such as instructing Google Home to play music.

Predictably, the Assistant integrates with Google Play Music and Spotify, and a premium subscription to either service enables it to play nearly any song you request. Disappointingly, though, if you only have a regular, free Play Music account, you can't play songs you've uploaded yourself. You can stream your songs to the Home over Bluetooth, or via Google Cast, but it's an irritating speed bump.

Meanwhile, the sound is more open and warmer than the Echo's flatter tone at moderate volumes. At higher volumes, though, it sounds unpleasantly boxy, and its maximum volume of 74dBa sounds much quieter than the Echo. There's no external

speaker output either, and you can't stream to other devices over Bluetooth. You can, however, cast your playlist to a Chromecast-compatible device. If you have multiple Google Home devices, you can also use the Google Home app's multi-room feature to stream music to several devices at once. You can't currently pair two Home units in stereo, but the US-only Google Home Max has that ability, so it could materialise in the future.

Another issue is that, where the Amazon Echo has seven microphones, the Home only has two. We had no problem speaking to it from across the room in normal conditions, but with music or TV audio in the background, the Google Assistant seemed to miss our invocations slightly more often than Alexa.

As you'd hope, the Google Home integrates with Google Calendar, so you can ask it for your next appointment, or create new events by voice. Alexa can do that too, but Google Home recognises the voice of the person asking, and automatically selects the appropriate calendar (if it's been registered). There's also simple integration with messaging apps and services, and you can use voice control to cast and control the playback of YouTube and Netflix video.

To open up other capabilities, IFTTT connects your Google Home to a range of

online services, plus IoT gadgets and platforms. It works natively with Philips Hue and (Google-owned) Nest, but it doesn't have such an extensive library of partnerships as Amazon. On the plus side, the Google Home app is better-looking and much more responsive than the Amazon Alexa app, although it still gathers all your Chromecast and Home-compatible devices into an overwhelming forest of menus and shortcuts.

Conclusion

On paper, the Google Home is a solid Echo competitor, but it has a less personal character, the design isn't as practical, it doesn't hear as well, it doesn't go as loud and it won't talk to a standard Bluetooth speaker. If you're a Google fan, the Home is tremendously capable, and it's only going to get smarter with the company's vast data trove and immense computing resources at its disposal. Right now, though, it's half a step behind the Echo and decidedly more expensive.



SOUND	VOLUME	OVERALL SCORE
11/20	8/10	
FEATURES	VALUE	76%
33/40	24/30	

Libratone Zipp / £230 incVAT

Libratone Zipp Mini / £160 incVAT

SUPPLIER www.amazon.co.uk

Libratone's Zipp and Zipp Mini speakers take their names from the chunky fastener that secures their boldly coloured fabric covers. They also sport distinctive leather straps that encourage you to pick them up and go – with a claimed ten-hour battery life, these speakers don't need to be chained to a mains socket. Unlike the JBL Link 20, however, they're not waterproof, so if you fancy a spot of Bach in the bath, we suggest you don't balance one precariously on the edge of the tub.

In fact, look a little more closely and it's clear that Libratone's characterful speakers don't have much in common with this month's other contenders at all. That's because, rather than being



Zipp Mini

designed as smart speakers from the beginning, they're regular Bluetooth speakers that have been retrofitted with updated firmware to work with Alexa.

And, sad to say, it's not a good fit. For a start, while both Zipp units have built-in microphones, they're not designed for always-on operation. When Libratone announced the Alexa upgrade last year, the idea was that you'd tap the panel on the top to activate the microphone, before issuing your command to Alexa. That's clearly far less convenient than simply being able to call out to her from across the room.

Either way, even that capability hasn't materialised. It might at some future point, but for now, all



Libratone Zipp

you get is a 'skill' that lets Alexa stream music to the Libratone speakers on your home network. In other words, the Zipp does technically work with Alexa, but you'll need a

Sonos One / £199 incVAT

SUPPLIER www.amazon.co.uk

Sonos specialises in high-quality, multi-room audio, and the One looks and feels like a solid, mature bit of audio hardware. It sounds fantastic too: at moderate volume, the bass is reassuringly weighty, yet wonderfully precise. The overall tone is perhaps not quite as excitable as the likes of the JBL Link 20, and the mid-range becomes a bit oversaturated at maximum volume – but you'll probably never need to turn it up that far, as the Sonos One goes up to a deafening 84dBa.

The One also does a pretty good impression of an Amazon Echo. You can address it as 'Alexa', instruct it to stream music, control smart home devices, access 'skills' and so on. As usual with third-party products, however, you can't change the wake word, and you can't make calls to other people's Echo devices.

The Sonos One has some unique foibles too. For one, you get almost no visual indication that Alexa is listening – in place of

the Echo's light ring, there's just a tiny white LED on the top. Instead, the One plays a little chime every time it hears its wake word.

Unfortunately, if (like us) you're in the habit of addressing Alexa in complete sentences, the chime invariably interrupts you while you're talking and wrecks your flow, and it can't be disabled either. The One feels slower to respond than the Echo too, though that may be an illusion caused by the lack of visual feedback.

Another quirk is that – again, as is often the case with third-party devices – configuration is split between the Amazon Alexa app and Sonos' own software. This setup can be rather confusing, because the Sonos ecosystem



doesn't map perfectly onto Alexa's smart features. For example, you can configure Google Play Music as one of your streaming

separate Echo device to actually control it.

If you don't mind jumping through that hoop, the sound isn't bad at all. The Mini (which at 224mm tall really isn't that small at all) sounds admirably solid and well balanced; a hint of distortion creeps in at maximum volume, but it's unlikely you'd ever want to push it up that high indoors. The full-sized Zipp goes even louder, and while the bass response can get a little over-enthusiastic at times, it's undoubtedly one of this month's better sounding speakers.

Indeed, taken on their own terms, the Zipp and Zipp Mini are clever bits of kit: DLNA support makes them very flexible, there's a convenient USB charging port on the rear of each, and if you have two Zipp units you can use the native Libratone app to play music through them as a stereo pair. They're nowhere near as smart as their rivals, though – and the price isn't remotely competitive next to the Amazon Echo or Google Home.



sources in the Sonos app, but you can't use Alexa to play it.

On the plus side, the One handles two-speaker stereo configurations superbly. There's no messing around with channel settings: as soon as a second device is detected, you're invited to link it to the first with a tap. As with the KitSound Voice One, a stereo pair of Ones has a transformational effect, giving a real sense of space and scale to an already engaging sound.

Indeed, if you can afford it, a pair of Sonos One speakers in stereo mode provide the best musical experience we've heard this month – and with a £50 discount for buying two together, a twin pack isn't much more expensive than a single HomePod.

As a general home assistant, however, the Sonos One isn't quite so exceptional – yes, it sounds great, but the smart side is just a little bit clunky.



Zolo Halo / **£55** inc VAT

SUPPLIER www.amazon.co.uk

If you're looking for small, low-cost Alexa device, but can't tolerate the hollow sound of the Echo Dot, the Halo could be what you want. It has a tiny 70 x 70mm footprint, with a low-rise design that won't dominate your desk, yet crams in a speaker that's three times the size of the Dot's speaker.

Of course, you're never going to get thundering bass from a device this size, and we measured the Halo's maximum volume at a fairly restrained 68dBA. Even so, it gives an impressively full-bodied performance; the low end is warm enough to fill out the sound, while the upper frequencies never become tinny or harsh.

It's also possible to buy a second Halo and configure them as a stereo pair. The process involves a bit of clunky dragging and tapping in the Zolo app, but you then get an impressively airy-sounding system. Alternatively, you can plug the Halo into a full-sized hi-fi, via the 3.5mm output socket at the rear. However, you can't connect wirelessly to a Bluetooth speaker: you can use Bluetooth to play music from your phone on the Halo, but (unlike the Echo Dot) it won't stream in the other direction.

On the subject of missing features, it's hardly a shock to note that the Halo also can't currently make voice calls, and that the wake word can't be customised. You can't include the Halo in one of Alexa's multi-room music groups either, although you can separately group Halo devices together in the Zolo app. Otherwise, there's very little you can't do. The Halo is perfectly happy to stream music from Spotify, as well as Amazon Music and TuneIn, and you'll have no problem using it to access 'skills', routines and smart home controls.



It's also pleasing to see some thought going into the physical design. A raised ring on the top glows blue to indicate activity, so you can always see at a glance when the Halo is listening or working. The microphone mute button is accessible at the front, and while the Halo has only two microphones, they're sensitive enough to pick up commands even with music playing at top volume.

The Halo is an endearing little speaker. The limited multi-room capabilities are a shame, especially since it's the cheapest way to get the Alexa experience in stereo. Even so, if you're shopping for a first smart speaker, or seeking to bring voice controls to an extra room without shelling out for a full-fat Echo, the Halo is well worth a look.



PC system reviews

GAMING PC

PC Specialist Vulcan XR / £1,999 incVAT

SUPPLIER www.pcspecialist.co.uk

Like several £1,999 gaming rigs we've seen this year, PC Specialist's Vulcan XR pairs a GTX 1080 Ti graphics card with an Intel Core i7-8700K CPU. It's a great combo for a sub-£2,000 gaming rig, but PC Specialist hasn't pushed the envelope here. The CPU runs at its stock speed, much like the Chillblast Fusion Fireblade (see Issue 176, p58), but it's miles behind the 4.8GHz overclock applied by Stormforce in its Crystal i7 8700K GTX 1080 Ti system (see Issue 177, p58).

The Zotac GTX 1080 Ti card used here is a Mini version, which means a tiny 211mm body. That's great for a mini-ITX machine, and the Mini cards are often cheaper than their bigger siblings, but it means a tiny overclock, from 1480MHz to 1506MHz. Comparatively, the Chillblast ran a full-size card at 1544MHz.

The components plug into an Asus TUF Z730-Plus Gaming motherboard – the same board used by

Stormforce. It's an unusual choice for a gaming PC – the TUF acronym means the board has extra hardware protection, such as steel-reinforced PCI-E slots, overvoltage protection, and improved chokes and capacitors. You get isolated audio circuits, and Asus says the stainless-steel rear I/O panel lasts longer than the metal on more conventional boards.

Many of those protections are found on more conventional gaming boards, but they're still welcome. It has the usual RGB LEDs and big heatsinks, and there's also a second M.2 slot. There are memory slots free too, and three 1x PCI-E slots.

However, the board is also limited. The second PCI-E slot is restricted to 4x speed, and the board doesn't support Nvidia SLI. There's no optical S/PDIF, only three audio jacks, and no Wi-Fi either. Chillblast's MSI board might not have the TUF gear, but it's better for dual graphics thanks to a

faster secondary PCI-E slot and support for Nvidia SLI, plus it also offers Wi-Fi.

Elsewhere, the PC Specialist offers better competition. Its 512GB Samsung 960 Pro SSD has more space and speed than the drives in rivals: its read and write results of 3,471MB/sec and 2,039MB/sec are faster. It also has 16GB of 3000MHz DDR4 memory – faster than the 2400MHz offered by Stormforce and Chillblast. Also, the PSU is a 650W Corsair semi-modular unit with an 80 Plus Gold rating.

PC Specialist has housed all the gear in a Cooler Master MasterCase MC600P. It's a step up from the H500P used by Stormforce, offering a similar size with more features.

Interestingly, the PSU shroud is open at the side, but that means it's easier to access the free hard disk bay and its tool-free cage. Unusually, there's also a small cage at the top of the rig with two more hard disk bays and a pair of vacant 5.25in slots. There's a pair of 2.5in slots free on top of the PSU shroud, too.

The front, top and rear panels all attach with magnets, which means they can be easily removed, allowing you to easily swap the solid front for a meshed design. At the top and the rear, this setup also means you can access the cooling hardware. Impressively, there are thumbscrews galore beneath the panels, which makes it even simpler to access the rest of the chassis. The PSU shroud and the top hard disk cage can be removed, and the latter can be repositioned. The Cooler Master is spacious too. The small graphics card frees up room, and the thin 240mm Cooler Master MasterLiquid Lite cooler is hidden in the roof.

On the downside, PC Specialist's cable tidying isn't great – wires trail a little at the bottom of the enclosure, and the power cables are plain. The case's side panel is also a little awkward – it releases with a stiff, single screw rather than easy thumbscrews. The flap that hides the power button and front I/O can get annoying too.

PC Specialist offers a three-year labour warranty with a year of parts coverage, but only one month of collect and return service. It isn't a terrible deal, but Stormforce offers three years of collect and return service and parts coverage, and you get two years of collect and return parts cover with the Chillblast too, plus a five-year labour warranty.



/SPECIFICATIONS

CPU 3.7GHz Intel Core i7-8700K

Motherboard Asus TUF Z730-Plus Gaming

Memory 16GB Corsair Vengeance RGB 3000MHz DDR4

Graphics Zotac GeForce GTX 1080 Ti 11GB

Storage 512GB Samsung 960 Pro M.2 SSD, 2TB Seagate Barracuda hard drive

Case Cooler Master MasterCase MC600P

Cooling CPU: Cooler Master MasterLiquid Lite 240 with 2 x 120mm fans; GPU: 2 x 80mm fans; front: 2 x 120mm fans; rear: 1 x 120mm fan

PSU Corsair TX650M 650W

Ports Front: 2 x USB 3, 2 x USB 2, 2 x audio; rear: 4 x USB 3.1, 1 x USB 3.1 Type-C, 2 x USB 2, 1 x Gigabit Ethernet, 1 x PS/2, 3 x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty One year parts and labour with one month collect and return, plus two years labour only return to base

1

Don't be fooled by the Zotac graphics card's size – that's a GTX 1080 Ti card

2

A Core i7-8700K CPU sits under the liquid cooler, but it isn't overclocked

3

You only get plain PSU cables, and the wires are a bit of a mess too

Performance

The PC Specialist shares its stock-speed processor with the Chillblast, and its better SSD and quicker memory help it to outpace that machine. Its image editing result of 57,876 was 4,000 points better, and it held modest leads in the Handbrake and multi-tasking tests.

Its overall result of 182,859 was around 8,000 points ahead. That's ample for most tasks, but the Stormforce's 4.8GHz clock speed made it quicker, adding 8,000 points in our image editing test.

The different CPU speeds only resulted in tiny differences between the three machines in our games tests though. The PC Specialist stayed well above 30fps in all our 4K tests, and above 60fps at 2,560 x 1,440, thanks to the amazing power of the GeForce GTX 1080 Ti CPU. That's plenty of performance for VR gaming too.

Meanwhile, the CPU's peak delta T of 58°C was fine, and the GPU topped out 3°C cooler. Throttling wasn't a problem, either. However, the PC Specialist produced a low rumble when idle and a little more noise when stress-tested – both the aforementioned rival machines are quieter. It's not a terminal problem, but it's definitely a mark against the PC Specialist with such close competition.

Conclusion

The PC Specialist's outpaces stock-speed rivals thanks to better memory and excellent storage, but its application performance still lags behind overclocked systems.

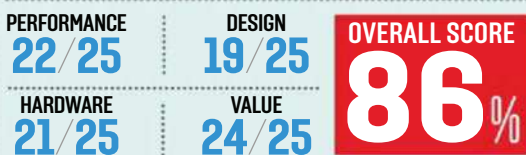
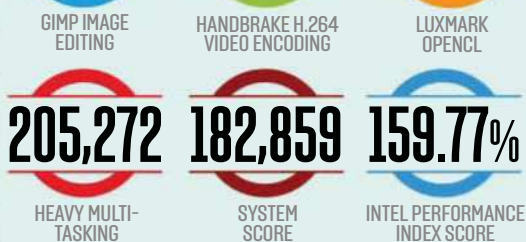


Elsewhere, the motherboard has a middling feature set, the noise output is louder than the near-silent competition and its cables could do with a tidy.

On the plus side, the Cooler Master case is great, particularly if you're into tinkering and upgrading. The Vulcan is decent machine, especially when it comes to its case and storage, but its rivals in this price league are slightly more compelling.

MIKE JENNINGS

CPC REALBENCH 2015

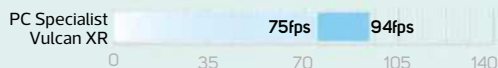


VERDICT

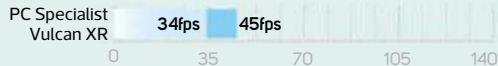
Solid performance, great storage and a versatile case makes this PC ideal for tinkerers, but there's tough competition in this price league.

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA



3,840 x 2,160, Ultra Detail, TAA

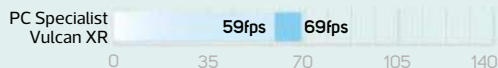


THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, Nvidia HairWorks off

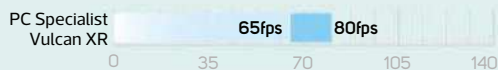


3,840 x 2,160, High Detail, Nvidia HairWorks off

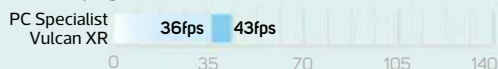


DEUS EX: MANKIND DIVIDED

2,560 x 1,440, Very High Detail, DX12



3,840 x 2,560, Very High Detail, DX12



Minimum Average

GAMING PC

Alienware Area 51 Threadripper Edition / **£5,589** inc VATSUPPLIER www.dell.co.uk

We're used to seeing outrageous Alienware systems, but the Area 51 Threadripper Edition is bold even by the firm's usual standards. It weighs 28kg, and it measures 569mm tall and 639mm deep. And then there's the shape: it's triangular, with slats on the front surrounded by RGB LEDs, plus the familiar, glowing power button. Perhaps more interestingly for a top-end Dell/Alienware machine, it doesn't come with Intel hardware, instead featuring AMD's Threadripper 1950X CPU.

This chip is a monster, with 16 cores and 32 threads via SMT. Its base speed of 3.4GHz can also boost to 4.2GHz using XFR, and it has 32MB of cache at its disposal. Despite it being inside an Alienware machine, though, the 1950X isn't a gaming chip – no game needs 16 cores. Instead, the 1950X is designed for high-end work: content creation, graphic design, CAD and huge databases.

The Alienware's 16-core CPU is partnered with 64GB of 2666MHz memory, a capacity that's again geared towards work rather than play. There's also a 512GB PC401SK Hynix SSD and a 2TB hard disk. This machine also has some quality gaming gear, though, with Alienware aiming to build a desktop rig that can do anything. The GTX 1080 Ti cards offer plenty of gaming power, even at 4K, although the cards in this machine only run at stock speeds of 1481MHz.

Meanwhile, each of the unit's three points is punctuated

by a handle, and Dell says the Area 51 is easy to tilt to access its various ports and connections. We had no issues with the case's well-balanced build quality, but it's a big and heavy machine to shift around.

At the back, you get seven USB ports and a Type-C connection. At the front, you get four USB ports, and there's integrated Wi-Fi and Killer Gigabit Ethernet. There are some changes beyond the usual Area 51 design too – the optical drive has been jettisoned to a USB peripheral in the box, and the card reader has vanished too.

The side panels are easy to open too but then the interior disappoints. The 16-core CPU is chilled by a basic 120mm all-in-one liquid cooler, and the plastic-clad graphics cards resemble reference cards. The motherboard has a PCI-E slot free, but that's it. Around the rear, there are three empty 3.5in bays and a single vacant 2.5in slot alongside the daughterboard that controls the Alienware's lighting.

Dell has provided power and SATA cables for all of those storage bays, which is pleasing, but the cables at the front are



unsleeved, multi-coloured and messy. Likewise, the Dell 1,500W PSU is a modular, plain metal unit. The Alienware doesn't have a side window, but we still expect better at this price: systems from British builders often have perfect cable routing, bespoke water cooling and a better-looking PSU inside more versatile enclosures, and for less money too. For example, the same price as the Area 51 could alternatively buy a fully custom water-cooled (and immaculately built) Scan 3XS Carbon Fluid Extreme SLI machine with a 16-core Core i9-7960X overclocked to 4.3GHz and a GPU overclock.

The Alienware's components attach to a standard Dell motherboard with no high-end features and hardly any expansion room. Different flavours are available though. The entry-level Threadripper 1900X PC costs £2,149 inc VAT, and each specification can be modified extensively.

A further disappointment is the Dell's standard warranty, which only lasts for a year, even if it is on site.

Performance

Our heavily multi-threaded Handbrake video-encoding test saw the Alienware 1950X score 749,859 with its 16-core CPU, which is a superb result, as is its score of 2,944 in Cinebench. However, Threadripper isn't built for single-threaded speed, especially at stock speed with just a 120mm all-in-one liquid cooler, making the Alienware's score of 29,782 in our mostly image editing test decidedly mediocre.

Alienware includes overclocking modes in its BIOS. The peak option runs the core at 3.75GHz, but using this option also cuts the chip back to using four cores. The overclock added almost 5,000 points to the image editing score, but it dropped the Handbrake score to 258,746 in the process. The Threadripper 1950X is quick in heavily multi-threaded

We had no issues with the case's well-balanced build quality

/SPECIFICATIONS

CPU 3.4GHz AMD Ryzen Threadripper 1950X

Motherboard Dell Alienware 08FN1W

Memory 64GB SK Hynix 2666MHz DDR4

Graphics 2 x Nvidia GeForce GTX 1080 Ti 11GB

Storage 512GB SK Hynix PC401 M.2 SSD, 2TB Seagate Barracuda hard drive

Case Alienware Area 51

Cooling CPU: Dell Alienware water-cooling unit with 1 x 120mm fan; GPU: 2 x 80mm fans; front: 2 x 120mm fans

PSU Dell D1500EF-00 1500W

Ports Front: 4 x USB 3, 2 x audio; rear: 7 x USB 3.1, 1 x USB 3.1 Type-C, 2 x Gigabit Ethernet, 1 x optical S/PDIF, 5 x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty One year parts and labour on site

1

A pair of GeForce GTX 1080 Ti cards in SLI handle gaming duties

2

A Threadripper 1950X sits under the Alienware liquid cooler

3

The cables at the front are unsleeved, multi-coloured and messy

software, then, but there are few applications that will genuinely need 16 cores.

The SK Hynix M.2 SSD is also a disappointment at this price, with a decent read result of 2,675MB/sec but a poor write pace of 649MB/sec – a long way behind the performance of Samsung’s latest NVMe drives.

On the plus side, the two GTX 1080 Tis remain fearsomely quick. The cards raced beyond 60fps minimums in Fallout 4 and The Witcher 3 at 4K, and in the tough Deus Ex test, it delivered a minimum of 45fps. The Alienware will handle any game on any screen or VR headset. Look closer, though, and the Area 51 is less impressive, with SLI issues meaning the machine is slower in Deus Ex at 4K than at 2,560 x 1,440.

In terms of thermal performance, the GPU and CPU peak delta Ts of 61°C and 42°C respectively are fine. However, with every core stressed the 1950X only ran at 3.35GHz – below the chip’s stock speed. The Area 51 makes a fair amount of noise too, especially with all of its components stressed. It’s not a disaster, but this rig is certainly louder than the aforementioned Scan with custom water cooling. That’s less problematic for gaming, where speakers or headsets are used, but it’s an issue for quiet working environments.

Conclusion

The Area 51 makes a big first impression, but get beyond the flashing lights and angles case, and there’s little to like. The cooling system is lacking, the internal build quality is a mess, the motherboard is ordinary and it feels as if Alienware



hasn’t really put much thought into this machine. The graphics cards are quick, but so they should be at this price.

The Area 51 is louder and less versatile than the aforementioned Scan PC too, which will also offer faster application and gaming performance, along with a proper water-cooling system. The Area 51 costs the same price as the Scan, but it can’t compete on any front. Whether or not you need an extreme core count, home-grown systems do a better job for less money.

MIKE JENNINGS

CPC REALBENCH 2015

29,782 749,859 211,586

GIMP IMAGE EDITING

HANDBRAKE H.264 VIDEO ENCODING

LUXMARK OPENCL

178,862 250,205

HEAVY MULTI-TASKING

SYSTEM SCORE

PERFORMANCE

22/25

DESIGN

18/25

OVERALL SCORE

72%

HARDWARE 18/25

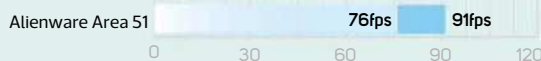
VALUE 14/25

VERDICT

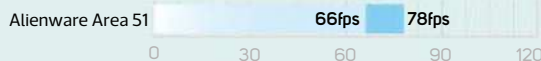
Skin-deep design gives way to a PC that’s slower, noisier, less versatile and messier than the competition. Take your money to an independent PC builder instead.

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA

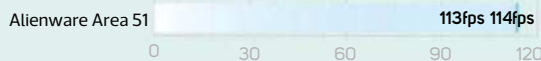


3,840 x 2,160, Ultra Detail, TAA

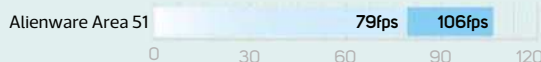


THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, Nvidia HairWorks off

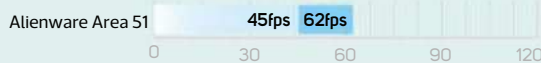


3,840 x 2,160, High Detail, Nvidia HairWorks off

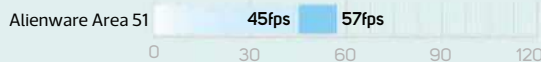


DEUS EX: MANKIND DIVIDED

2,560 x 1,440, Very High Detail, DX12



3,840 x 2,560, Very High Detail, DX12



Minimum Average

GAMING PC

Scan 3XS Horizon Ti / £2,150 inc VAT

SUPPLIER www.scan.com

The Scan 3XS Horizon Ti is the second system we've seen with the Ryzen 7 2700X, and the specification means business – it has the new CPU, an overclocked GTX 1080 Ti, a 500GB Samsung NVMe SSD and 16GB of DDR4 memory. That's the same core specification as the CCL RyzenX GT (see Issue 178, p64), yet Scan's £2,150 PC impressively costs around £450 less than the CCL.

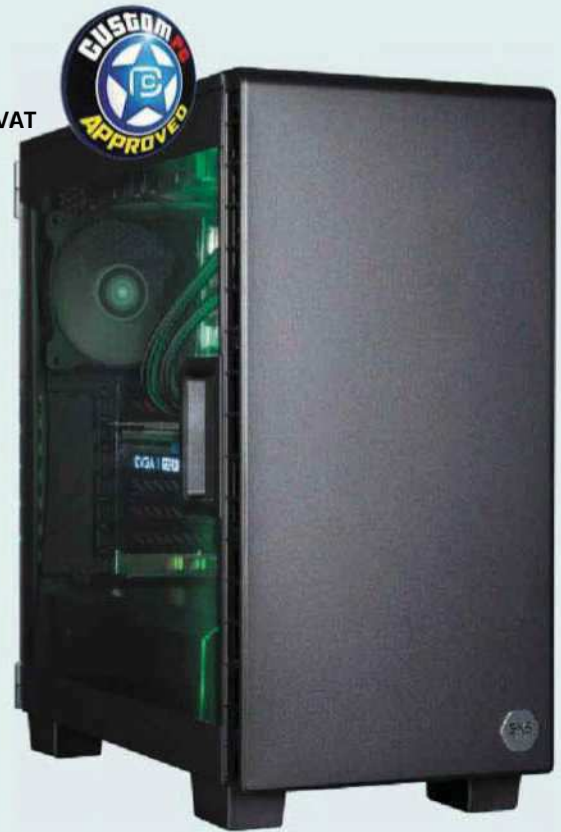
The 2nd Gen Ryzen technology shrinks the manufacturing from 14nm to 12nm, clock speeds have been upgraded to a 3.7GHz base clock and a 4.3GHz boost peak, and the boost process has been refined. The litany of improvements means Scan hasn't overclocked this chip – the same strategy used by CCL.

Scan has plugged the Ryzen 7 2700X into an Asus Strix B350-F Gaming motherboard. It's solid, but a step below the CCL's Asus Strix X470-F Gaming, and that can be seen in the smaller heatsinks and modest lighting. The Asus board uses the older B350 chipset, and there's no SLI support, USB 3.1 Type-C connector or Wi-Fi. Like the CCL, though, Scan has rectified the latter by installing a separate Wi-Fi card.

These minor shortcomings won't affect many users, though, and elsewhere the board is good. There are two memory slots free, plus 1x and 16x PCI-E slots vacant for upgrades. There are six USB 3.1 ports at the rear, and the Scan and CCL boards have the same audio and networking hardware too.

The Scan has 16GB of 2666MHz memory, and a 500GB Samsung 960 Evo SSD alongside a 2TB hard disk, which is a solid balance of speed and capacity. The CCL machine had faster memory and two 4TB hard disks, which is good if you need loads of storage space, but it's overkill for most people. Meanwhile, the Scan's EVGA GTX 1080 Ti card overclocks the 1480MHz core to 1556MHz, putting it in a similar league to the CCL's Asus card.

The Scan's PSU is a Corsair TX550m, which has an 80 Plus Gold rating. The 550W power output is fine for a single-GPU system with no real dual-GPU capability, and it's semi-modular too. The components sit inside a Corsair Carbide 400C mid-tower case. Its plastic side panel is windowed, hinged and opens with a single handle, while the front panel is an attractive slab of metal with vents on either side. At the rear there are also three 2.5in bays and a single 3.5in bay.



The top has a magnetic dust filter, with another filter beneath the PSU. The PSU and two hard disk bays are covered by a plastic shroud, and the radiator for the new Corsair Hydro H100x liquid cooler sits in the roof. Meanwhile, single 120mm intake and exhaust fans are installed.

It's a careful build, where Scan has clearly thought about accessibility. The cooler doesn't impede the memory, and the graphics card doesn't block the SATA ports either. As usual, Scan's done a great job with cable routing too; the main power cables and various small wires are carefully secured in straight lines.

The CCL's Fractal R6 case has more room for additional hard disks, and the machine had cables with coloured braiding that matched the system's RGB LEDs. It was also kitted with sound-absorbing material, more USB ports and an optical drive. It was a little sturdier too – the Scan's case has a slightly flimsy side panel and PSU shroud. However, you can't really complain when the Scan system costs so much less than the CCL.

Finally, the Scan and CCL machines both offer three years of parts and labour coverage too, but Scan also offers a year of on site service with this machine, making for a better overall deal.

Performance

The stock speed Ryzen 7 2700X is formidable, especially in heavily multi-threaded tasks. The Scan's Handbrake score of 539,854 is barely different to the CCL, and it's way ahead of the results we've seen from Core i7-8700K machines. The Scan also scored 182,937 in the multi-tasking test. That's a good result, but it's a little further back from the CCL, which scored 210,150 thanks to its X470 motherboard and faster memory.

AMD's 2nd Gen Ryzen chips also improve single-threaded performance over their predecessors, thanks to

/SPECIFICATIONS

CPU 3.7GHz AMD Ryzen 7 2700X

Motherboard Asus ROG Strix B350-F Gaming

Memory 16GB Corsair Vengeance LPX 2666MHz DDR4

Graphics EVGA GeForce GTX 1080 Ti 11GB

Storage 500GB Samsung 960 Evo M.2 SSD, 2TB Western Digital Blue hard drive

Case Corsair Carbide 400C

Cooling CPU: Corsair Hydro H100x with 2 x 120mm fans; GPU: 2 x 90mm fans; front: 1 x 120mm fan; rear: 1 x 120mm fan

Networking Gigabit Ethernet, 802.11ac Wi-Fi

PSU Corsair TX550m 550W

Ports Front: 2 x USB 3, 2 x audio; rear: 6 x USB 3.1, 2 x USB 2, 1 x optical S/PDIF, 5 x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty Three years parts and labour – first year on site, then return to base

- 1 As usual, Scan has done a great job with tidying and routing the cables
- 2 The Ryzen 7 2700X isn't overclocked, but it still offers formidable speed
- 3 It's always great to see a 500GB Samsung 960 Evo SSD installed

new boosting algorithms, and the Scan's image editing result of 56,857 is still excellent. We have no qualms with the Scan's SSD either. The Samsung drive returned read and write speeds of 3,102MB/sec and 1,813MB/sec respectively.

Meanwhile, the EVGA GeForce GTX 1080 Ti card will happily play any game at 4K and on VR headsets. Its lowest frame rate at 4K was a still respectable 35fps minimum in our highly demanding Deus Ex: Mankind Divided test. The CCL was a little quicker in some tests, but only by marginal amounts.

The Scan was an excellent thermal performer too. The CPU's peak delta T of 46°C is only 3°C higher than the CCL, and with every core stressed, the chip ran at a consistent frequency of 3.875GHz. During a gaming test, where the CPU's cores are less stressed, the chip peaked at 4.025GHz. Meanwhile, the GPU delta T peaked at 48°C, which is fine. The Scan was far quieter than the noisy CCL rig too. It was virtually silent in low-intensity tasks and only produced a low rumble during tougher tests.

Conclusion

The Scan 3XS Horizon Ti is a great all-rounder – it will handle content creation, design and other complex workloads alongside gaming and general-purpose tasks. Elsewhere, the Scan has a great GPU, consistently quiet operation, fine temperatures, and a case that's subtle and compact.

Of course, the Scan's lesser budget means it falls behind the CCL in some areas. The motherboard isn't as versatile,



and the CCL had loads more hard drive capacity, a better case and faster memory (and more of it). These are small niggles when you consider the price though – with the exception of the memory speed, the Scan offers a better-balanced spec, similar performance and quiet operation in a machine that undercuts the CCL by £450 – it's a cracking great 8-core gaming rig for the money.

MIKE JENNINGS

CPC REALBENCH 2015

56,857 539,854 113,156

GIMP IMAGE EDITING

HANDBRAKE H.264 VIDEO ENCODING

LUXMARK OPENCL

182,937 200,569

HEAVY MULTI-TASKING

SYSTEM SCORE

PERFORMANCE
23/25

DESIGN
21/25

OVERALL SCORE
89%

HARDWARE
21/25

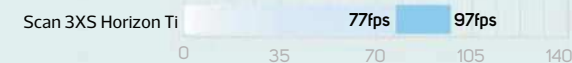
VALUE
24/25

VERDICT

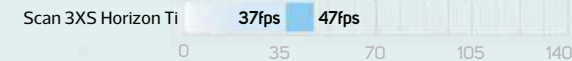
Superb gaming and multi-threaded application performance in a smart and unfussy rig for a fantastic price, although it's a little limited in places.

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA

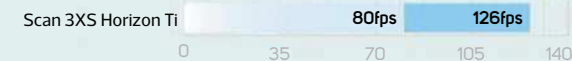


3,840 x 2,160, Ultra Detail, TAA

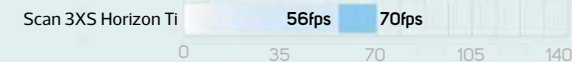


THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, Nvidia HairWorks off

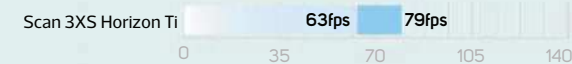


3,840 x 2,160, High Detail, Nvidia HairWorks off

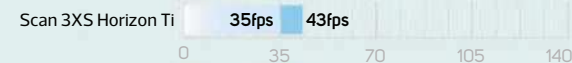


DEUS EX: MANKIND DIVIDED

2,560 x 1,440, Very High Detail, DX12



3,840 x 2,560, Very High Detail, DX12








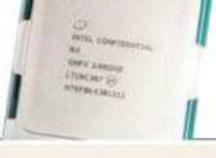


Minimum Average

Elite

Our choice of the best hardware available


Processors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ENTRY-LEVEL CPU WITH INTEGRATED GRAPHICS	AMD Ryzen 3 2200G (AM4)	www.scan.co.uk	Issue 176, p22	£84
	CPU WITH INTEGRATED GRAPHICS	AMD Ryzen 5 2400G (AM4)	www.scan.co.uk	Issue 176, p23	£135
	BUDGET GAMING CPU	Intel Core i3-8350K (LGA1151-V2)	www.overclockers.co.uk	Issue 175, p46	£155
	ALL-ROUND 6-CORE CPU	AMD Ryzen 5 2600	www.overclockers.co.uk	Issue 179, p21	£161
	ALL-ROUND 8-CORE CPU	AMD Ryzen 7 2700X	www.scan.co.uk	Issue 178, p22	£283
	GAMING 6-CORE CPU	Intel Core i7-8700K (LGA1151-V2)	www.scan.co.uk	Issue 175, p56	£319
	HEAVY MULTI-THREADING CPU	AMD Ryzen Threadripper 1950X (TR4)	www.ebuyer.com	Issue 170, p20	£790
	EXTREME MULTI-THREADING CPU	Intel Core i9-7980XE (LGA2066)	www.scan.co.uk	Issue 171, p20	£1,650

CPU coolers




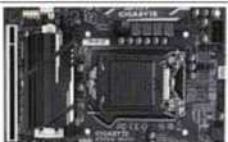

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	BUDGET AIR COOLER (LGA115X)	Rajjintek Rhea	www.overclockers.co.uk	Issue 163, p86	£16
	MID-RANGE AIR COOLER (LGA115X, LGA2011, AM4)	ARCTIC Freezer 33 eSports One	www.amazon.co.uk	Issue 175, p21	£35
	LOW-PROFILE AIR COOLER (LGA115X, LGA2011)	Noctua NH-D9L	www.amazon.co.uk	Issue 143, p17	£45
	120MM ALL-IN-ONE LIQUID COOLER (LGA115X, LGA2011, AM4)	ARCTIC Liquid Freezer 120	www.novatech.co.uk	Issue 178, p49	£55
	240MM ALL-IN-ONE LIQUID COOLER (LGA115X, LGA2011, AM4)	Fractal Design Celsius S24	www.scan.co.uk	Issue 167, p25	£110
	280MM ALL-IN-ONE LIQUID COOLER (LGA115X, LGA2011)	NZXT Kraken X62	www.overclockers.co.uk	Issue 160, p52	£140
	360MM ALL-IN-ONE LIQUID COOLER (AM4, LGA115X, LGA2011)	Corsair H150i Pro	www.scan.co.uk	Issue 175, p29	£165
	THREADRIPPER AIR COOLER	Noctua NH-U14S TR4-SP3	www.overclockers.co.uk	Issue 173, p30	£75

Virtual reality






	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	VR GAMING HEADSET	Oculus Rift Touch bundle	www.overclockers.co.uk	Issue 177, p82	£399

Motherboards

LGA1151-V2

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ATX BUDGET Z370	MSI Z370 SLI Plus	www.scan.co.uk	Issue 175, p24	£126
	ATX MID-RANGE Z370	Gigabyte Z370 Aorus Ultra Gaming	www.scan.co.uk	Issue 172, p46	£157
	ATX HIGH-END Z370	Asus ROG Maximus X Hero	www.scan.co.uk	Issue 172, p43	£236
	MINI-ITX BUDGET Z370	Gigabyte Z370N WiFi	www.ebuyer.com	Issue 174, p44	£135
	MINI-ITX MID-RANGE Z370	Asus ROG Strix Z370-I Gaming	www.scan.co.uk	Issue 174, p43	£179








LGA2066

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ATX PREMIUM X299	Asus Prime X299 Deluxe	www.scan.co.uk	Issue 168, p52	£371
	ATX MID-RANGE X299	Asus ROG Strix X299-E Gaming	www.scan.co.uk	Issue 168, p50	£300
	ATX BUDGET X299	ASRock X299 Killer SLI	www.scan.co.uk	Issue 171, p22	£217
	MICRO-ATX X299	MSI X299M Gaming Pro Carbon AC	www.cclonline.com	Issue 174, p24	£255
	MINI-ITX X299	ASRock X299E-ITX/ac	www.overclockers.co.uk	Issue 174, p26	£380






TR4

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ATX MID-RANGE X399	MSI X399 Gaming Pro Carbon AC	www.scan.co.uk	Issue 170, p50	£322
	ATX PREMIUM X399	Asus ROG Zenith Extreme	www.ebuyer.com	Issue 170, p48	£464
 NEW ENTRY	MICRO-ATX X399	ASRock X399M Taichi	www.overclockers.co.uk	Issue 179, p28	£310

AM4

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ATX HIGH-END X470	Gigabyte X470 Aorus Gaming 7 WiFi	www.novatech.co.uk	Issue 179, p47	£220
 NEW ENTRY	ATX MID-RANGE X470	MSI X470 Gaming Pro Carbon AC	www.box.co.uk	Issue 179, p50	£160
 NEW ENTRY	ATX BUDGET X470	Gigabyte X470 Aorus Ultra Gaming	www.box.co.uk	Issue 179, p48	£129
	ATX BUDGET B350	Asus ROG Strix B350-F Gaming	www.overclockers.co.uk	Issue 167, p20	£107
	MICRO-ATX BUDGET B350	Gigabyte AB350M-Gaming 3	www.ebuyer.com	Issue 169, p28	£67
	MINI-ITX B350	MSI B350I Pro AC	www.alza.co.uk	Issue 177, p22	£113
	MINI-ITX X370	Asus ROG Strix X370-I Gaming	www.cclonline.com	Issue 173, p32	£163






Memory

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	8GB DUAL-CHANNEL DDR4	8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16)	www.scan.co.uk	Issue 163, p86	£96
	16GB DUAL-CHANNEL DDR4	16GB Corsair Vengeance LPX 3000MHz DDR4 (CMK16GX4M2B3000C15)	www.scan.co.uk	Issue 166, p90	£165
	16GB DUAL-CHANNEL DDR4 RGB	16GB G.Skill Trident Z RGB 3200MHz DDR4 (F4-3200C14D-16GTZR)	www.cclonline.com	Issue 177, p45	£253
	32GB QUAD-CHANNEL DDR4 RGB	Corsair Vengeance RGB 3200MHz DDR4 (CMR32GX4M4C3200C16)	www.overclockers.co.uk	Issue 177, p48	£390
	16GB DUAL-CHANNEL RGB (AMD RYZEN)	16GB (2 x 8GB) 3466MHz Corsair Vengeance RGB (CMR16GX4M2C3466C16)	www.scan.co.uk	Issue 178, p24	£204

Software

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	OPERATING SYSTEM	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£100

Graphics cards

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	JUST 1,920 X 1,080 GAMING	Zotac GeForce GTX 1050 Ti 4GB Mini	www.ebuyer.com	Issue 163, p86	£155
	1,920 X 1,080 AND SOME 2,560 x 1,440 GAMING	Nvidia GeForce GTX 1060 3GB	www.scan.co.uk	Issue 159, p43	£195
	2,560 X 1,440 GAMING	Nvidia GeForce GTX 1060 6GB	www.scan.co.uk	Issue 159, p23	£245
	SMOOTH 2,560 X 1,440 GAMING	Asus ROG Strix GeForce GTX 1070 Ti	www.scan.co.uk	Issue 173, p20	£530
	4K GAMING	Asus ROG Strix GeForce GTX 1080 Ti OC	www.scan.co.uk	Issue 168, p28	£995





Cases

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	BUDGET ATX	Phanteks Eclipse P300	www.overclockers.co.uk	Issue 176, p28	£55
	SUB-£100 ATX PERFORMANCE	Phanteks Enthoo Pro M Glass	www.overclockers.co.uk	Issue 161, p24	£110
	SUB-£150 ATX QUIET	Fractal Design Define R6	www.cclonline.com	Issue 174, p20	£106
	SUB-£150 FULL-SIZED ATX	Phanteks Enthoo Luxe	www.awd-it.co.uk	Issue 144, p53	£131
	SUB-£150 MID-SIZED ATX	Cooler Master Cosmos SE	www.scan.co.uk	Issue 144, p41	£130
	PREMIUM ATX CASE	Phanteks Enthoo Evolv ATX Glass	www.overclockers.co.uk	Issue 169, p43	£175
	MINI-ITX TOWER	Fractal Design Define Nano S	www.scan.co.uk	Issue 153, p22	£57
	MINI-ITX CUBE	Fractal Design Core 500	www.scan.co.uk	Issue 150, p20	£40
	MICRO-ATX	Fractal Design Define Mini C	www.scan.co.uk	Issue 161, p26	£75
	PREMIUM MICRO-ATX	NZXT H400i	www.overclockers.co.uk	Issue 175, p32	£105









Case fans

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	120MM QUIET FAN (BEST RUN AT 5V)	Corsair SP120 Quiet Edition	www.scan.co.uk	Issue 155, p56	£15
	120MM PERFORMANCE FAN (BEST RUN AT 12V)	Thermaltake Pure S12 LED	www.amazon.co.uk	Issue 155, p58	£10

Power supplies

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	BUDGET 400W	XFX XT Series 400W 80 Plus Bronze	www.awd-it.co.uk	Issue 163, p86	£36
	MID-RANGE 450W	Corsair CX450M	www.scan.co.uk	Issue 164, p84	£50
	MID-RANGE 550W	EVGA SuperNova GS 550W	www.alza.co.uk	Issue 146, p50	£79
	HIGH-END 550W	Super Flower Leadex Platinum 550W	www.overclockers.co.uk	Issue 146, p52	£103
	MID-RANGE 750W	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£130
	HIGH-END 1.2KW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£330






Storage

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	MAINSTREAM HARD DISK	Western Digital Blue 4TB	www.overclockers.co.uk	Issue 166, p54	£95
	PERFORMANCE HARD DISK	Seagate BarraCuda Pro 6TB	www.overclockers.co.uk	Issue 166, p50	£218
	SATA SSD	Crucial MX500 500GB	www.ebuyer.com	Issue 176, p43	£95
	HIGH-PERFORMANCE M.2 SSD	Samsung 970 Evo 500GB	www.cclonline.com	Issue 179, p24	£189
	M.2 HEATSINK	EK Water Blocks EK-M.2 NVMe Heatsink	www.overclockers.co.uk	Issue 178, p87	£11
	SINGLE-BAY NAS BOX	Synology DS118	www.box.co.uk	Issue 174, p34	£160
	DUAL-BAY NAS BOX	Synology DS216j	www.box.co.uk	Issue 154, p28	£160
	DUAL-BAY MEDIA NAS BOX	Synology DS218play	www.box.co.uk	Issue 174, p34	£215






Monitors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	BUDGET 24IN FREESYNC MONITOR	AOC G2460VQ6	www.ebuyer.com	Issue 174, p52	£143
	24IN MONITOR	Dell UltraSharp U2417H	www.scan.co.uk	Issue 162, p58	£215
	24IN 144Hz FREESYNC ESPORTS MONITOR	Samsung C24FG70	www.ebuyer.com	Issue 176, p34	£180
	24IN FREESYNC MONITOR	ViewSonic XG2401	www.amazon.co.uk	Issue 167, p52	£199
	24IN G-SYNC MONITOR	AOC AGON AG241QG	www.currys.co.uk	Issue 169, p55	£410
	27IN 2,560 X 1,440 FREESYNC MONITOR	Samsung C27HG70	www.overclockers.co.uk	Issue 171, p28	£549
	27IN 2,560 X 1,440 G-SYNC MONITOR	Asus ROG Swift PG279Q	www.scan.co.uk	Issue 155, p48	£693
	34IN ULTRA-WIDE CURVED G-SYNC MONITOR	Asus ROG Swift PG348Q	www.ebuyer.com	Issue 157, p42	£985
 	5K MONITOR	Iiyama ProLite XB2779QQS	www.scan.co.uk	Issue 179, p34	£744


Networking

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ROUTER	Netgear Nighthawk X4S R7800	www.ebuyer.com	Issue 160, p44	£153
	BUDGET MESH NETWORK	BT Whole Home Wi-Fi	www.currys.co.uk	Issue 172, p54	£200
	PREMIUM MESH ROUTER	Netgear Orbi (RBK50)	www.amazon.co.uk	Issue 172, p57	£289
	WI-FI ADAPTOR	Asus PCE-AC68	www.scan.co.uk	Issue 128, p88	£59
	PREMIUM ROUTER	Asus ROG Rapture GT-AC5300	www.overclockers.co.uk	Issue 170, p35	£380

Peripherals

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	MEMBRANE GAMING KEYBOARD	Corsair Gaming K55 RGB	www.overclockers.co.uk	Issue 176, p52	£50
	MECHANICAL GAMING KEYBOARD	Cooler Master MasterKeys Pro L White	www.scan.co.uk	Issue 165, p55	£80
	PREMIUM MECHANICAL GAMING KEYBOARD	Corsair Gaming K70 RGB Rapidfire	www.ebuyer.com	Issue 154, p21	£133
	MMO KEYBOARD	Corsair Gaming K95 RGB Platinum	www.ebuyer.com	Issue 164, p26	£175
	GAMING MOUSE	Corsair Glaive RGB	www.box.co.uk	Issue 167, p19	£65
	AMBIDEXTROUS GAMING MOUSE	Razer Lancehead Tournament Edition	www.ebuyer.com	Issue 177, p53	£75
	MMO GAMING MOUSE	Corsair Scimitar Pro RGB	www.box.co.uk	Issue 164, p24	£70
	WIRELESS GAMING MOUSE	Logitech G403 Prodigy Wireless	www.overclockers.co.uk	Issue 171, p40	£90
	STEERING WHEEL AND PEDALS	Logitech G920 Driving Force	www.currys.co.uk	Issue 159, p55	£220

Audio

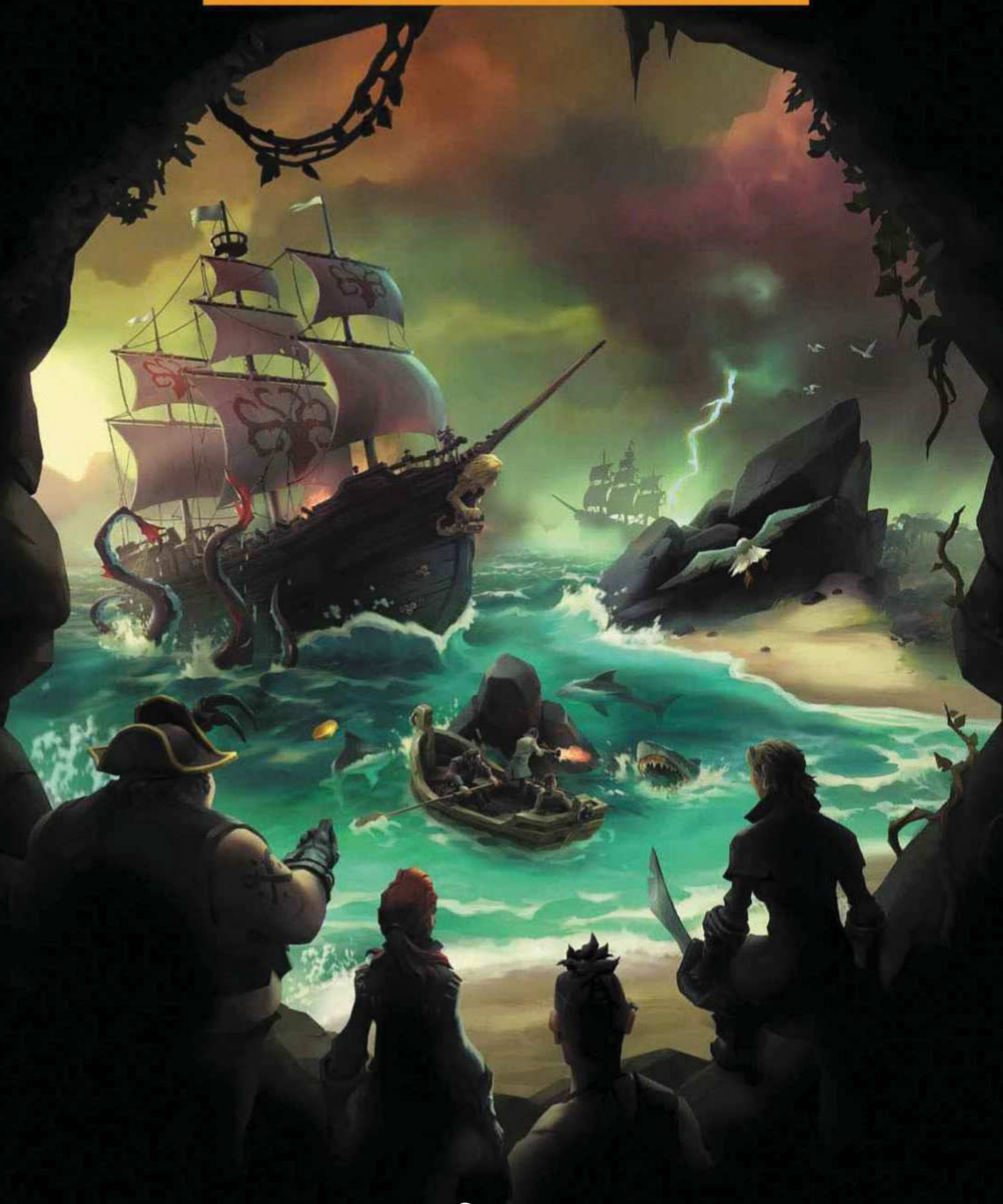
	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	PCI-E SOUND CARD	Asus Strix Raid DLX	www.scan.co.uk	Issue 148, p28	£159
	2.1 SPEAKERS	Acoustic Energy Aego ³	www.amazon.co.uk	Issue 164, p49	£200
	HEADSET	HyperX Cloud Alpha	www.currys.co.uk	Issue 173, p50	£90
	SURROUND-SOUND HEADSET	Asus ROG Centurion	www.cclonline.com	Issue 163, p49	£189
	WIRELESS HEADSET	SteelSeries Arctis 7	www.amazon.co.uk	Issue 178, p58	£130
	PREMIUM WIRELESS HEADSET	SteelSeries Arctis Pro + GameDAC	www.scan.co.uk	Issue 179, p31	£250

NEW ENTRY

Systems

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	AMD APU PC	Falcon Raptor RX	www.falconcomputers.co.uk	Issue 176, p56	c.£550
	SKYLAKE-X PC	Scan 3XS Carbon Aura	www.scan.co.uk	Issue 168, p66	c.£2,750
	BUDGET COFFEE LAKE PC	PC Specialist Ultima X01	www.pcspecialist.co.uk	Issue 172, p60	c.£1,479
	MID-RANGE COFFEE LAKE PC	Wired2Fire Diablo Aurora	www.wired2fire.co.uk	Issue 173, p56	c.£2,499
	WATER-COOLED COFFEE LAKE PC	CCL Iris Fusion LQ	www.cclonline.com	Issue 175, p62	c.£3,100
	PREMIUM COFFEE LAKE PC	Scan 3XS Vengeance Aura SLI	www.scan.co.uk	Issue 172, p64	c.£3,799
	DREAM PC	Scan 3XS Barracuda	www.scan.co.uk	Issue 145, p58	c.£9,499
 NEW ENTRY	AMD RYZEN 7 PC	Scan 3XS Horizon Ti	www.scan.com	Issue 179, p64	£2,150
	THREADRIPPER PC	CyberPower Ultra Threadripper Xtreme	www.cyberpowersystem.co.uk	Issue 171, p62	c.£3,469
	EXTREME THREADRIPPER PC	Chillblast Fusion Centauri Ryzen Threadripper Ultimate	www.chillblast.co.uk	Issue 173, p58	c.£7,500
	MINI-ITX GAMING PC	Corsair One Elite	www.corsair.co.uk	Issue 177, p60	c.£2,799
	PREMIUM PC	Scan 3XS Carbon Fluid Extreme SLI	www.scan.co.uk	Issue 170, p58	c.£4,950
	HIGH-PERFORMANCE GAMING LAPTOP	Scan 3XS LG17 Carbon Extreme	www.scan.co.uk	Issue 159, p30	c.£2,550
	THIN AND LIGHT GAMING LAPTOP	Alienware 13	www.alienware.co.uk	Issue 168, p32	c.£1,849
	BUDGET GAMING LAPTOP	MSI GE72 7RE Apache Pro	www.saveonlaptops.co.uk	Issue 167, p28	c.£1,137
	ULTRABOOK LAPTOP	Razer Blade Stealth	www.razerzone.com	Issue 167, p36	c.£1,350
 NEW ENTRY	COFFEE LAKE LAPTOP	Scan 3XS LG15 Vengeance Pro	www.scan.co.uk	Issue 179, p32	£1,400

Games



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RICK LANE / INVERSE LOOK

GROUCH POTATO

Split-screen gaming has fallen by the wayside,
and Rick Lane wants to bring it back

I love cooperative gaming. Playing games with a friend nearly always makes the experience more enjoyable, and playing a great game designed specifically for co-op is one of life's greatest joys. However, as a 30-year-old man with a young child, setting aside time for gaming isn't always easy, and pinning down a time with two or three friends with their own commitments requires military levels of organisation.

Fortunately, I'm blessed with a partner who likes games as much as I do, and I recently bought a Steam Link, as there are plenty of PC cooperative games that I figured would be fun to play together. What I discovered, however, is that the vast majority of 'couch-coop' PC games are short, throwaway experiences, designed primarily for parties. Meanwhile, the more substantive cooperative experiences, such as *Far Cry* and *Left 4 Dead*, are online only. There are very few couch-coop games designed for people to play together for longer than half an hour.

Perhaps I shouldn't be surprised. The PC has always been the spiritual home of online multiplayer gaming, and was never a bastion of local-coop. But today the PC is an enormously diverse format, with experiences ranging from hardcore driving simulations to casual platformers designed for gamepad play. Cooperative gaming represents a part of this increase in diversity, but there's one area where the PC is increasingly falling short – split-screen gaming.

There are hundreds of cooperative games available on PC now, and quite a few local-coop ones, but the number that offer split-screen play is comparatively tiny. The majority that do include split-screen modes are racing games such as *Blur*, *Dirt Showdown* and *Trackmania Turbo*, alongside a few weird outliers such as *Serious Sam 3* and *Rocket League*, the latter

probably being the best split-screen game on PC available now. Again, crowding around your PC to play a game wasn't viable for most of the platform's history, particularly when monitors were small.

Now, though, with wireless controllers, video game streaming, lap controller stations and 50in 4K TVs, nothing is stopping a split-screen revolution, apart from the desire of developers to implement it. Split-screen implementation isn't simple, of course. The game engine has to be modified to accommodate multiple screen views, and rendering a scene two or more times on the same screen is going to impact upon the overall visual detail too.

Most game developers will only go to these additional lengths if split-screen gaming is either a core part of the game's concept, or if there's a viable market for it. But that's precisely my point – I think that nowadays there *is* a market for it – just look at the current boom in cooperative board games. An entire generation of video game players has grown up, and the only time they really have to play games is time they mostly spend together. However, their options to actually play together are fairly limited, and it must have created a sizeable market niche.

That's why it's so frustrating when a big game such as *Far Cry 5* comes out, which includes cooperative play as a core part of its experience, and would be perfect to play on the sofa with your partner, but the option isn't available. It's possible that the publishers are looking at it as a lost sale on an extra game or console, which I guess is understandable, but it might also end up being a lost sale from people who don't have time to play a 40-hour game in the evening separately, but would like the opportunity to play it together in the same room. **PC**

The vast majority of
'couch-coop' PC games
are short, throwaway
experiences

Rick Lane is Custom PC's games editor. [@Rick_Lane](#)



Total War Saga: Thrones of Britannia / £26.99 inc VAT

DEVELOPER The Creative Assembly / PUBLISHER Sega / WEBSITE www.totalwar.com



After pitting dragons against giants, and elves against rat-men, in Total War: Warhammer, a game set in the perpetually damp and overcast British Isles is inevitably a bit anticlimactic. Granted, Thrones of Britannia is specifically about Anglo-Saxon Britain, where the followers of Alfred the Great clash against the Vikings of the North in arguably the most turbulent period of British history, but it's still not quite the same as fielding an army of dinosaurs or mechanical Steam Tanks. Britain doesn't even have War elephants.

With colourful flights of fancy replaced by grey skies and greyer beaches, this standalone Total War needs an ace up its sleeve. That ace, apparently, is innovation. As suggested by the extended title, Total War Saga is an offshoot game where the Creative Assembly can tear up the rule book, or at least let the family dog chew it. It forgoes the increasing grandeur of previous games, using our drizzly island as the setting for a more detailed experience that places as much emphasis on factional politics as on smashing an enemy army's flanks with a well-timed cavalry charge.

Thrones of Britannia kicks off in 878 AD, just after Alfred the Great defeated the Danish Great Heathen Army at Edington, the start of his gradual uniting of the various Britannic Kingdoms into the country vaguely recognisable as England. Thrones of Britannia lets you assume control of Alfred's Kingdom of West Saxe and attempt to follow in his footsteps, or rewrite history by controlling several other factions that include Vikings, Scots and Irish Gaelic tribes, as well as the Welsh.

In terms of your sense of the conflict's scale, Total War Saga doesn't feel much different to other Total War games. Although the map is technically smaller, it's split into many more provinces, while the battles play out on a similar scale to other Total War games. Instead, Britannia introduces a bunch of new mechanics and completely overhauls others in a significant rethinking of the game's political and warfare strategy.



Arguably the most notable is the introduction of factional politics. All characters in your faction, from leaders such as Alfred to generals and regional governors, have a relationship determined by unique personality traits, and several shared stats. Influence, for example, dictates the amount of respect characters command within your faction, while loyalty controls their likeliness to betray you and start a civil war. To keep your faction under control, you need to maintain a higher level of influence than your nobles, while also trying to secure their loyalty by bestowing honorary titles and estates upon them, arranging marriages (or annulling troubled ones) or simply buying them off.

The idea is to create a layer of emergent storytelling underneath the broader game of grand strategy, in the same vein as Paradox Interactive's Crusader Kings II. And like Crusader Kings II, Britannia can produce interesting events. If rumours circulate that a noble is plotting against you then you can choose to pay off that noble, or ignore the rumour and lower that noble's influence with the ensuing snub. However, continual bribes may be interpreted as weakness, while ignoring rumours can put you at risk of surprise attacks.

You can also engage in your own plots to lower a noble's influence, strip them of estates or assassinate them outright. However, such actions also carry potential consequences, successful or not. Unfortunately, at present

OVERALL SCORE

80%

/ VERDICT

The Creative Assembly uses a smaller, more narrowly focused Total War structure to try some new ideas, and enough of them work to make this offshoot island of a game a surprising success.



Britannia has a subtler, more nuanced ebb and flow than other Total War games, forcing you to plan your campaign in more detail, while also enabling greater strategic options. Provinces, for example, include multiple settlements, only one of which has walls. As such, there's more scope to occupy or sack smaller villages to damage another faction's economy, and for them to do the same to you.

It also results in fewer attritional sieges and more tactically diverse battles, with villages making for an interesting tactical challenge that doesn't simply involve smashing your army

against a big wall. Britannia also throws curveballs, such as Viking raiding parties landing on the coast, or vassal Kingdoms suddenly deciding they don't want to be vassals anymore. The result is one of the more strategically satisfying campaign maps of the whole series.

Meanwhile, the battles are basically fine. The unit roster is a relatively basic mix of infantry, archers and cavalry for all factions (with some specialist units such as Viking berserkers). You're not going to see anything wild, or even mildly bizarre (such as Rome's flaming pigs), but the fairly tight unit roster means battles are mostly well balanced. That said, battles are now more about the quality of the army you field, rather than the quantity of units, and having a good general on site will make your units more capable and less likely to rout.

Thrones of Britannia is hardly the most spectacular Total War game, and its most significant new feature is also its least successful. However, the other innovations make for an engaging game, while the smaller, more practical unit roster gives you more robust and stable battles. Britannia may not be the biggest or most glamorous Total War game, but its legacy may well shape the series for years to come.

That said, Britannia makes other, smaller changes that meaningfully evolve the game. For example, unit recruitment has been overhauled, so you no longer recruit units from specific buildings. Instead, new unit types are unlocked by researching technologies, and are recruited from a pool of units directly into any army.

This change has several consequences. Firstly, you no longer have to recruit units from all four corners of the map to assemble an army. If your army needs archers, you can recruit them immediately from any location. However, units are only recruited at around half-strength, so you'll need to wait a few turns to attack with all your might. Meanwhile, more elite units tend to replenish less frequently, so you have to think about how best to distribute your forces. The new recruitment system improves over the old one, more accurately representing how army levies worked in the pre-industrial era.

Armies now also run on supplies, which will naturally accrue within your borders and deplete in enemy territory. An army that runs out of supplies will suffer from desertion, so you'll need to return home periodically to restock. In addition, your people's appetite for war changes according to the War Fervour statistic, with either continual war or continual peace resulting in public unrest.

Armed with these changes, Britannia is a game that offers a different experience from other Total War titles. It's a game that's more about strategy and tactical depth than pure spectacle. It's a game that's more about the quality of your army than the quantity of units. It's a game that's more about the legacy of the series than the individual game.

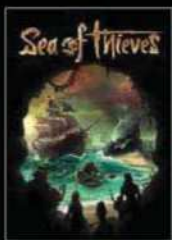


RICK LANE



Sea of Thieves / £49.99 inc VAT

DEVELOPER Rare / PUBLISHER Microsoft / WEBSITE www.seaofthieves.com



A sailing ship is the ideal mode of transport for an open-world game; it's essentially a giant wooden fort that goes wherever you go. It's simultaneously a vehicle, a weapon and a storage space, which are generally the essentials in a virtual world. A sailing ship is also a puzzle game itself, where one wrong move will end in the world's worst case of rising damp. Sails must be spliced, helms manned, anchors weighed, all in time with the movements of the wind and the waves. Care and maintenance are also crucial. A hole in the hull must be plugged with a plank, while seawater pouring into your cargo hold must be bailed out posthaste.

A ship embodies many of gaming's key motivators, namely management, mastery and adventure. Sea of Thieves evidently understands these factors, placing much of its emphasis on learning the rhythms of pre-

industrial nautical navigation.

Whether you're playing alone or as part of a crew of up to four maritime miscreants, you're constantly moving about your vessel, touching and tweaking it in various places to stop it smashing into rocks or veering into an enemy galleon's cannon sights.

It's a unique blend of teamwork and plate spinning that makes simply getting to your location an innately satisfying experience. Which is just as well, because once you arrive at your chosen destination, there's alarmingly little else to do.

Perhaps that's why there's so little preamble when you start your multiplayer pirate adventure. Sea of

Thieves begins with you picking your preferred piratical avatar and one of two ship types – a slow yet durable galleon, which is ideal for four-player crews, or a smaller, faster sloop, designed for either two players or solo seamanship. You're then plonked directly into the game, and the only advice you get is on how to accept missions. There's no sailing school, no introduction to the game world and no backstory. You're a pirate, miladdo, do pirate things!

Developer Rare clearly wants you to figure it all out for yourself, which makes sense in the context of cooperative multiplayer. Partly because of humour – there aren't many virtual sights quite as amusing as watching a friend trying to work a cannon and accidentally firing themselves out of it – but also because it encourages teamwork. Successful sailing requires precision and attention at each station on the ship. The winds change frequently, so the sails must be rotated to maintain speed, while anchors must be raised and dropped at the right moment to prevent calamity. The ships also turn very slowly, so the helmsman must begin turning well in advance to avoid any approaching obstacles.

Alongside these primary jobs are a bunch of secondary jobs, such as navigating the game's island archipelago using the ship's map, repairing any damage to the ship and manning the crow's nest to watch for oncoming dangers, such as brewing storms or other ships. It's possible to do it on your own, and sailing a sloop alone is both highly instructive and satisfying in its own right, but you'll want to experience Sea of Thieves' unique pirate party at least once.



OVERALL SCORE

65%

/ VERDICT

Splendid sailing on a sumptuous sea can't make up for Sea of Thieves' lack of depth.



Sea of Thieves certainly scrubs up well. The ocean's look and mood constantly change, ranging from placid crystalline waters burning bronze with the sunset, to roiling aquatic rollercoasters that toss your ship about like a child's toy. In severe storms, the sea can be so violent that unwary pirates might be thrown overboard. Islands rear up as foreboding grey lines on the horizon, then mutate into miniature paradises of glittering sands and lush palm forests. However, danger often lurks amid the foliage, in the form of skeletal swashbucklers that attack relentlessly with both sword and musket.

The mood on deck can change equally quickly. One minute you might be playing a sea shanty on a variety of virtual instruments, and the next minute racing for the cannons as an enemy sail silhouette hoves into view.

Your overall goal is to accumulate gold, which you can do by performing odd jobs for the game's three NPC factions. The Merchant's Guild will send you off to capture chickens and pigs, and deliver them to other ports. The Gold Hoarders will supply you with treasure maps to follow, and the Order of Souls will task you with eliminating undead pirates and bringing back their skulls.

Each of these missions is presented in a typical hands-on fashion. Treasure maps are clutched tightly in your virtual hands, and you must identify the correct island by its outline

then pinpoint the spot marked by an X. Once there, you must get out your spade and dig, until you hear the all-important clunk of metal hitting wood. Tracking down the treasure is only half the battle, as you must return it safely to port while avoiding the grasping hooks of other chancing marauders roaming the waves.

The first few hours of Sea of Thieves are tense and thrilling, as you slowly learn the mastery of your craft in a vast and merciless ocean. After this time, however, it soon becomes apparent that, depth-wise, Sea of Thieves is more of a puddle than an ocean. Its handful of randomly generated mission are highly repetitive, and there are very few secrets or interesting adventures to be found on the game's idyllic desert islands.

Of course, you can try to make your own fun by hunting down other player vessels and plundering their loot, and the game's systems allow for a certain level of creativity in attacking other vessels.

You can try to sink them with cannons, swim beneath the waves to sneak aboard, and even use your trusty grog tankard to fill a vessel with water. But even if you manage to amass a vast hoard of treasure, it can only be spent on cosmetic items, a new texture for your spyglass, a new paint job for your ship's hull and so on.

It's admirable that Rare wants to keep a level playing field and prevent experienced players from becoming overwhelmingly powerful, but the lack of meaningful ways to spend your ill-gotten gains makes the whole endeavour feel a bit pointless. Combine this lack of depth with the absence of variety in the mission design, and there's not much reason to stick once you've paddled in Sea of Thieves' piratical pool.

It's unfortunate, because the core of Sea of Thieves is truly wonderful, while its stunningly designed oceanic world yearns to be explored. It's likely that Rare will build substantially on the framework that's currently available, but right now Sea of Thieves is in dire need of more meat on its crossed bones.

RICK LANE





Apex Construct / £24.99 inc VAT

DEVELOPER Fast Travel Games / PUBLISHER Fast Travel Games / WEBSITE www.apexconstructgame.com

Apex Construct is a VR game that aims to be more than an hour-long experiment. Its post-apocalyptic story sees you awaking in a wrecked world, missing your memory and your left hand. Fortunately, you're greeted by a benevolent-seeming AI called Father, who gives you a robotic replacement arm. Father explains that civilisation was destroyed by another AI called Mother and you're the last human left alive – you then need to track down and deactivate Mother before she deactivates you.

The game comprises a sequence of semi-open levels surrounding a central hub, with many paths gradually unlocking as the game progresses. Apex Construct's ruined world is presented in an eerily pleasant painterly aesthetic, with an architectural style somewhere between Dishonored's pseudo-Victorian brickwork and Half Life 2's blue-tinged chrome. It's also built specifically with VR in mind. The landscape is cracked and jumbled like an upturned Lego box, with buildings stacked atop one another and lying across bus-wide crevasses in the shattered Earth.

You must delve deep into this ruined world, infiltrating long-defunct AI laboratories and cybernetic manufacturing plants, in your search for Mother. Apex Construct is at its best when you're nosing around these dead institutions, solving puzzles by rooting through dusty store cupboards for a hidden button or code. VR brings a wonderful physicality to these previously

simple interactions, and it's very satisfying to take a clipboard off a shelf and bring it close enough to your face to read its contents. You also store items in your inventory (which is attached to your wrist) by picking them up and placing them on yourself, at which point they shrink into a miniature version of the item in question.

For combat, you get a recurve bow, which you draw and shoot like an actual bow to defeat the scuttling robotic enemies that prowl Apex's world. It's a great idea, and the bow fires with a satisfying 'thrum' each time you release its virtual string. However, fighting more than one opponent at a time is tricky, especially if you're using teleportation-based movement to negate motion sickness. The bow also comes with a front-facing shield attached to help you block enemy attacks, but it depletes quickly when there's three enemies firing at you at once.

There's a couple of other issues too. For many of its puzzles, the game employs virtual computer consoles, but typing on their virtual keyboards is quite fiddly and frustrating. Also, while the voice acting is passable, the breathy tones of Father sound rather unconvincing. It's a game that's clearly stretching its own resources, so there's a rough edge to some of its systems and production.

Nonetheless, Apex Construct is a significant step forward for more substantial VR games, providing a world that deserves to be explored.

RICK LANE

OVERALL SCORE

80%

/ VERDICT

An ambitious, intriguing VR adventure with fun combat and puzzle-solving, despite the odd rough edge.

RICK LANE / THE ENGINE ROOM

The AI system that makes games

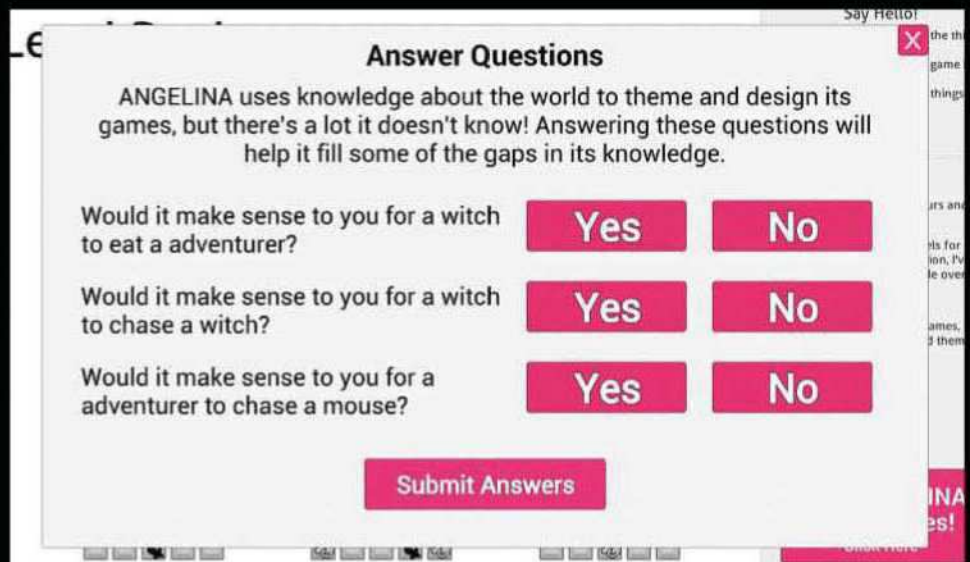
Can a computer make a game all by itself?
Rick Lane speaks to ANGELINA creator, Mike Cook

In a small corner of one of the Tobacco Dock London venue's many alcoves, a developer quietly worked on its games amid the pleasant hubbub of this year's EGX Rezzed convention. Two computers sat side by side. One monitor displayed a simple questionnaire where players could fill in their answers, while a simple grid-based puzzle game could be played on the other screen. Depending on the time of day, that game could involve anything from mice avoiding cats while trying to eat cheese, to cows chasing bananas while avoiding UFOs.

The same creator lay between those two computers. Its name is ANGELINA, and it's an artificial intelligence (AI) system that makes its own games. ANGELINA is the brainchild of Mike Cook, who began creating the AI system in 2011 as his PhD project at University College London. The ultimate, ideal end goal was to create an AI system that can conceive of a game idea and then implement it autonomously much like a human.

Getting your head around this concept can be quite difficult, as we're talking about a piece of software that can, for all intents and purposes, create its own pieces of software. Cook compares the system to how games such as Minecraft and Spelunky procedurally generate landscapes. ANGELINA's work is similar, but with game rules.

'I've written down this rule that if an object touches another object, the



Rezzed Attendees were able to provide Angelina with information, which it could then use to make its games

second object gets destroyed,' says Cook. 'And I told ANGELINA that this is a rule you can use, and if players see it, they will interpret it as killing, eating or collecting. It can take this rule, and like Spelunky's jigsaw levels, it can make a jigsaw ruleset out of these pieces. There's a lot of intelligence needed to figure out what's good and what isn't.'

Because ANGELINA is still an ongoing project, its capacity to develop games is limited to what it has been 'taught'. 'Some bits still really rely on my input,' says Cook. 'So when it creates rulesets for its game, it looks through this big archive of game rules that I've written down.'

Cook also discusses how ANGELINA designs levels. 'It completely does this from scratch,' he says. 'It tests the levels and plays

them to see whether they're good – it reuses the ones that are good and throws away the ones that are bad.'

ANGELINA has gone through many different forms since Cook began the project in 2011. Its initial version could produce very simple, Pac-Man-style games that revolved around interacting with different coloured dots. One game might involve you chasing blue dots and avoiding red ones, while another might switch them around. Later versions of the AI sourced information from the Internet and built games around that information, including a spree of games built around information collected from Guardian articles. For one version of the AI system, Cook designed a simple 3D engine in Unity with which ANGELINA could develop first-person maze games.

Level Design

Mouse Of The Dead

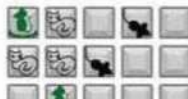
Mice will chase Cats. Mice push Mice. Mice push Mice. If Mice touch Mice, they eat them and you gain a point. If you score two points, you win!

Use the arrow keys to move Cats. Use the arrow keys to move Cats. If all Cats are on Mice, you lose!

Playout



Best Levels Played So Far



Here, the AI has made a game about cats chasing mice, although it's still pinning down precisely how cats relate to mice

Say Hello!

#whatisXY - Ask me what the thing is at those co-ordinates!
 #whatgame - Ask me what game I'm working on right now
 #whatsnext - Ask me what things I'm working on this week

Status

I've been working for 3 hours and 53 minutes!

I'm currently designing levels for a game I'm making. This session, I've played 685 levels, and made over 1498391 moves!

If you're interested in my games, you can play and download them online:

gamesbyangelina.itch.io

Help ANGELINA Make Games!
[Click Here](#)

Although ANGELINA's creative repertoire is fairly limited, the way it can interpret the rulesets it understands are fascinating, sometimes even surprising its creator. One example is a game ANGELINA created called Before Venturing Forth, a simple maze game in which an adventurer must find the exit from a dungeon while avoiding roving skeletons.

'In my mind it was obvious that there would only be one adventurer and there would only be one exit, but I never told it that,' Cook says. 'In the game ANGELINA made, you control a group of adventurers, and you only have to get one of them to the exit - basically, a lot of the solutions to levels involve getting someone killed.'

When Cook initially conceived of the project, he imagined ANGELINA as an all-purpose game developer, essentially a box that would sit in a corner and periodically produce entire games through raw calculation and autonomous decision making. However, if the goal of AI is produce a human-like intelligence, then that's not how human beings make games. Games are nearly always a collaborative art, with many individuals involved in their production.



An earlier version of ANGELINA created platform games derived from Guardian articles

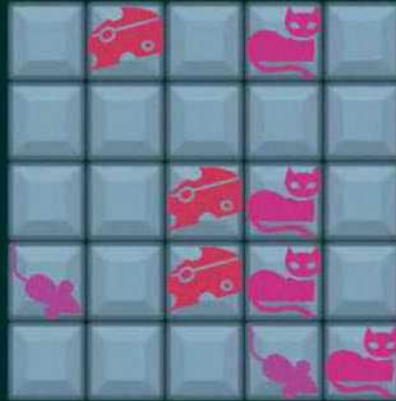
This realisation spurred Cook to build a new and very different version of ANGELINA. Rather than using the Internet to source concepts and ideas, it used the visitors of the Rezzed show itself. Any visitor could sit down and suggest a new concept to ANGELINA (we suggested 'bananas') and also tell ANGELINA a fact (bananas are yellow). ANGELINA, meanwhile, could ask attendees questions, such as: 'Would it make sense to you that

a monkey could eat a banana?' The AI system could then store all this information in its database and use it in its games.

Cook's new vision for ANGELINA isn't as an omnipotent game developing machine, but as an intelligence system that makes games just like a human would make them. 'I don't want it to become independent - we often think of AI as not needing humans at all. I want this to be embedded,' he

Level 4

The arrow keys move Mice. If Mice touch Cheese, the Cheese get eat and you gain a point. If you score two points, you win!



Cats will chase Mice. If Cats touch Mice, the Mice get kill. If there are 0 Mice left, you lose!

Press R to Retry

More at gamesbyangelina.itch.io

says. For example, Cook deliberately tweaked ANGELINA for the Rezzed show, so it would to develop games very quickly and people could see the games being made.

'But the levels aren't very good,' says Cook, so after Rezzed is done, I'm going to slow ANGELINA down and it's then going to take a week or two weeks to make a game. This is the opposite of my approach up to this point. The research was previously based on asking how to make it faster and more efficient, but with this version I've realised that faster doesn't help, really.'

Cook is also very keen to demystify ANGELINA's processes, and the processes of AI in general. The Rezzed version of ANGELINA showed attendees not just levels the AI system had created, but also levels it had rejected for not being good enough. 'I want you to see ANGELINA make a mistake and then throw away a level, or think of an idea that you might think is rubbish, and then ten minutes later ANGELINA itself thinks, "Actually, that IS rubbish" and gets rid of it.'

Ultimately, Cook wants ANGELINA to work directly with other creators. 'I'm planning to get an agreement with a few artists saying, "Okay, occasionally you'll get

emails from this thing and don't be scared—I will pay for whatever it orders. Then ANGELINA can email them on a Monday, and say, "I'm making a game about cows and I want it to be a scary game. I'm using these colours, can you do me some sprites by Friday?" And on Friday the artists will email back.'

The obvious end goal is for ANGELINA to make games just like a person would, but such idealism is still some way off. ANGELINA still can't come up with its own rules for games, which is one of the next steps Cook wants to take, and there remain many concepts that can be

A more advanced game of cat and mouse, with collectible cheese

In this game, adventurers must avoid the skeletons, and the player controls several adventurers at once

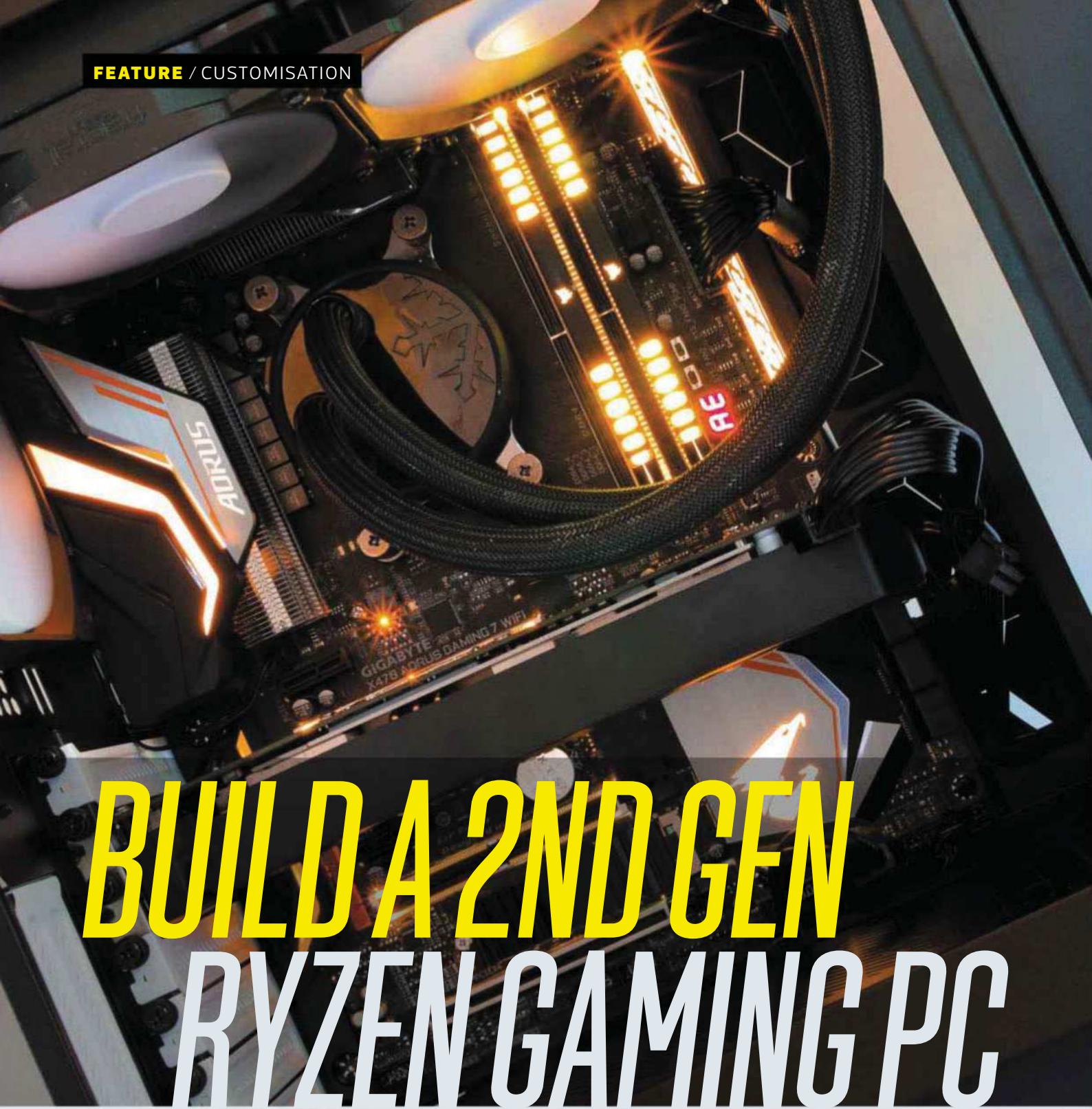
quite hard for AI to understand – for example, ideas that blend fiction with reality, such as whether cats can love witches. Witches don't exist in the real world, and whether cats can feel love is debatable, but in a fictional context, cats are closely associated with witches.

In the short term, Cook's plan is to enter one of ANGELINA's games in the Independent Games Festival (IGF). 'As a kind of milestone on the horizon, I'd love it to be nominated,' he says, although the last time ANGELINA entered a competition – the Ludum Dare Game Jam – the judges had trouble separating ANGELINA from the game ANGELINA actually made. 'In the jam it ranked highly for innovation, and its game wasn't innovative. People thought ANGELINA was innovative,' says Cook.

Indeed, perhaps the biggest milestone for ANGELINA will be when people can clearly understand it as a developer of games, and not a type of game in and of itself. 'I'll know ANGELINA has succeeded when someone steals one of its ideas or clones one of its games,' Cook says. 'Or inspire someone. I know lots of small indie developers and I'd love it if they worked with ANGELINA one day and got inspired by it.' **CPC**

Level 3





BUILD A 2ND GEN RYZEN GAMING PC

ANTONY LEATHER ASSEMBLES AN 8-CORE PC USING AMD'S NEW 2ND GEN RYZEN 7 2700X CPU AND AN X470 MOTHERBOARD



The 2018 CPU war is in full swing, with AMD firing the first shots with its excellent 2nd Gen Ryzen CPUs. AMD has made significant headway all round, with better lightly threaded performance, and its 8-core chips have also extended their lead over Intel's 6-core CPUs in heavily multi-threaded tasks. Building an AMD system needs some careful forethought to get the most out of it,

though, as Ryzen CPUs benefit from good cooling and fast memory.

What's more, the Ryzen 7 2700X can actually be quicker when it's left at stock speed too. In this feature, we've selected some of our favourite gear to create an awesome, super-quiet PC based around AMD's Ryzen 7 2700X 8-core CPU, and we'll show you how to put it all together and set it up too.

THE GEAR

CPU

AMD Ryzen 7 2700X /
£293 inc VAT

SUPPLIER www.scan.co.uk

Offering the highest boost frequencies of any 2nd Gen Ryzen CPU, the Ryzen 7 2700X is the most compelling CPU in the line-up. With eight cores and 16 threads, frequencies of up to 4.3GHz and Core i7-8700K-beating performance in multi-threaded tasks, it's a great choice for a general-purpose system. Paired with fast memory, it can also keep up with an Intel system in games. It generates a fair amount of heat, though, so it needs a powerful CPU cooler.



ALTERNATIVES

If you don't need quite as many cores and threads, the Ryzen 5 2600 (see p21) costs under £170 inc VAT and is still a great multi-purpose CPU. Our sample easily overclocked to 4.1GHz too. Meanwhile, if you want the best gaming performance, but still need some added multi-threaded grunt, Intel's Core i7-8700K is currently available for under £300, although you'll need to pair it with a Z370-chipset motherboard.

MEMORY

16GB (2 x 8GB) Corsair Vengeance RGB 3466MHz /
£200 inc VAT

SUPPLIER www.scan.co.uk

Our testing last month revealed that the latest Ryzen platforms can offer worthwhile performance gains with faster memory, all the way up to 3466MHz. Above this frequency, memory prices start to skyrocket, so you'll see diminishing returns from your extra cash. Some of the biggest benefactors were games, with the Ryzen 7 2700X closing the gap even further between it and Intel's Core i7-8700K, just by using faster memory.

Corsair's Vengeance RGB 3466MHz kit is one of the cheaper kits at this speed, at



around £200 inc VAT, and with many games and applications regularly using more than 8GB these days, any system costing over £1,000 should have 16GB of RAM. Stepping down to 3000MHz will only save you £20-30, so our 3466MHz kit is a no-brainer for high-end Ryzen system. Corsair's kit is also equipped with RGB lighting that can be controlled via your motherboard.

MOTHERBOARD

Gigabyte X470 Aorus Gaming 7 WiFi / **£220 inc VAT**

SUPPLIER www.novatech.co.uk

Our Labs test-winning X470 motherboard this month is Gigabyte's X470 Aorus Gaming 7 WiFi (see p47). It's a good overclocker, has excellent on-board VRM cooling, it looks fantastic, and it has a powerful fan and pump control system. It also caters well for our Samsung 960 Evo SSD with its included M.2 SSD heatsink. It's RGB lighting is second to none, and there's also plenty of RGB headers on the PCB should you wish to add your own LED strips.



ALTERNATIVES

Gigabyte's X470 Aorus Ultra Gaming (see p48) is around £90 cheaper than the X470 Aorus Gaming 7 WiFi and still overclocks well. However, it has fewer features and less capable power circuitry and cooling.

GRAPHICS CARD

Palit GeForce GTX 1060 Dual 6GB / **£270 inc VAT**

SUPPLIER www.ebuyer.com

If you want to play games at 1,920 x 1,080 or 2,560 x 1,440, Nvidia's GeForce GTX 1060 6GB is a great choice. It's a good overclocker, it runs very cool and it can handle most games at 2,560 x 1,440 at high settings with a minimum frame rate of 30fps or higher. We opted for Palit's GeForce GTX 1060 Dual 6GB card, which is an excellent overclocker, plus its dual-fan cooler is quiet under load and it switches off its fans below certain temperatures.



ALTERNATIVES

If you're only going to be playing games at 1080p, then consider the cheaper GTX 1060 3GB, which is still a potent graphics card and can handle some games at 2,560 x 1,440 too. The even cheaper GTX 1050 Ti is also a solid choice if you only want to play games at 1080, and are prepared to occasionally drop your graphics settings a little.

SSD

Samsung 960 Evo 500GB / **£189 inc VAT**

SUPPLIER www.scan.co.uk

Most modern motherboards have at least one 4x PCI-E 3 M.2 slot for NVMe SSDs, which often offer read and write speeds up to seven times faster than a standard 2.5in SSD, while also having the benefit no cables. The Samsung 960 Evo we've chosen has ample room for games, programs and Windows, while also being very fast. We'll be making use of our motherboard's M.2 heatsink to keep it cool under load too.



ALTERNATIVES

A PCI-E SSD is still an extravagance, and despite the fast benchmark figures, you won't notice a difference in speed in general use, at least not in the same way as moving from a hard disk to an SSD.

However, you can still take advantage of your motherboard's M.2 slots by using a SATA M.2 SSD.

These drives offer identical speeds identical to their 2.5in counterparts, and you can pick up a 500GB Crucial MX500 for £109 inc VAT from www.scan.co.uk

HARD DISK

WD Blue 2TB / **£56 inc VAT**

SUPPLIER www.scan.co.uk

You may find that 500GB of storage space is enough, but if you have large media collections you want to store as well, a hard disk is your best option. We've opted for a 2TB WD Blue, but if you need a larger or faster hard disk, you can also consider Seagate's BarraCuda 6TB.



PSU

Corsair CX550M / **£57 incVAT**

SUPPLIER www.ebuyer.com

Our system only drew a little over 200W under load, but if you combine high CPU usage with GPU acceleration in content creation then you could start to see this figure top 300W. To ensure there's enough headroom, we've opted for Corsair's semi-modular CX550M, which offers 550W of power, and will also enable you to add a more powerful graphics card later.



It also has the now rare ability to house more than two hard disks, and it has plenty of scope for using large all-in-one liquid coolers or custom water cooling too.

ALTERNATIVES

The Phanteks Enthoo Evolv looks better than the Define R6 but costs significantly more money. For smaller budgets, the Phanteks Eclipse P300 is a great choice for under £60, although its out-of-the-box cooling is poorer than that of the Define R6.

CPU COOLER

Fractal Design Celsius S24 /

£100 incVAT

SUPPLIER www.novatech.co.uk

It pays to give 2nd Gen Ryzen CPUs a decent cooler. As we've seen lower temperatures using all-in-one liquid coolers with 240/280mm radiators than 120mm models (see p102), we've spent a little more money here and gone for Fractal Design's



Celsius S24. This quiet cooler has a 240mm radiator and a pair of fans, offering much better cooling than any of the 120mm radiator coolers we've tested recently. It's also Socket AM4-compatible out of the box.

ALTERNATIVES

If you're on a tight budget then ARCTIC's Freezer 33 eSports One is a capable air cooler and costs just £35 inc VAT, but it will be louder and have higher processor temperatures than our chosen cooler. ARCTIC's Liquid Freezer 120 is a big step up from most air coolers and offers decent cooling at low noise levels for £55 inc VAT, but again, it isn't as potent as the Fractal Design Celsius S24.

TOTAL: £1,491 incVAT

CASE

Fractal Design Define R6 / **£106 incVAT**

SUPPLIER www.cclonline.com

Our current favourite quiet full-tower case is Fractal Design's excellent Define R6. It offers excellent cooling, a trio of 140mm fans out of the box, a PSU cover to hide unsightly cables and a tempered glass side panel.

BUILDING THE PC

INSTALL CPU

The pins on Ryzen CPUs are fragile, so take care not to drop the CPU or otherwise bend the pins. Lift up the lever next to the socket, flip it up, and firmly install the CPU with the Ryzen logo rotated 90 degrees clockwise. You can then push down the lever to lock in place **01**.

REMOVE THE PLASTIC COOLER MOUNTS

The Fractal Design Celsius S24's pump and waterblock unit uses the standard metal AMD

motherboard backplate but has its own mounting mechanism. You'll need to remove the four screws and two plastic mounts on top of the motherboard **02**.

INSTALL THE COOLER MOUNTING PINS

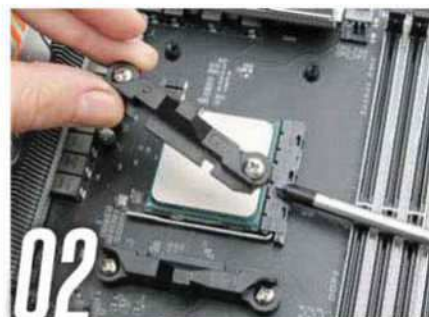
Locate the four AMD Socket AM4 mounting pins in the Fractal Design cooler's accessories set and secure them to the motherboard backplate under the four threads around the CPU socket. Hand-tighten them as far as you can go **03**.

INSTALL SSD

Remove the protective plastic on the underside of the M.2 heatsink, insert your SSD into the motherboard M.2 slot **04**, then screw the heatsink into place on top. Removing the SSD sticker may improve thermal transfer but it could void your warranty, so we don't recommend it.

INSERT FRONT PANEL CABLES INTO CONNECTOR

Gigabyte includes a connector that holds all the small front panel cables together, making





it much easier to install them when the motherboard is mounted in the case. Thread the labelled sockets into the connector's corresponding pins **05**.

INSTALL PUMP

It's easier to secure the pump to the motherboard prior to installing it in the case, so attach the AMD mounting ring to the pump section and secure it to the pins you've installed on the motherboard **06**. We're using the PWM mode on the pump, which is selectable by twisting the top section.

INSTALL MEMORY

Our dual-channel memory kit comes with two modules, which need to be fitted in the second and fourth slots as you move away from the CPU socket. Flip down the notches, then push the memory firmly into place – the notches will flip up and grip the modules **07**.

TEST MOTHERBOARD AND GPU

The motherboard has a power button that makes it simple to test your hardware before case installation **08**, making sure none of it was dead on arrival. Attach the power cables

from your PSU – you'll need the 24-pin ATX connector on the right edge of the motherboard, the 8-pin CPU power connector on the top edge of the motherboard and a 6-pin PCI-E connector for the graphics card. You'll also need to connect power to the CPU cooler, using the CPU fan header to the top right of the CPU socket.

Install the graphics card in the motherboard's top 16x PCI-E slot, then you can connect it to the monitor, plug the PSU into the mains and turn on the PSU's power switch if it isn't on already. You can now use the power button on the motherboard's rear I/O panel to power on the PC for a few moments to check there's a display being sent to the monitor. Once you see the POST screen, hold down the power button again to switch off the PC.

REMOVE TOP VENT COVER

Fractal Design includes a large plastic top vent cover for the top fan mounts, which can reduce noise if you're not using them. We'll be fitting the radiator here, so it's important to remove the top cover **09**, so the Celsius 24 cooler can exhaust warm air out of the roof.

INSTALL MOTHERBOARD

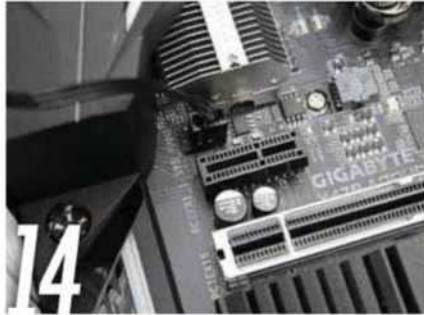
With the case on its side and the radiator supported on the case, check there are standoffs in the case that correspond with the screwholes in the motherboard (so the solder points under the board don't short-circuit on the metal tray), then lower the motherboard into the case **10**. The motherboard has an integrated I/O shield, so there's no separate one to install. Secure the motherboard in place using the screws provided with your case, and attach the front panel connector to the pins at the bottom of the board.

INSTALL RADIATOR

Attach the fans to the radiator, and then install it in the roof of the case, with the front of the fans pointing downwards, using the short screws provided with the cooler **11**. Orientate the fans so that they're blowing into the radiator and exhausting hot air out of the case.

REMOVE UNWANTED DRIVE BAYS

The Define R6 includes a number of mounts for hard disks and SSDs in the front section, which sits behind the front case fans. It's worth removing the white drive mounts from



the front of the case if you're not using them, in order to boost airflow **12**.

INSTALL OTHER CASE CABLES

Connect the case's audio and USB 3 front panel connectors to the appropriately labeled ports on your motherboard **13**. Route them from the back of the case, then through to the front using the case's cable-routing holes – you can tidy them up later.

CONNECT CASE FANS

The motherboard has plenty of fan headers, so use the ones closest to the fans to make for easier cable tidying **14**. Make note of the fan headers you use, so you can identify them in the EFI later when you fine-tune the fan speeds. They all work in the same way, so you can use any headers you like.

USE FAN HUB

The Define R6 has a PWM fan hub, which can use a single 4-pin PWM fan header to control several case fans. If you want all your fans to respond to a single fan header, connect your fans to the hub instead **15** – you then only need to configure one fan header in the EFI.

REMOVE UNWANTED PSU CABLES

The PSU has a semi-modular design, with key cables permanently attached. However, the rest of them can be removed to reduce cable clutter if you don't need them. We don't need the Molex cables, for example, so they can stay in the box **16**.

INSTALL PSU

Install the PSU underneath the case's PSU cover. You can now thread the cables around the back of the motherboard tray **17** and through the cable-routing holes in the case.

CONNECT MOTHERBOARD POWER CABLES

Thread the 8-pin EPS 12V connector and 24-pin ATX connector through the case's cable-routing holes nearest their corresponding sockets on the motherboard, and connect them to the motherboard **18**.

INSTALL GRAPHICS CARD

Install the graphics card in the top 16x PCI-E slot in the motherboard. By removing the drive mounts in the front of the case next to

the graphics card, you're potentially increasing the airflow available to it. Finally, connect the 6-pin PCI-E power connector to the graphics card. **19**

INSTALL HARD DISK

Hard disks install in the white 3.5in mounts in the front of the case **20**. Have the rear of the hard disk pointing at the far side of the case, so you can route the cables straight behind the motherboard tray.

Use one of the lower mounts so you can remove the upper mounts to improve airflow. We've used a WD Red drive here as an example for installation, but the WD Blue range offers better value for general desktop use.

TIDY CABLES

With all the cables connected, use the included cable ties to gather the cables together to tidy up the inside of the PC behind the motherboard **21**. Make good use of the PSU cover to hide as many of them as possible – it's a great place to stash excess cables and they won't impact on cooling down there either.

SETUP, OVERCLOCKING & PERFORMANCE

CHECK EFI

When your system boots up, press the Del key to enter your motherboard's EFI system. You can then apply the Extreme Memory Profile (XMP) in the M.I.T section [22](#). This setting should set the RAM to the correct speed, timings and voltage, but it's worth double-checking the voltage in the advanced voltage settings section of the M.I.T tab [23](#). If the motherboard fails to boot at the standard 1.35V then try 1.4V, as this setting is known to fix some memory speed issues.

You can also tweak the fan control settings in the EFI. Head to the Smart Fan 5 section and identify the system fans. We set the front fans in the case to only operate when the CPU is above 45°C, so when you're typing or watching a movie, they should be silent. [24](#)

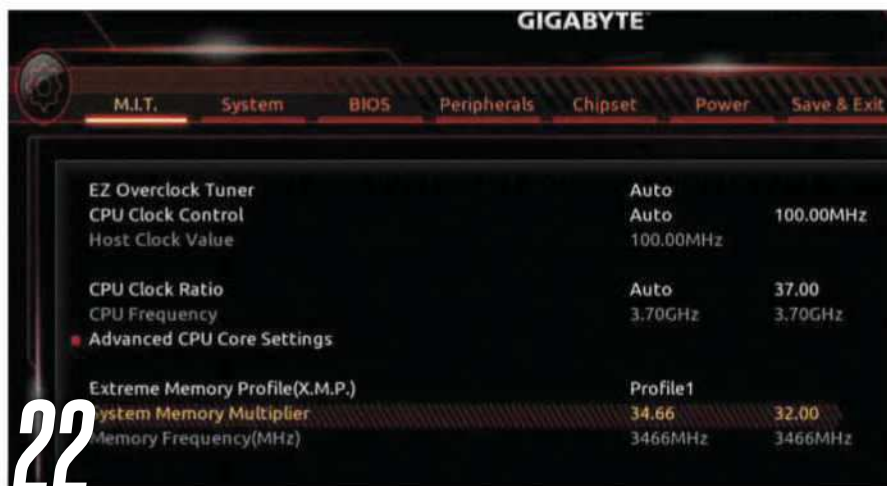
STOCK SPEED VS OVERCLOCKED CPU

We thought long and hard about whether to overclock our Ryzen 7 2700X for this build. However, because we reached lower frequencies when applying an all-core overclock than the CPU could reach at stock speed while boosting, we've left it at stock speed. This decision meant faster results in games such as Ashes of the Singularity, and also in our RealBench image editing and multi-tasking tests.

However, we can appreciate that some people prefer to have higher all-core frequencies, especially for heavily multi-threaded work. If you'll be doing a lot of rendering or content creation that regularly uses all cores and threads, overclocking the CPU is probably a good idea. For example, our video encoding result increased from 535,250 at stock speed to 563,134 and Cinebench rose from 1,810 to 1,907, by applying a 4.25GHz all-core overclock.

To start, use AMD's Ryzen Master software (www.amd.com) to overclock your CPU in Windows and find some stable settings. You can then apply a long-term overclock in the EFI, but it's quicker initially to use Ryzen Master. Click on a profile tab at the bottom and then select the manual button halfway down to access the overclocking controls. Start with a vcore of 1.425V and work backwards from there. We've found up to 4.3GHz has been possible with that voltage on some motherboards, but most of them hit a wall at 4.25GHz.

For this reason we've only gone with a 4.2GHz frequency, which should be achievable on most Ryzen 7 2700Xs. Apply 4.2GHz, making sure it's applied to all cores and then set the vcore voltage control to



22



23



24

1.425V [25](#). Click Apply & Test at the top – this command will carry out a short stress test so you can check the temperature of your CPU. We found it remained below 70°C and was stable. If you encounter stability issues, try 4.1GHz instead.

If it looks stable, download Prime95 version 26.6 (www.mersenneforum.org) and run the smallfft test, reducing the voltage by one notch every five minutes until you encounter stability issues, such as the system freezing. If this happens, increase

the voltage by two notches in Ryzen Master and test it again for 30 minutes.

If the PC remains stable and the CPU temperature below 85°C, one last test is our own RealBench suite (www.asus.com/campaign/Realbench). If your system gets through all the tests without issue, then go into the EFI and apply that voltage and frequency – go to the frequency settings and advanced voltage settings sections in the M.I.T tab.

OVERCLOCK THE GRAPHICS CARD

The Palit GeForce GTX 1060 Dual 6GB has plenty of cooling headroom and some people have managed some sky-high overlocks online too. We've settled for some fairly conservative numbers and your mileage may vary of course. Start by downloading MSI Afterburner (www.guru3d.com) and GPU-Z (www.techpowerup.com). Use Afterburner to increase the power limit and temperature limit to their maximum settings, before adding 150MHz to the core clock and 400MHz to the memory clock.

These tweaks should result in a boost frequency of 1860MHz. You then need to stress-test your tweaking, so download Unigine Superposition (<https://benchmark.unigine.com>) and run the benchmark in extreme mode. Watch for any artefacts or anomalies on-screen compared with running the benchmark at stock speed. Check Afterburner, or the sensors tab in GPU-Z, for the maximum load temperature too. As long as it's below 85°C under load, you should be fine. Finally, try some lengthy sessions in your favourite games to make sure your system is still stable.

These settings are likely to be well below the capabilities of many cards, so you may want to push the frequencies a little further, but these settings should be perfectly



Add 150MHz to the core clock and 400MHz to the memory clock in MSI Afterburner

stable on most cards. The overclock boosted the minimum frame rates considerably. For example, in Deus Ex, the minimum frame rate increased by over 10 per cent,

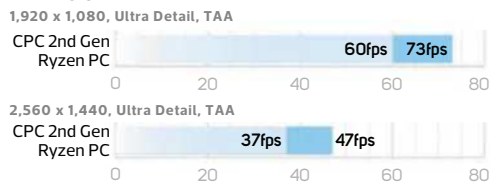
from 29fps to 32fps at 2,560 x 1,440, while in Fallout 4 at the same resolution, the minimum frame rate rose from 34fps to 37fps. **GPC**

RESULTS

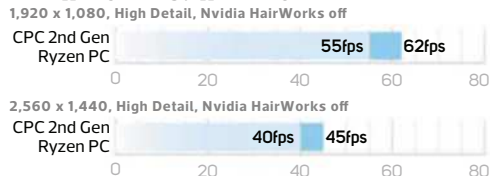
CPC REALBENCH



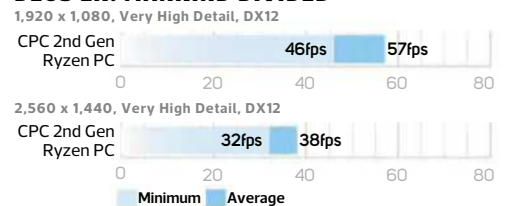
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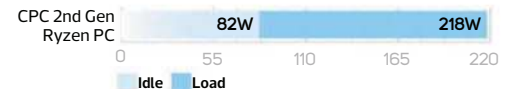
THE WITCHER 3: WILD HUNT



DEUS EX: MANKIND DIVIDED



POWER CONSUMPTION



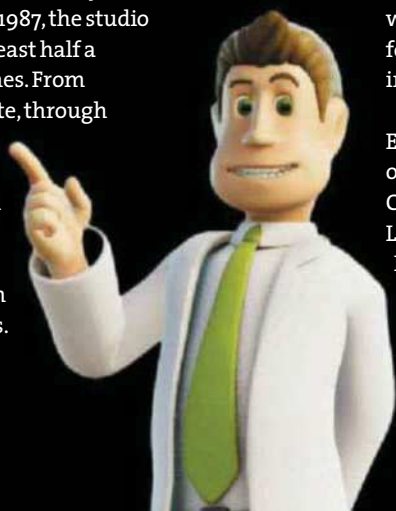


LEASE OF LIFE



Rick Lane speaks to the creators of *Two Point Hospital*, the spiritual successor to *Theme Hospital* spearheaded by a group of Bullfrog and Lionhead alumni

Bullfrog Productions is one of the most cherished PC game developers. Founded by Peter Molyneux in 1987, the studio produced at least half a dozen classic PC games. From *Populous* to *Syndicate*, through *Theme Park* to *Dungeon Keeper*, Bullfrog developed a reputation for its systemically rich and distinctly British management games. The company's last



unique game was *Theme Hospital*, a project headed by programmer Mark Webley and artist Gary Carr. It was enormously successful, selling four million copies and remaining in the charts for a decade.

Bullfrog was closed by owner Electronic Arts in 2001, but the spirit of the studio lived on as Webley and Carr joined Molyneux's new firm Lionhead, where they worked on *Black & White* and *The Movies*. Yet as they moved up the Lionhead ladder, the memory of *Theme Hospital* was never far away.

'They both had an ambition to do something similar again, because they enjoyed working on it such a long time ago, and really enjoyed working in a studio of that size,' says Ben Hymers, co-founder of Two Point Studios, who worked with Carr during his time at Lionhead.

'They always had this ambition to get back into it, and they talked about it many times through the years whenever they ended up in a pub together.'

In April 2016, Lionhead was shut down by Microsoft, seemingly



ending the lineage that began with Bullfrog almost 30 years previously. As it turns out, however, the story of the quirky British management sim wasn't quite over.

'Gary saw the writing on the wall before then, and we had a few chats about Gary's thoughts on starting out something new, and going back to the old sim-management games.' Hymers and Carr spoke to Mark Webley, who decided to join the project after taking a little convincing. Not long afterwards, Two Point Studios was born, and the team knew precisely what game it wanted to make first.

Theme Hospital reborn

Two Point Hospital sees players take charge of constructing and maintaining a series of clinics, hospitals and other medical facilities across the game's fictional setting of Two Point County. You'll build and furnish rooms, hire doctors, purchase medical equipment and research, and treat all manner of diseases and ailments. It's all presented in a chunky, colourful art style, and features the wry, tongue-in-cheek humour that was the hallmark of many of Bullfrog's best games.

It is, on the face of it, a straight-up modern take on Theme Hospital,

The game uses its art and animation to communicate what's going on – the patients clutching their stomachs clearly feel sick

You'll build and furnish rooms, hire doctors, purchase medical equipment, and research and treat all manner of diseases



and the developers are open about capitalising on the 'nostalgia-factor' for that game. 'Theme Hospital consistently makes it into the top charts on Good Old Games, so it just seemed like a no-brainer,' says Hymers. 'But that's not the main thing. It's probably mostly because it's what we all know. There's a lot of stuff to draw influence from in the old games.'

Yet while the developers are happy to draw a comparison between the two games, they also want to emphasise that Two Point Hospital is a distinct game, one that aims to tackle the problems faced both in the development of Theme Hospital and in the development of management sims as a whole.

Structural changes

One such problem is the broader structure. Management sims tend to come in two forms – you either build one institution, be it a theme park or a prison, and carry on expanding it until you get bored, or you follow a linear campaign in which you build sequences of theme parks, prisons and so on. With Two Point, the developers wanted to offer a slightly different game structure.

'Each hospital allows you to unlock multiple things at a time, rather than level one, level two, level three,' says Hymers. 'But there will also be this set of goals. We're going for stars: here's your set of objectives to get the first star, the set of objectives to get the second star



One condition sees patients become mysteriously wrapped up in bandages like mummies

wants to keep the tone light-hearted, so patients suffer from conditions such as 'light-headedness', where their heads turn into literal light bulbs, and another condition sees them mysteriously wrapped up in bandages like mummies. 'The mummies have an entirely different animation set,'

says Brooks. They kind of lumber when they walk, and they don't open the door like anyone else; they slam their fists against it. When they're cured, they end up in a sort of sarcophagus that gets raised up and all their bandages disappear.'

Final release

Two Point doesn't have an official release

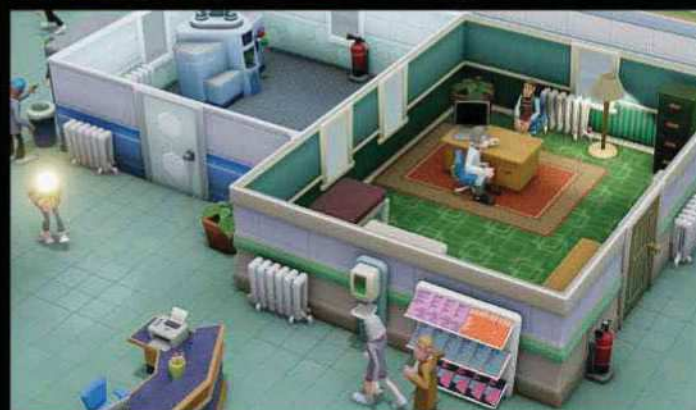
and so on; it's the stars that unlock the levels.'

The developers are also keen to ensure that the player isn't just going through the motions with each hospital they build. They want each level to feel distinct, offering both fixed and random challenges that are different each time.

Hospital staff, for example, will have more diverse career goals than simply wanting bigger wages (a key problem in Theme Hospital), and these goals will offer specific challenges to the player.

'They might have some career goals, such as wanting to diagnose five patients with a particular illness,' says Rich Brooks, a programmer at Two Point Studios. If you help them meet this goal, 'you can really improve their happiness and they'll perform better in their jobs later on,' he says. In addition, each hospital will have a distinct theme that will match its more specific challenges. 'You'll get more fractures in a hospital at the bottom of a ski slope,' says Hymers.

Alongside this open-ended structure, the developers have 20 years of technological advancement and programming experience at their disposal. Consequently, they're looking to make the game's underlying mechanics as detailed as possible. 'We've got a micro-interaction system, explains Brooks. 'It's just little tiny things, such as characters walking past another might interact, or see something. Maybe someone's sick and they will see that, then they'll feel sick and there will be a wave of people going "Wow, that's horrible".'



Art and animation

Such detail is all well and good, but it's pointless if these little mechanical details aren't communicated to the player. Two Point is keenly aware of this situation, and wants to ensure that the game's art and animation is able to make the player always aware of what's happening and why. 'We've got a really clean look to the game, so you can quite clearly see what's going on, explains Hymers. 'But that's carried through with the motion of the game. If you see someone sprinting to the toilet holding their bum, you think, "Oh, okay, he needs the toilet, that's cool." But it's also just good visually.'

Indeed, humour was a key component of making Theme Hospital's work, and the case is very much the same here. Two Point

Patients will suffer from conditions such as 'light-headedness', where their heads turn into literal lightbulbs

On the face of it, Two Point Hospital is a straight-up modern take on Theme Hospital

date for the game yet, but they're planning to launch it towards the end of 2018. The game is complete in terms of features, but the developers want to allow as much time as possible to test and balance it, mainly because of the complex nature of management sims and the strange scenarios they're capable of producing.

'We've got automated tasks that just play the game and make sure it doesn't break,' says Hymers. 'I discovered this hospital the other day that had just spawned a bunch of people - it had 10,000 bits of wee on the floor. It's interesting how the simulation can sometimes run away, and it's difficult wrangling it.'

Whether or not Two Point Hospital can conjure the same medical magic as Theme Hospital in its day is yet to be seen. However, the developers have the credentials to pull it off and, aside from the odd spate of virtual incontinence, the project seems to be well under control. 'As someone who has come in as a fan of the Bullfrog era, I was delighted to see what the game was when I joined the studio a year ago,' Brooks says. 'The feel is right - I think it's what you'll expect, which makes me quite excited to release it.' **EPG**





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

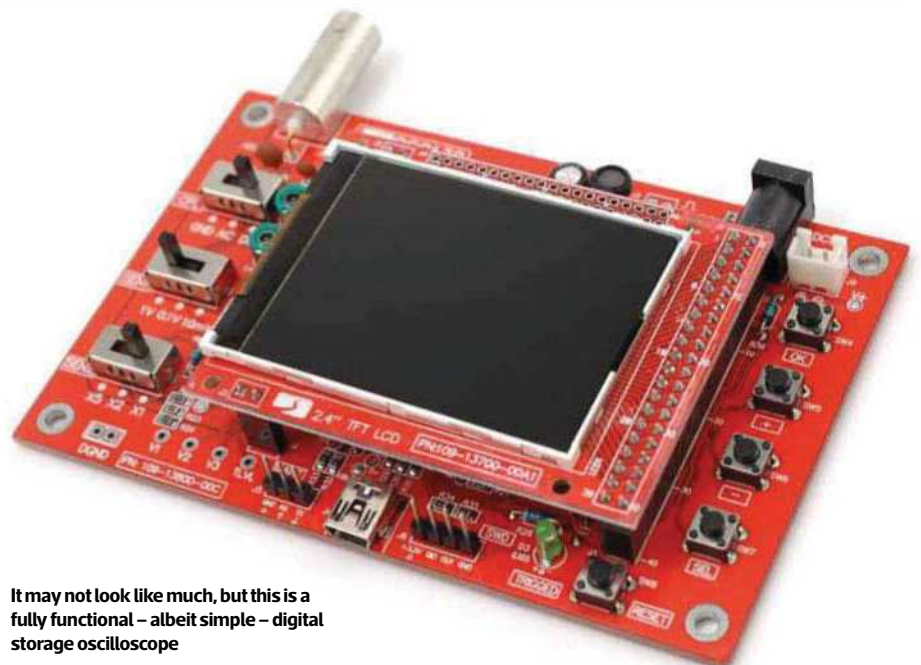
REVIEW

Quimat Pocket Oscilloscope

An oscilloscope is one of the handiest tools you can have on your workbench when it comes to diagnosing electronics issues. Unfortunately, they're also traditionally bulky, expensive and complicated to use. The march of technology has done much for the former issue, thanks in no small part to the replacement of cathode ray tube (CRT) displays with much smaller LCD panels. It has begun to help out with the latter two issues as well, as proven by the existence of the DSO138.

Designed by JYE Tech and released under an open-source licence and then, predictably, immediately cloned by a wide variety of Far Eastern electronics concerns, the DSO138 is two devices in one. The first, naturally, is a digital storage oscilloscope; the second is an ARM Cortex M3 development board. Once you replace the oscilloscope firmware with your own programs, this board has a handful of switches, a colour LCD display and a BNC connector for its analogue input.

The DSO138 – whether an original or a clone (in this review, we're using a Quimat-branded clone) – is available in kit or pre-assembled forms. The cheaper kit version typically includes the ARM Cortex microcontroller and a couple of other



It may not look like much, but this is a fully functional – albeit simple – digital storage oscilloscope

integrated circuits pre-soldered. However, while the majority of components use a through-hole connection, there's a number of surface-mount parts that could be tricky for beginners. The pre-assembled version, naturally, is ready to use out-of-the-box.

Mostly, anyway. The DSO138 requires, in its standard form, a 9V power supply, which isn't

usually included with the kits. You don't need a high amperage, but if you haven't got a power supply lying around already, you'll be disappointed when you connect a cable to the mini-USB port at the bottom of the board and find it's not bus-powered. A handheld variant in an acrylic case with a lithium polymer battery is available for more portable use, at

additional cost. Alternatively, the DSO138 will run happily from a 9V PP3 battery if you supply a suitable pigtail connector.

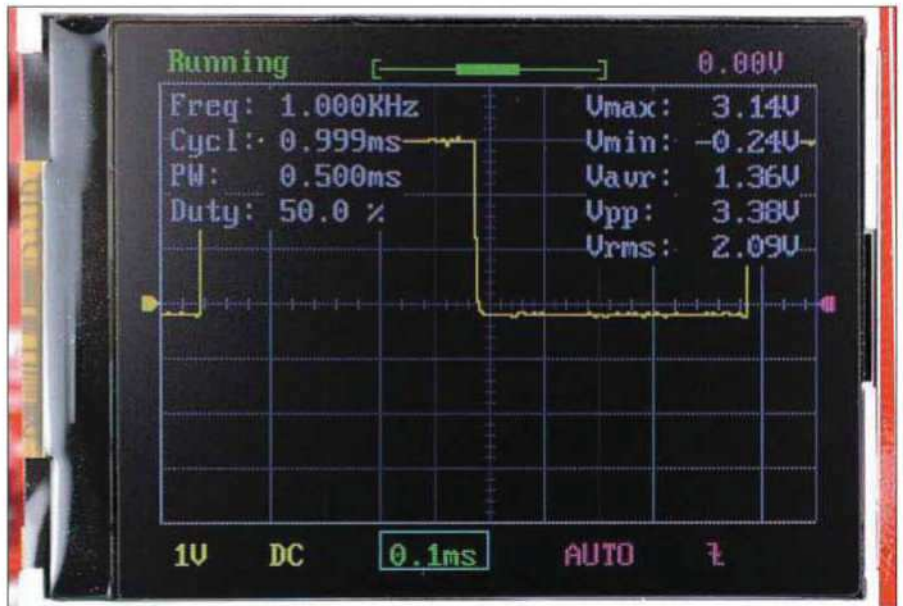
Most DSO138 kits include a probe, and the Quimat-branded clone is no exception. While there's a BNC connector on one end, the other end terminates not in the pen-like probe of a classic oscilloscope but in two shielded crocodile clips.

For beginners and hobbyists, it's a fair trade-off. It's suitably sized for clipping to 2.54mm headers, the probe is perfectly functional and the use of a BNC connector means you could always pick up a cheap pen-type probe as an extra if you prefer.

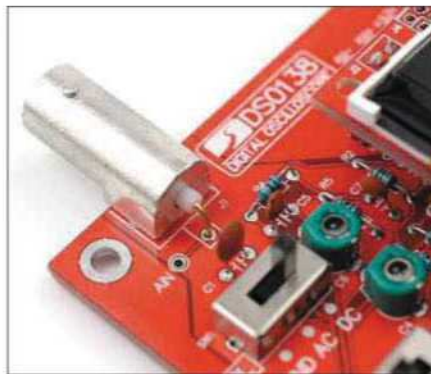
Beginners and tinkerers are the target market for the DSO138 and its variants. Using a general-purpose low-cost microcontroller to drive an oscilloscope makes for a cheap device, but with specifications that sit firmly at the bottom end of the market. The DSO138 is capable of 12-bit sampling at one million samples per second (1MS/sec) with bandwidth up to 200kHz. These figures compare poorly with Digilent's OpenScope MZ (reviewed in Issue 169), itself an entry-level education-focused microcontroller-based scope, which offers ten times the bandwidth and a 6.25MS/sec sampling rate across two independent channels.

The DSO138 has two features on its side, though. The first is the on-board display, missing from the wireless-capable OpenScope MZ, which offers surprising clarity - thanks in no small part to the clever use of a limited colour palette. The second is pricing: a cloned DSO138 self-assembly kit can be found on www.amazon.co.uk for as little as £13.90 inc VAT and assembled versions cost below £20 inc VAT. These prices are well below the roughly £100 inc VAT landed price for an OpenScope MZ, making as DSO138 easily affordable for anyone wishing to experiment before splashing out on a more capable scope.

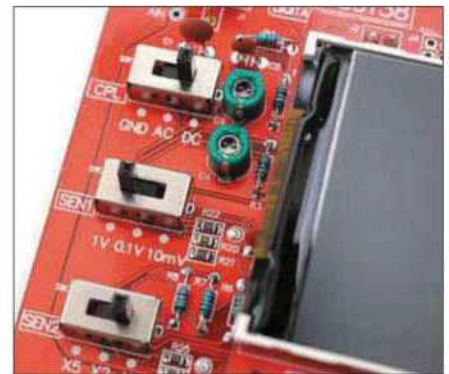
It also makes experimentation more viable, with claims of support for 50V inputs unmodified and 400V inputs with an optional 10x probe - neither of which I fancied testing myself, being less confident in the board's capabilities than its manufacturer. It will be



Considering its size, the DSO138's LCD is crisp and clear, even in motion



A BNC connector means you can use any standard oscilloscope probe, as well as the bundled probe



Instead of using a touch-screen interface, the DSO138 uses physical switches and buttons

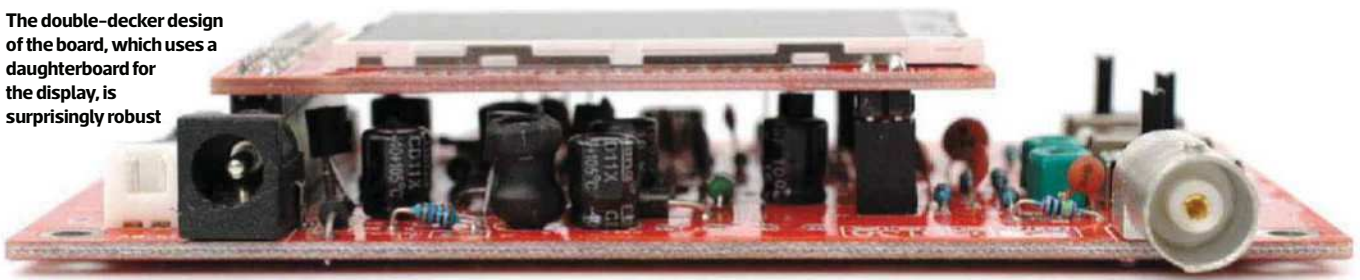
much easier to live with the result of exceeding the DSO138's tolerances if you've released the magic smoke from a device that's a little less pocket-friendly.

Whether you'd ever use any of the board's non-oscilloscope features, such as the ability to reprogram it for use as a multimeter, or a general-purpose ARM Cortex M3 development board - is questionable. The support is certainly there, and accessible by just connecting a micro-USB cable (not included, oddly) to the port at the bottom of the board, but there are better kits available for these purposes.

Anyone wanting to delve into the board's specifications and capabilities, though, would do well to avoid the typically poor instructions included with the clone kits, and take your browser to www.jyetechn.com for the full details. Here you'll find an admission that the majority of surface-mount parts aren't pre-soldered in the kit version, which the clone producers often omit from their product descriptions.

If you'd prefer to avoid the cheaper clone devices, you can also buy an original JYE Tech DSO138 kit from <https://fluxworkshop.com>, where a DIY kit will cost you £25 inc VAT.

The double-decker design of the board, which uses a daughterboard for the display, is surprisingly robust



TUTORIAL

Reverse SSH tunnel

SSH – the Secure Shell protocol – is one of the most useful tools around, allowing you to connect to a remote system over an encrypted tunnel and launch a shell, transfer data or even forward X applications. It just has one, teeny tiny limitation: you have to be able to find the system to which you’re connecting.

Following CrashPlan’s decision to cease offering consumer-orientated remote backup facilities, I set up a Raspberry Pi with Syncthing to serve as my offsite backup store (see Issue 171). That was the easy part; the hard part is ensuring I can maintain access to the device, for maintenance and troubleshooting, once it’s in its new home.

Traditionally, remote access requires a hole to be punched in the firewall – for home users, this means forwarding a port on the router. That’s fine if you’re happy doing it, but it’s not a readily accessible method for non-technical folks. It requires both that you know how to configure a router and that you can set up the target device for a static IP. For the person attempting to connect remotely, you also need to know the router’s public IP address, which can change on a daily basis if you have a dynamic connection, requiring you to ask your long-suffering remote host to sign up to a dynamic DNS service and change yet more settings on the router.

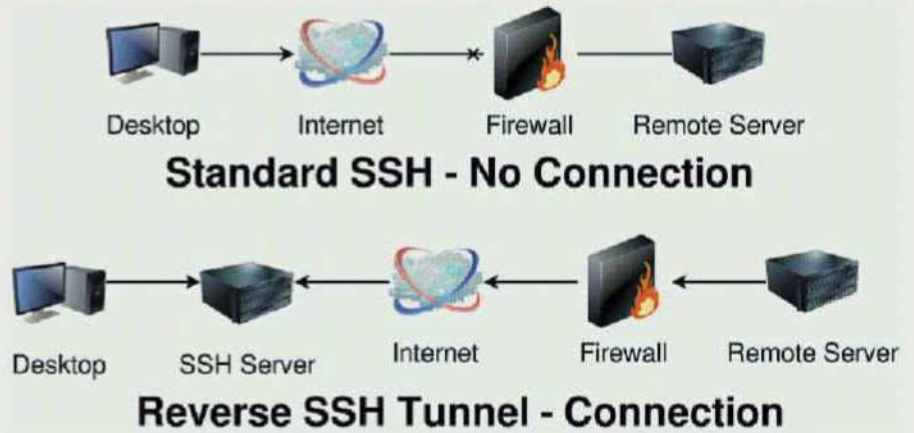
An often underused feature of SSH makes all that faffing unnecessary, however. Using a reverse tunnel, I can simply pop my Syncthing-equipped Pi in the post and ask the recipient to connect it to their network sans-configuration, and still retain full remote access.

1 Set up the midpoint

An SSH reverse tunnel takes the hassle of firewall-punching and IP configuration out of

KIT LIST

- A remote device, such as a Raspberry Pi, running SSH
- A publicly accessible midpoint device running SSH
- Your desktop or laptop with an SSH client (optional)



A simple home broadband router firewall makes for painful SSH connections, unless you have a reverse tunnel configured

the hands of the remote device and into yours. If you have a local machine running an SSH server already, it can serve as the midpoint of the connection. Simply forward Port 22 on your router – or a higher-numbered port, if you want some small protection against port-sniffing – to your local machine, which ideally needs to be accessible 24/7. Another Raspberry Pi works perfectly for this job, if you haven’t already set up a local machine.

Before you do, however, you’ll want to secure the system. A good starting point is to install a tool to ban anyone attempting to access connection with brute force:

```
sudo apt update && sudo apt
install -y fail2ban
```

For more tips on securing SSH servers, consult <http://tinyurl.com/hardssh>

2 Configure the remote system

Note down the public IP of your SSH midpoint, and its port if you’re using a non-standard port, and connect via standard SSH to the device that will become your remote. Start by editing the SSH configuration to prevent the tunnel from dying while you’re not using it:


```
sudo nano /etc/ssh/ssh_config
```

Insert the following two lines below ‘Host *’, then save the file with Ctrl-O and exit with Ctrl-X:

```
ServerAliveInterval 60
```

```
GNU nano 2.7.4 File: /etc/ssh/ssh_config
# Any configuration value is only changed the first time it is set.
# Thus, host-specific definitions should be at the beginning of the
# configuration file, and defaults at the end.
# Site-wide defaults for some commonly used options. For a comprehensive
# list of available options, their meanings and defaults, please see the
# ssh_config(5) man page.
Host *
  ServerAliveInterval 60
  ServerAliveCountMax 2
# ForwardAgent no
# ForwardX11 no
# ForwardX11Trusted yes
# RhostsRSAAuthentication no
# RSAAuthentication yes
# PasswordAuthentication yes
# HostbasedAuthentication no
# GSSAPIAuthentication no
AG Get Help  AQ Write Out  AW Where Is  AK Cut Text  AJ Justify  AC Cur Pos
AX Exit      AR Read File  AL Replace  AU Uncut Text AT To Spell  AL Go To Line
```

Configuring the client on the remote end will keep the connection alive, even when idle

 This symbol means the command should all be on one line

```
pi@nanoserver:~$
System load: 0.14          Processes: 169
Usage of /: 34.9% of 219.88GB   Users logged in: 1
Memory usage: 28%           IP address for em1: 192.168.0.8
Swap usage: 0%

Graph this data and manage this system at:
https://landscape.canonical.com/

0 packages can be updated.
0 updates are security updates.

New release '16.04.4 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

*** System restart required ***
No mail.
Last login: Thu Apr 19 15:28:51 2018 from trioptimum.local
blacklaw@Altair:~$ ssh -p 2200 pi@localhost
Last login: Thu Apr 19 15:27:21 2018 from ::1

Wi-Fi is disabled because the country is not set.
Use raspi-config to set the country before use.

pi@nanoserver:~$
```

While it seems like you're connecting locally, your connection actually goes to the remote device

```
GNU nano 2.7.4 File: /usr/bin/sshtunnel.sh Modified
#!/bin/bash

while true; do
  sudo -i -u pi ssh -N -R 2200:localhost:22 blacklaw@ddns.halfacree.co.uk
  sleep 20
done
```

This simple bash script will kick the tunnel back to life if it gets disconnected

ServerAliveCountMax 2

Next, generate an SSH key:

```
ssh-keygen -o -a 100 -t ed25519
```

And copy it to your midpoint:

```
ssh-copy-id username@midpointip
```

Get into your midpoint with SSH to verify that it authenticates with the new key, and no longer prompts you for a password.

3 Test the tunnel

The reverse tunnel needs to be opened on the remote device. Launch it with the following command:

```
ssh -N -R 2200:localhost:22
username@midpointip
```

If all has gone well, you'll see the shell of your midpoint system, which is the exact opposite of what you wanted, right? Well, no: the -R flag tells SSH to open the reverse tunnel, and to map Port 2200 on the midpoint machine to Port 22 on the remote machine.

The result is that any traffic hitting Port 2200 on the midpoint machine will be transferred over the tunnel to Port 22 on the

remote machine – invisibly, as if by magic, with no firewall modifications, and even if you don't know the IP address of the remote machine.

Test it out by connecting to the tunnel on your midpoint machine:

```
ssh -p 2200 pi@localhost
```

If your remote device's username isn't 'pi,' switch out that part. You can also connect from your desktop or laptop using the midpoint server as a jumping-off point:

```
ssh -t username@midpointip
ssh -p 2200 pi@localhost
```

4 A permanent tunnel

Having to connect to the remote device to create your connection to it won't help when it's actually remote, though, so to set up the tunnel to launch automatically use the following command:

```
sudo nano /usr/bin/sshtunnel.sh
```

Enter the following, then save and quit:

```
#!/bin/bash
while true; do
  sudo -i -u pi ssh -N -R
2200:localhost:22 username@
midpointip
  sleep 20
done
```

Make the file executable:

```
sudo chmod +x /usr/bin/
sshtunnel.sh
```

And finally add it to rc.local to run on system start:

```
sudo nano /etc/rc.local
```

Add the following to the file just above 'exit 0', then save and quit.

```
/usr/bin/sshtunnel.sh &
```

Reboot the Raspberry Pi, try connecting to the tunnel again, and enjoy a permanent connection wherever your Pi ends up. If you want to support multiple devices, simply give each one a unique port number: 2201, 2202 and so on.

NEWS IN BRIEF

MakerBot launches teacher cert scheme

3D printing specialist MakerBot Industries has announced an official teacher certification scheme, as it attempts to become the de facto standard for education use. Originally open-source and building on community designs, the MakerBot family of 3D printers went closed-source in 2012 – a move that lost the company the trust of the maker community, and birthed its focus on education and industry. The training scheme is available exclusively to paying customers, the company has confirmed, offering a 5-10 hour online course for \$99 US with the option of an additional five hours hands-on for a total of \$199 US (around £70 and £140 respectively, excluding taxes). More information is available at www.makerbot.com



REVIEW

Push Start: The Art of Video Games

At first glance, *Push Start: The Art of Video Games* should be easy to love. A hefty, mostly full-colour hardback coffee-table tome, Stefan Gunzel's creation takes the usual formula: full-page, or occasionally two-page, reproductions of screenshots or screenshot extracts from games spanning the 8-bit era onwards, with a small smattering of text.

We've also seen this format in the *In Pixels* or *Visual Compendium* books, but it sadly misses its mark in *Push Start*. The problem begins at the start, where images from early low-resolution systems are presented blown up to full-page size with no consideration for how they would appear on the CRT displays for which they were designed. A few pages on, into the arcade section, there's a far bigger concern: games that used vector displays, rather than bitmap displays, presented as screen captures from bitmap-based emulators, at the lowest possible resolution.

Looking at *Battlezone* or *Tempest*, you'd be forgiven for thinking they were blocky, low-resolution bitmap games you might see on Atari's 2600 rather than in the

Push Start is an imposing book, but it sadly fails to live up to its grand vision



The visuals range from surprisingly high quality to terrible, with vector games suffering the most

arcades. However, the truth is that the smooth vector lines of both games put any console of that era, bar the vector-based and now rather rare Vectrex, to shame.

Throughout the book, it's clear that emulation has been used to capture the majority of images, and not always at optimum settings. It's also clear that other images, particularly from the 32-bit era onwards, aren't original captures, exhibiting as signs of JPEG compression artefacts, particularly on entry 189,

popular wolf-'em-up *Okami*. It's a shame, as given the lack of explanatory text or analysis (the most detailed game entries containing nothing more than title, release year, platform, developer, designer and composer), a little more effort on the visuals, the book's key focus, would have helped.

A small five-page treatise on 'games as art' in English and German is included at the rear, following on from an incomplete visual timeline of games console and home computer releases, but it fails to scratch the itch you'd expect from a book promising to pull back the kimono of art in video gaming.

A surprise awaits at the very back though: a 10in translucent vinyl record, which contains eight tracks by remix artist Big Twice, all based on popular games included in the book: *Castlevania*, *Super Mario Bros*, *Mega Man 2*, *Ninja Gaiden*, *Street Fighter*, *Space Harrier*, *Puzzle Bobble* and *Tetris*. An MP3 download code is also included, for those who traded in their decks long ago.

Sadly, reading the book – even with the soundtrack – leaves you feeling unfulfilled. Whether it's the imagery, or factual errors in the scant information it provides, *Push Start* is unlikely to satisfy even at its currently discounted pricing. The book's size gives the impression of a monumental effort, but it feels like perhaps its creator bit off more than he could chew, and ended up rushing it. *Push Start* is available now from www.amazon.co.uk, for £23.79 (VAT exempt), but it's not a title I can really recommend. **GPC**

NEWS IN BRIEF

Google AIY kits updated

Google has announced new versions of its Artificial Intelligence Yourself (AIY) kits for 2018, which now include a bundled Raspberry Pi Zero WH microcomputer as standard. The AIY Vision Kit and AIY Voice Kit versions 1.1 (the original release of which was reviewed back in Issue 167) are, by and large, relatively unchanged from their original releases bar the inclusion of the Raspberry Pi Zero WH. The smallest mainstream Pi comes in its Wi-Fi, Bluetooth and pre-soldered-GPIO-header equipped flavour. The company has also released a companion app for its Android mobile platform, which it claims speeds up the setup process.



Gareth Halfacree is the news reporter at www.bit-tech.net, and a keen computer hobbyist who likes to tinker with technology. @ghalfacree

WIN!

A Razer Naga Trinity and Goliathus Chroma

Razer Naga Trinity

Experience the power of total control in your hand, no matter what game you play. Designed to provide you with that edge you need in MOBA/MMO gameplay, the Razer Naga Trinity lets you configure your mouse for everything, from weapons to build customisations, so you'll always be ahead of the competition.

Equipped with an advanced 5G optical sensor, with true 16,000dpi resolution, the Razer Naga Trinity is optimised for precision and speed, ensuring movements are swift, your spells are on target and that you get out of the fire when battles turn intense.

With interchangeable side plates for two, seven and 12-button configurations, you can customise your mouse to suit your gameplay. Each button is designed to stand out so you'll never mis-click, and the buttons provide tactile and audible feedback so you'll be assured of every actuation. With up to 19 programmable buttons, you'll be spoilt for choice, whether you're assigning just the essentials or going full-out to bind item hotkeys, spells or any other in-game commands you need.

Razer Goliathus Chroma

Razer's bestselling soft gaming mouse mat is now Powered by Razer Chroma, ready to illuminate every victory in a stunning spectrum of colours. Watch your game light up with vivid brilliance as you swipe across the Razer Goliathus Chroma with speed and precision. With a full spectrum of 16.8 million colour options, watch your Razer Goliathus Chroma light up with in-game alerts and effects, or personalise it in any shade you like.

The Razer Goliathus Chroma is optimised for all sensitivity settings and sensors. Whether you're using a laser or optical sensor, you'll have total tracking responsiveness for reliable in-game control.



The Goliathus Chroma helps you to achieve the perfect balance of control and speed, with a micro-textured cloth surface designed for speed and control play styles. Translate every mouse movement into exact cursor movement and enjoy ultimate precision during the most action-packed gaming sessions.

To be in with a chance of winning this fantastic Razer RGB mouse and mouse pad combination, simply answer the question below.

QUESTION: What is the name of Razer's RGB lighting control system?

A. Coda **B.** Cola **C.** Chroma



Email your answer to competition@custompcmag.org.uk, with 'Razer Competition 179' in the Subject line. Closing date 19 July, 2018. See www.dennis.co.uk/comp/terms for the full competition rules.



ANTHONY LEATHER'S

Customised PC

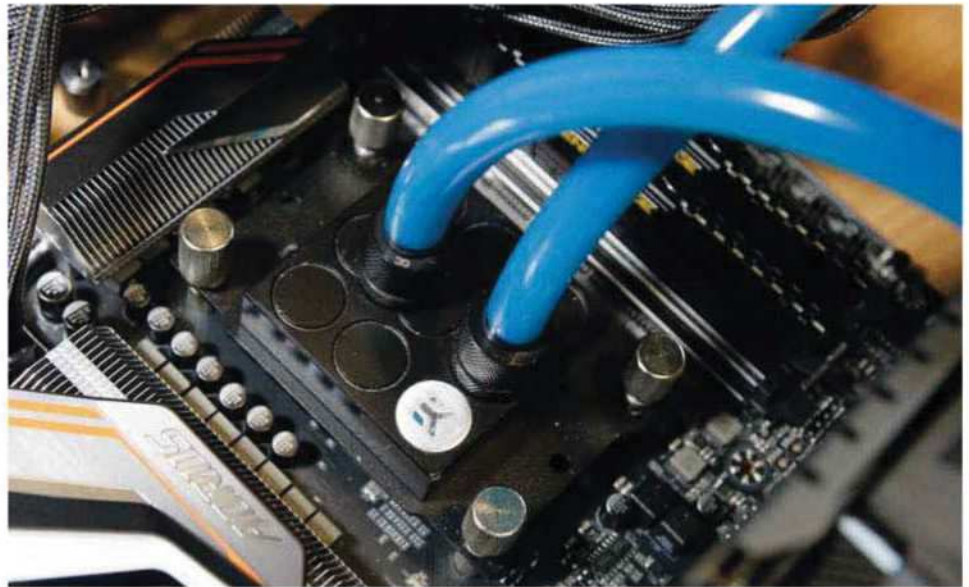
Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Cooling 2nd Gen Ryzen CPUs

Many of the benefits of water-cooling your PC are purely aesthetic these days, although water cooling still offers the coolest and quietest way to deal with the heat produced by your PC's components. You may want to kit out your PC with an oversized radiator and slow-spinning fans, for example, to make it inaudible when it isn't handling very high workloads, and much quieter than your average, non-water-cooled system under load to boot.

However, with AMD's 2nd Gen Ryzen CPUs sporting new frequency boosting algorithms, I was interested to see whether water-cooling them could make a difference to stock speed performance and possibly increase overclocking headroom too. I also wanted to see if the fairly hefty Wraith Prism RGB cooler in the Ryzen 7 2700X box is capable of dealing with an overclocked 8-core CPU.

To start, I set about overclocking the Ryzen 7 2700X to 4.25GHz using a 1.425V vcore. With AMD recommending that 1.45V should only be used for temporary benchmarking, 1.425V should be fine for long-term overlocks. The boosting algorithms have no effect here, as they're disabled when you apply an all-core overclock, so it doesn't matter how low the temperature goes as long as it's not too high.



The Ryzen 7 2700X benefitted from water cooling, with lower temperatures and lower noise levels

Cooling ability when overclocking

Sadly, the Wraith Prism RGB cooler wasn't able to deal with the heat generated by this overclock, and the CPU temperature quickly flew past 90°C when running Prime95's smallfft test to stress all cores, then the system froze. Clearly, the Wraith Prism RGB is only good for dealing with a stock-speed Ryzen 7 2700X, and using an all-core overclock much lower than 4.25GHz will actually result in lower performance in lightly threaded tasks than at stock speed, thanks to AMD's higher boosting frequencies.

Switching to a Cooler Master MasterLiquid ML120L RGB all-in-one (AIO) liquid cooler saw the temperature hit a still fairly toasty 88°C, but it did level out here, with an ambient room temperature of 23°C. However, while this operating temperature might be fine for short-term multi-threaded loads, or lightly threaded loads such as games, if you plan on pushing all your cores to their limits for long periods of time – for example, when rendering or encoding – you'll want your CPU sitting running at a much lower temperature.

Finally, I used a custom water-cooling loop, comprising a Laing DDC



pump, a 280mm radiator with two 140mm fans and an EKWB Supremacy Evo waterblock with an AM4 mounting kit. After five minutes at load with all the cores at 4.25GHz, the temperature levelled out at just 75°C, which is 13°C cooler than the AIO cooler and with much quieter, slower-spinning fans.

It's clear, then, that to push a 2nd Gen Ryzen 8-core CPU to its limits for long periods of time, you'll need a more potent cooler than a single 120mm-fan all-in-one liquid cooler unit, although the latter will suffice if you'll mainly be gaming or photo editing. The Wraith Prism RGB cooler that's included with the Ryzen 7 2700X is also nowhere near powerful enough to handle large overlocks on the CPU, and is best used with your CPU running stock speed. A larger AIO liquid cooler is probably the answer if you want to get the most out of your CPU for the smallest outlay, while a custom loop will give you a huge drop in load temperature that will allow you to load your overclocked CPU across all cores for long periods of time, and without making a racket.

How cooling affects stock speed performance

The next test was to see if there was a difference in performance between the coolers at stock speed, as AMD's new boosting algorithms prefer lower

temperatures. Starting with Cinebench, the Wraith cooler managed a score of 1,803, the AIO liquid cooler managed 1,810 and our custom water-cooling kit had a lead at 1,831 – it's not exactly a huge leap in performance, but it's certainly noticeable.

Our CPC RealBench image editing test also saw an improvement, moving from 56,556 with the Wraith to 57,090 with the AIO liquid cooler and finally to 58,621 with our water-cooling kit – our CPU was around 4 per cent faster just by using water cooling.

The video encoding test again saw a reasonable boost to the score, starting at 535,680 with the Wraith, going to 542,517 with the AIO liquid cooler and then 548,976 with our water-cooling kit. It's a smaller boost, probably because the CPU was under a much heavier load, so eventually even our water-cooling kit would have seen boost frequencies fall, but it's around 2.5 per cent faster with water cooling nonetheless.

Our heavy multi-tasking test saw another sizeable boost to performance by bolstering our cooling. The score started at 190,728 with the stock cooler, then rose to 194,653 with the Cooler Master MasterLiquid ML120L RGB liquid

The Wraith prism RGB cooler looks fantastic, but it can't cope with a high overclock

Boosting the cooling for your AMD Ryzen 7 2700X can result in faster performance, even at stock speed



cooler, while our custom water-cooling kit saw the score reach 198,554, 4 per cent faster than the stock cooler.

There are plenty of benefits, then, to water-cooling your Ryzen CPU. Unlike Intel's CPUs these days, the die is soldered to the heatspreader and not connected using thermal paste, so there's a large gap between a fairly potent all-in-one liquid cooler and a high-performance water-cooling kit, with our loop knocking a massive 13°C off the load temperature.

There's also the benefit of lower noise; while the Cooler Master MasterLiquid ML120L RGB liquid cooler coped with the overclocked CPU, it was considerably noisier than our custom water-cooling kit. Finally, you'll also see up to a 4 per cent improvement in performance at stock speed than with the stock cooler, thanks to the lower temperatures. However, the extra costs from boosting cooling mean you'll see diminishing returns, and a decent AIO liquid cooler with a 240mm or 280mm radiator and two fans is likely to offer similar cooling results at a far lower cost, albeit with probably a little more noise and less wow factor.

Conclusions

There are two main areas to prioritise if you want to get the best performance from your shiny new 2nd Generation Ryzen CPU, then. Firstly, you'll need fast memory – ideally somewhere in the region of 3466MHz, which yielded significant performance boosts compared to the 2666MHz or 3000MHz memory in our tests last month (see Issue 178, p24).

Secondly, while AMD's stock Wraith Prism RGB cooler copes well with a Ryzen CPU at stock speed, it's not equipped to handle a hefty overclock, and better cooling can also enable you to squeeze out a little more performance at stock speed. Premium cooling is needed to deal with the highest all-core overclock these new CPUs can achieve with all cores under load for long periods, as well as keeping noise to a minimum. **GPC**

How to Make your own PSU shroud

No PSU shroud at the bottom of your case to hide your cables? Antony Leather shows you how to make an illuminated one yourself

 **TOTAL PROJECT TIME** / 30 HOURS

P SU shrouds are a great new feature in PC cases. They help to cover your PSU's unsightly mass of cables, and they also provide a handy place to stow cables if there's limited space behind the motherboard tray. What's more, cooling can also be improved by cutting cable clutter, and directing airflow over the PSU from the front of the case towards the graphics card.

If your case doesn't have a PSU shroud, it's thankfully easy to create your own one custom one using coloured acrylic and simple spray paints. You can even add lighting for some added pizzazz. All you need is a sheet of acrylic and the means to bend it to shape.

TOOLS YOU'LL NEED



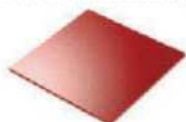
Masking and edging tape /
www.ebay.co.uk



Spray paint, plastic primer
and clear coat /
Most hardware stores



Dremel or fine blade saw /
Most hardware stores



Acrylic sheet /
www.ebay.co.uk



Vinyl cutter and
masking vinyl /
www.yolo.co.uk



Industrial heat gun /
www.ebay.co.uk



3M clear mounting tape /
www.amazon.co.uk



1 / CUT CARDBOARD BOX TO SIZE

An easy way to work out the shape and size of acrylic you'll need for your PSU cover is to create a cardboard template. Start by measuring the area where the cover will sit and cut a cardboard box to size.



2 / CREATE CARDBOARD TEMPLATE

Trim the box, so it sits neatly above the PSU. Make this cardboard mock-up as accurate as possible, as it will mean less adjustment when you're cutting the acrylic.



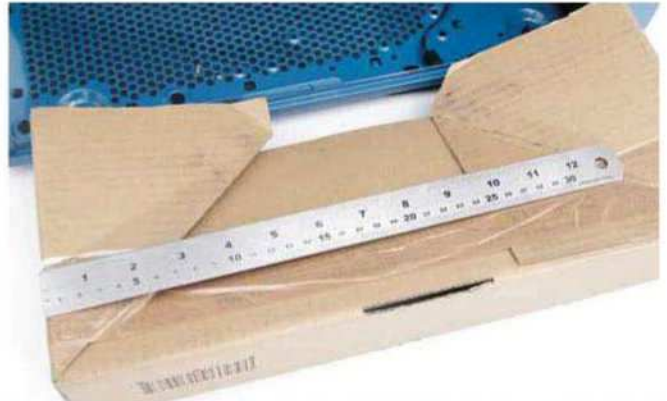
3 / CHECK FOR OBSTRUCTIONS

There may be drive bays or fan mounts that can get in the way of a PSU cover. Use the template to identify them – you can then either remove them or cut sections out of the cover to fit around them.



4 / IDENTIFY MOUNT LOCATIONS

You'll need to secure the PSU cover to the case, so identify possible mounting locations for it. We'll be creating a flat edge on our cover and using mounting tape, but it's just as easy to use existing screw holes if they're available.



5 / WORK OUT ACRYLIC SHEET SIZE

Once you've created your cardboard template, use a ruler to work out the size of acrylic sheet you'll need. It's easiest to create a two-sided cover with a single bend, as long as you factor in a couple of extra centimetres.



6 / ORDER ACRYLIC

Opaque acrylic is the most flexible option, as it can be illuminated from beneath or just provide a solid colour. Use 3mm acrylic sheet, but no thicker, as it can otherwise be harder to bend.



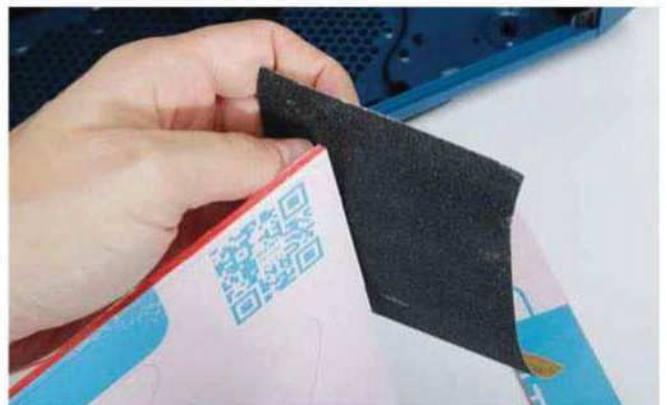
7 / MARK UP ACRYLIC FOR CUTTING

Leave the protective sheet on the acrylic and use this sheet to provide a surface to mark the acrylic for cutting. Use the pre-cut edges for as many sides of your cover as possible.



8 / CUT ACRYLIC

You can use a hacksaw with a fine-tooth blade, Dremel and soft material cutting disc, a jigsaw or a table saw to cut the acrylic. Use any motorised tools on a low speed to prevent the acrylic melting.



9 / SAND EDGES

Sand the edges with 800-grit sandpaper to smooth over any rough areas. There's no need to polish the edges, as they won't be visible.



10 / LOCATE BEND WITH TEMPLATE

Use your cardboard template to work out where the bend needs to sit on your acrylic. Now remove the protective sheets and mark this area onto the acrylic with a non-permanent marker pen.



11 / HEAT ACRYLIC

Use a handheld industrial heater to warm the acrylic, moving it swiftly back and forth over the area you want to bend. This part can take up to ten minutes.



12 / CREATE A BENDING JIG

Use a firm, square object as a jig around which you can bend the acrylic from two sides – the acrylic will be hot, so it can't be handled easily. Sturdy cardboard boxes can work well as long as they don't flex.



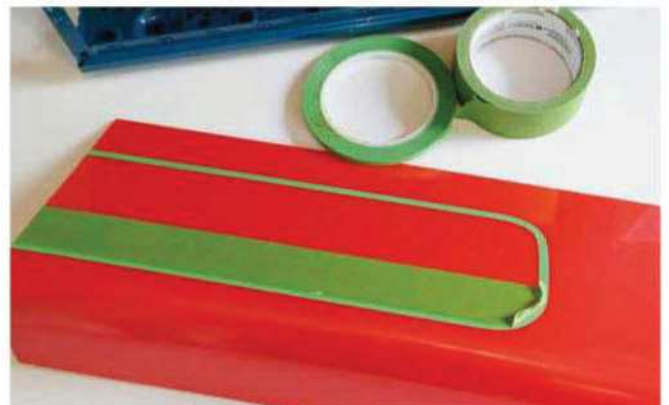
13 / TEST-FIT COVER

Once you've bent the cover to shape, test-fit it in the case and trim any sections that prevent a snug installation.



14 / CLEAN ACRYLIC

Once you've trimmed the edges, clean the acrylic with warm soapy water and rinse it thoroughly. It's now a good idea to don some nitrile gloves to prevent any residue from your hands spoiling the paint job.



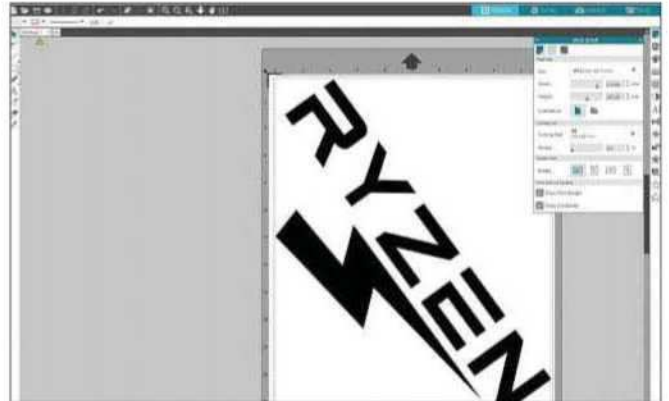
15 / CREATE MASKING

If you don't have access to a vinyl cutter to trim your own masking, you can use edging tape and frog tape to create your own design by hand.



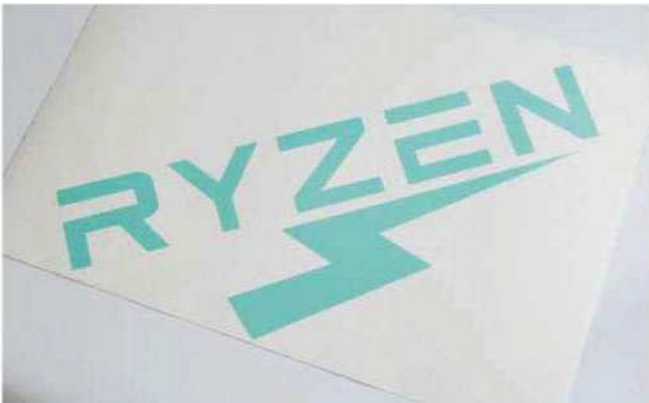
16 / USE A VINYL CUTTER

A vinyl cutter will allow you to create very detailed, complex and accurate masking if you intend to paint your PSU cover. You'll need self-adhesive masking sheets to create your own masking.



17 / CREATE YOUR DESIGN

You can import any image into the vinyl cutter's software, then trace the outline to create your masking design. This masking will sit under the paint, allowing you to peel it off later, revealing your pattern underneath in the colour of the acrylic.



18 / REMOVE UNWANTED VINYL

Once you've printed out your design, weed out the unwanted masking around it so that you're left with the design to be transferred to your PSU cover.



19 / USE TRANSFER TAPE

Transfer tape has an adhesive layer on one side that picks up your design off the paper backing, allowing you to transfer it in one go to your PSU cover. Wipe across the tape with a credit card, pressing it firmly onto the masking sections.



20 / APPLY DESIGN

Lift your masking design off the paper backing then press it onto the PSU cover in your desired location. Again, use a credit card to press the masking onto the cover before removing the transfer tape.



21 / SPRAY PLASTIC PRIMER

Normal primer may not take to the glossy acrylic surface, so it's a good idea to use plastic primer. Spray a single generous coat onto the acrylic in swift side-to-side motions from a distance of 6in.



22 / SPRAY BLACK COAT

Allow the primer to dry for 30 minutes, then apply the black colour coat using the same spray method. Apply additional coats, leaving each coat to dry for 15 minutes until you can no longer see the colour of the acrylic underneath.



23 / REMOVE MASKING

Allow the final coat to dry for ten minutes, then pick off the masking. Be extremely careful not to touch the painted surface.



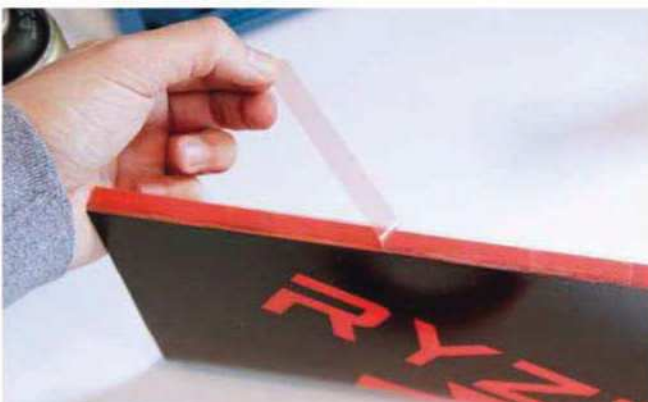
24 / SPRAY CLEAR COAT

It's a good idea to apply clear coat on top of the acrylic and paint to protect it against scratches. Apply three generous coats, leaving each one to dry for ten minutes before applying the next coat.



25 / CREATE MOUNTING EDGE

Trim a 10mm strip of acrylic the length of your PSU cover (or several smaller sections), and use acrylic cement or superglue to secure it to the edge of your PSU cover, to create a mounting point



26 / APPLY MOUNTING TAPE

Once the glue is dry, apply 3M double-sided mounting tape to the edge of the acrylic, then remove its plastic layer. You can also apply mounting tape to the base and rear of the cover to help secure it to your case.



27 / INSTALL COVER

Finally, install the PSU cover and press it firmly into place so the adhesive takes hold. If your case proves troublesome here, consider screwing the cover to the case or use a glue gun to apply glue underneath from the far side of the case. **CPC**

Folding@Home

Join our folding team and help medical research

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
Oniks	50000	BairdyUK	3000000	ggyenyen	30000000	apeman556	100000000
Smartwasp69	90000	Faster[ac]	3000000	Wibb	30000000	Lordsoth	200000000
WillTheVideoMan	200000	teens:)unite	7000000	MikePreston	40000000	GWallace	90000000
Nitro3d	400000	PeteUKLancs	8000000	Jazajay	50000000	clanseven	800000000
greyskin101	600000	Mr_Blue_Jam	9000000	Aardwork	100000000	KevinWright	800000000
Granby	900000	scoobyzilla	10000000	GWallace	100000000		
Gary_Seymour	1000000	Jon_Simmo	20000000	kcanti	300000000		
Sam943	1000000	matgsi	20000000	Desertbaker	900000000		

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



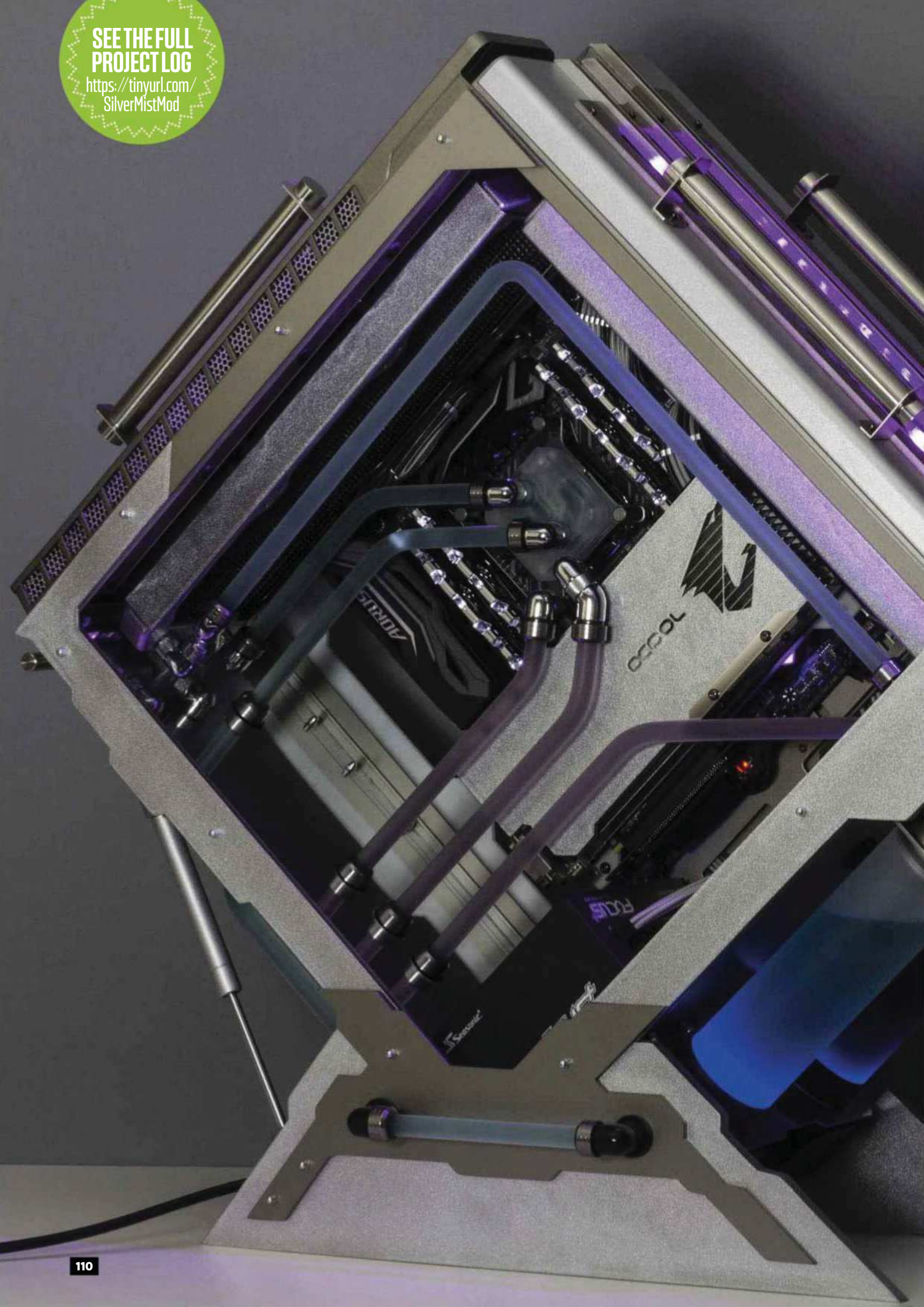
TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Doclonz	6,524,521,882	269,491
2	Nelio	4,193,786,334	472,539
3	HHComputers	3,541,552,293	84,834
4	PC_Rich	2,953,346,605	128,103
5	piers_newbold	2,368,952,185	101,795
6	Lordsoth	2,020,737,896	139,999
7	Scorpuk	1,737,721,606	48,780
8	Slavcho	1,396,559,056	53,942
9	Unicorn	1,359,045,074	51,436
10	daxchaos	1,152,278,376	34,289
11	Laguna2012	1,113,786,032	44,666
12	coolamasta	1,008,368,694	190,492
13	apeman556	1,007,972,467	45,136
14	Desertbaker	904,219,370	39,765
15	clanseven	881,186,934	18,647
16	KevinWright	834,685,633	45,685
17	Roveel	653,319,645	11,452
18	BeezaBob	647,466,416	28,513
19	StreetSam	571,113,589	90,251
20	The_M2B	569,541,142	73,077

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	Doclonz	5,941,241	6,524,521,882
2	PC_Rich	3,663,464	2,953,346,605
3	clanseven	2,919,480	881,186,934
4	Scorpuk	2,390,155	1,737,721,606
5	Slavcho	2,366,794	1,396,559,056
6	piers_newbold	2,302,934	2,368,952,185
7	Nelio	2,232,820	4,193,786,334
8	Lordsoth	1,851,608	2,020,737,896
9	daxchaos	1,473,653	1,152,278,376
10	Unicorn	1,331,061	1,359,045,074
11	Laguna2012	1,204,859	1,113,786,032
12	Desertbaker	1,109,285	904,219,370
13	kcanti	1,105,587	322,856,417
14	apeman556	1,016,750	1,007,972,467
15	KevinWright	693,088	834,685,633
16	Jobjohn	571,911	274,982,985
17	Allan_Smith	534,767	235,396,989
18	Jazajay	509,682	58,320,991
19	Wibb	426,510	32,875,687
20	Team_Thurlow	299,018	28,207,699

SEE THE FULL
PROJECT LOG
[https://tinyurl.com/
SilverMistMod](https://tinyurl.com/SilverMistMod)



Readers' Drives

Silver Mist

Alessandro Zaiti modded his spare NZXT H440 case beyond all recognition, tilting it at an angle, making custom parts and adding a gorgeous custom water-cooling loop with frosted acrylic tubing

QPC: What inspired you to build Silver Mist?

Alessandro: This project began with a 'let's start and see where it goes' attitude. The base idea involved the tilted layout and a pass-through tube routing system, which I always feature in my mods. The reason I chose this case layout is because it makes every single face of the case usable. I used the two top faces to house the intake and exhaust fans, then I used the bottom-front face for the

reservoir/pump combos and bottom-back face for the pass-through tube routing, as well as those gas pistons, which I think are a nice touch.

QPC: Why did you use the NZXT H440 case?

Alessandro: I'd used an NZXT Noctis 450 beforehand, and I found working with it interesting. The H440's clean external panels also give you a lot of freedom for modding – I had one lying around at home, so I thought I'd give it a go.

QPC: Where does the name come from?

Alessandro: Silver is the mod's main colour, and 'Mist' refers to the frosted acrylic I used for the tubing, reservoirs and some of the panels. Also, I left the silver panels a bit translucent, simulating a kind of 'silver mist' look with the backlight.

QPC: What specs did you choose, and why?

Alessandro: The hardware chosen was mostly provided by my sponsors, since I don't have a lot of money available. The X299 Aorus Gaming 3 is the motherboard Gigabyte sent me, the Core i5-7640X is what PC Frog provided and I had a spare GeForce GTX 970 card lying around. Initially, Silver Mist was meant to be my new personal rig, but then it became too big, so now it's not serving any purpose as such. I often find myself disassembling mods for the sake of space and saving hardware – it's a bit sad but I guess that's life.

QPC: What other mods have you built?

Alessandro: Other than Silver Mist, I've built five mods: VG Mod, Unicorn Destroy Mod, Pure Binomial, Hawk's Pyramid and Aura Master. VG Mod and Aura Master were for two different PC stores, so they're serving as demo and display machines. Unicorn Destroy Mod unfortunately had some serious technical problems, so it's no longer alive. Hawk's Pyramid was built for a particular event and I think it's on display somewhere now. Finally, Pure Binomial was the only mod I was able to sell to a customer, and now it's in his hands – I think he uses it to play video games.

QPC: What difficulties did you come across?

Alessandro: There was one major issue and one tedious problem. The major issue was physical stability: such a layout is totally uncommon in a case such as the NZXT H440, so it had some problems staying still – in particular, it tended to move a bit towards the back. I solved it in the end with the help of the side panels. I basically bolted them onto a point of the case, forcing it to stay in place.

The tedious problem was the process of making the sliding panel mounts. They were meant to have three layers of acrylic, which meant I needed 16 detailed strips of acrylic (eight per side), all of which had to be made by hand.

QPC: What tubing did you use?

Alessandro: Tubing is a part of this mod that everyone loves, and I can see why. The



/ MEET THY MAKERS

Name Alessandro Zaiti

Age 21

Location Pavia, Italy

Occupation Full-time modder, but soon returning to study product design

Main uses for PC Netflix and other video and music players, photo and video editing, web browsing

Likes Japanese traditional and pop culture; sushi, anime, collecting figures and JRPG video games. I also like pop-punk and post-hardcore music, as well as weightlifting

Dislikes Reality shows, super-spicy food, soccer and team sports in general



Alphacool Eisrohr Satin 13/10 frosted acrylic tubes look beautiful, and they fit perfectly with the concept for Silver Mist.

Also, as I prefer working with acrylic, it was a blast bending them – they're almost impossible to ruin if you do it properly.

CPC: What tools and materials did you use, and how did you find working with them?

Alessandro: The main tools I always use for my projects are a scroll saw, a Dremel and a power drill, everything else is optional. As for materials, I used a tonne of clear acrylic, plus L and U aluminium profiles. These materials are cheap, but they're so effective and it's easy

to work with them. There were a lot of moments where I wished I had access to a laser cutter, though, to be honest.

CPC: How long did the build process take?

Alessandro: It took me around three months to complete this project, working on it part-time. I think a good 300 hours went into it, if you also count the hours I spent staring at it and troubleshooting.

CPC: What did you learn from the build process?

Alessandro: I certainly learned a lot more about case structure and physical stability. I also confirmed a theory that I've been considering over the past six months, which is that it's useless to try to fill every blank space in a mod. I learned a lot

about cable management too. For the first time in one of my projects, there was an almost completely open back side with visible cables.

There's very little space to hide the ugly connections, but you still can't really see any of them; they're all hidden behind the front radiator, and literally inside the motherboard tray.

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Alessandro: I'm pretty happy with how it turned out overall. I might have taken some different routes in the build process with hindsight, but the way the end result looks is really satisfying. In my opinion, Silver Mist is a project that really pushed both my craftsmanship and design skills. **CPC**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

SYSTEM SPECS

CPU Intel Core i5-7640X

Graphics Nvidia GeForce GTX 970

Case NZXT H440

Memory 16GB Apacer Panther Rage DDR4

Motherboard Gigabyte X299 Aorus Gaming 3

Storage 2 x 240GB Apacer AS330 SSDs

PSU 750W Seasonic Focus Platinum with Cablemod Pro Cables

Cooling Dual water-cooling loop with Alphacool components, comprising Eisbecher 250 reservoir and VPP755 pump combos, a satin Eisblock CPU waterblock, 360mm (30mm thick) radiators, a NexXxoS graphics card waterblock and Eiszapfen fittings with modding nuts

Win these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!



Corsair K70 LUX RGB keyboard with your choice of switches

TOTAL VALUE £160 inc VAT / **MANUFACTURER** www.corsair.com

The K70 LUX RGB is a part of Corsair's LUX flagship line of gaming keyboards, featuring Cherry MX key switches backed by a lightweight, durable aluminium frame and dynamic, multi-coloured lighting. The USB pass-through port is positioned for uninterrupted gameplay, and ready for your mouse or wireless headset adaptor. You can also harness the power of CUE for sophisticated macro programming and dramatic lighting effects and animations.

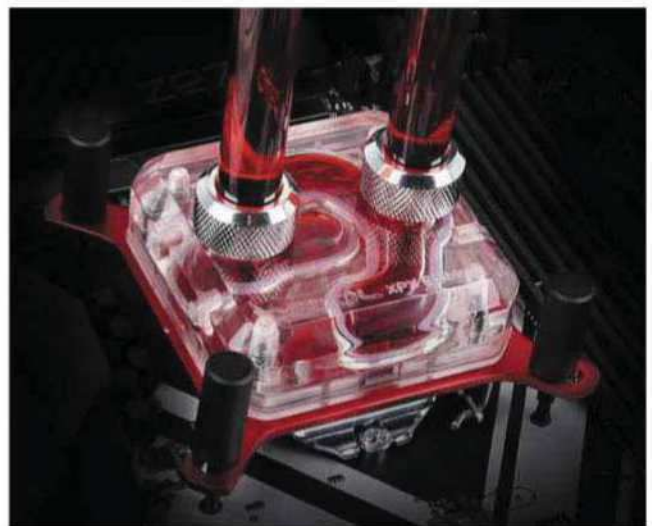


Meanwhile, 100 per cent anti-ghosting with full key rollover on USB helps to ensure accuracy, so every keystroke translates directly into accurate gameplay. The contoured, textured FPS and MOBA keycap sets keep you in control, while the Cherry MX key switches give you a linear response and fast actuation. Corsair will provide a keyboard with your own choice of Cherry MX switches – both Brown and Red RGB models are available.

Alphacool water-cooling gear

VALUE £150 inc VAT / **MANUFACTURER** www.alphacool.com, www.aqua-tuning.co.uk

Water-cooling hardware manufacturer Alphacool is offering a choice of £150-worth of its water-cooling components to every featured Readers' Drives modder. The company is behind some great products we've seen recently, including all-in-one liquid coolers and external radiators. For your prize, you can select from DIY water-cooling kits, the Eiswolf and Eisbaer all-in-one CPU and GPU liquid coolers, as well as a vast range of individual components, including waterblocks (pictured), fittings, reservoirs, pumps and radiators. Alphacool also makes coolant, tubing and fans, as well as modding and water cooling-related tools.





JAMES GORBOLD / HARDWARE ACCELERATED

GPU CHANGES ARE AFOOT

And Intel is playing the long game, argues James Gorbald

Five years ago, one of the most overhyped tech launches was Intel's new Haswell CPU line-up; with their new integrated GPUs, they were supposed to usher in an era of new affordable gaming PCs. Instead, despite a 25 per cent increase in execution units, the sort of increase AMD and Nvidia GPU designers can only daydream about, the Intel HD Graphics 4600 GPU was yet another massive disappointment. It wasn't merely that performance was still woeful, but the drivers were wonky too, creating all sorts of visual artefacts in many games.

Returning to the present day, Intel has finally managed to start shipping CPUs with game-ready GPUs. However, rather than producing yet another woeful in-house GPU, Intel has turned to AMD, its only rival in the CPU space, which happens to have quite a successful GPU business.

The resulting CPUs marry a quad-core Intel Kaby Lake CPU with an AMD Vega GPU, communicating with one another via the EMIB (Embedded Multi-Die Interconnect Bridge), allowing the two processors plus the VRAM to be mounted together in one package. Kaby Lake might seem like a strange choice, given that Coffee Lake has been out for a while now, but this just shows that completing this project was a long and delicate process.

However, despite there now being five different Kaby Lake 'G' processors in production, you'll be hard-pressed to find any PCs or laptops using them. There are several reasons, but the one that matters most is branding. All five models feature Core i5 or Core i7 branding, so they have a commensurably premium price tag.

As such, about the only devices in which these processors can be found is Intel's own Hades Canyon NUCs. While these PCs

are truly tiny for gaming systems they're certainly not affordable – they cost over £800, and then you have to add the RAM, storage and operating system. They're far too expensive to tempt mainstream gamers, especially when you consider that you can just about build or buy a far faster gaming PC with GTX 1070 graphics for the same outlay.

Contrast this approach with AMD's use of the same integrated Vega GPUs in its Ryzen G APUs. Being part of the Ryzen 3 and Ryzen 5 families, these processors have none of the problems

of being associated with AMD's premium processors and can be sold at a sensible price. While they're not currently flying off the shelf, as soon as they get upgraded to the latest Ryzen+ architecture, they'll be an excellent choice for an affordable gaming PC.

In the meantime, the tech press has been going gaga over a number of high-profile current and ex-AMD staff recently joining Intel's payroll. It's all resulted in a spate of

rumours and speculation about Intel's plans to try to break into the GPU space, which it tried and failed to achieve with the 740 graphics card in 1998, and again with its Larrabee project around ten years later.

However, I'm more inclined to believe that Intel isn't building a gaming GPU division and is instead eyeing up the massive market for GPU accelerators in servers. Not that a third major player in the gaming GPU market would go amiss, of course. What can be said with certainty, however, is that Intel has incredibly deep pockets – even if the first-generation new graphics product isn't a game changer, if Intel has the willpower then it certainly has the resources to get the subsequent generations right. **GPC**

There are five Kaby Lake 'G' processors, but you'll be hard-pressed to find any PCs or laptops using them

James Gorbald has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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