COMPUTER SHOPPER
DIGITAL VERSION
Reviews • Advice • Projects • Opinion • News

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THE END OF WINDOWS 7

Decide NOW whether to keep Windows 7 or upgrade p88

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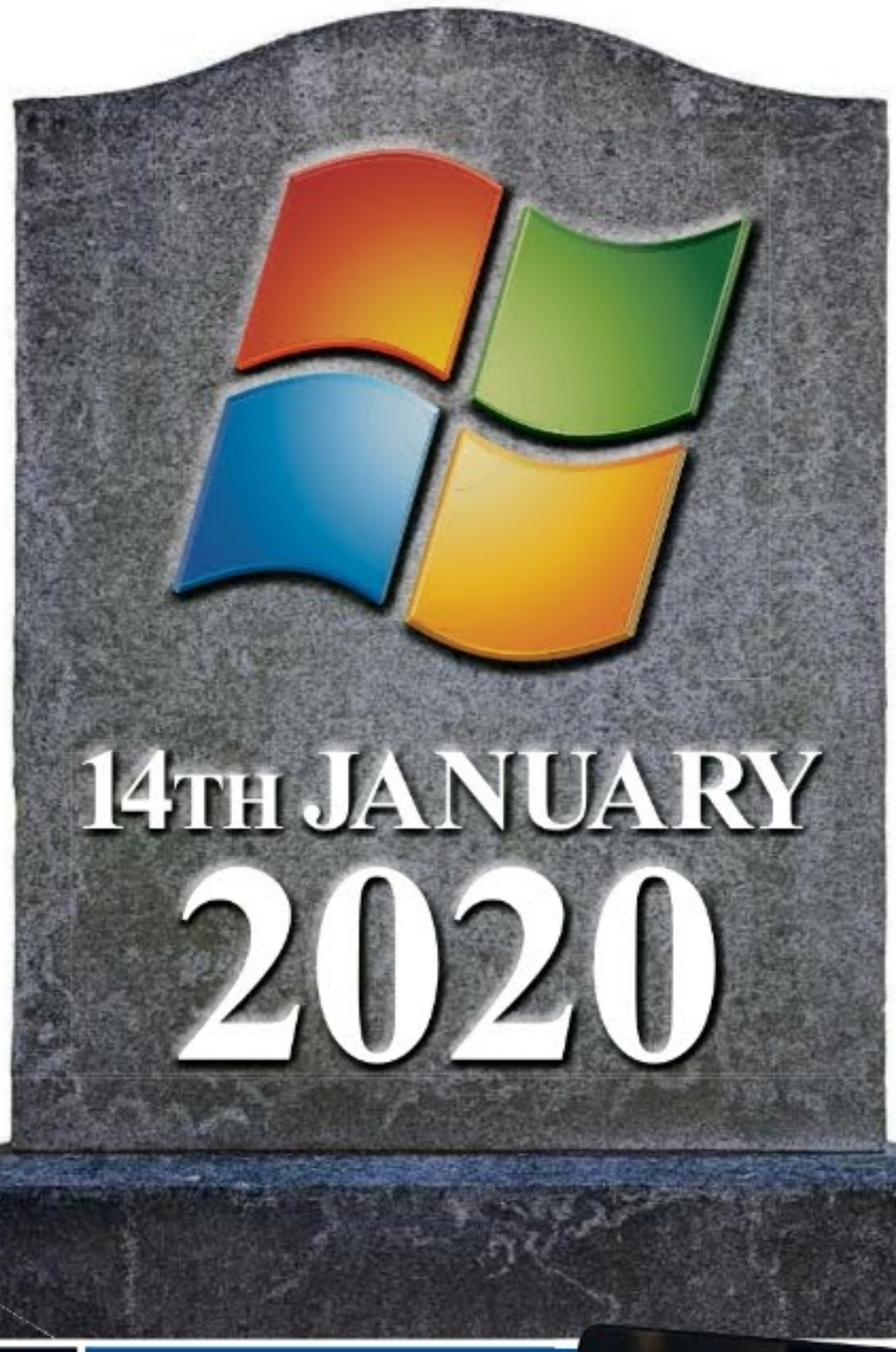
- REPURPOSE YOUR WINDOWS 7 PC
- GET OLD HARDWARE AND SOFTWARE TO RUN

+ UPGRADE TO WINDOWS 10 FOR FREE



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MUSIC MAESTRO

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If you look carefully through *Shopper* this issue, you'll spot a bit of a recurring theme.

Kay Ewbank extols the virtues of Cobol, a program that's been around for 60 years (page 10); Roland Moore-Colyer despairs at smartphone manufacturers' obsession with rushing out new devices every year rather than improving existing ones (page 12); and I'm raving about an application about to celebrate its 35th birthday (also page 12).

The technology world is so fast-paced and focused on the next big thing, that often older products are dismissed as irrelevant. We're under constant pressure to upgrade to the latest version of every application we're using, and shell out yet more cash to buy another device to replace the one we bought only recently. We don't want to risk missing out on that one amazing feature, we're warned, or be shamed in front of our friends and family with an outdated piece of kit.

But unfortunately for the manufacturers and retailers, not all of us are duped so easily. Microsoft might be ending support for Windows 7 in a couple of months, but a third of Windows users are still running the 10-year-old OS. According to industry estimates, that proportion will only drop to around 28% after the 14th January 2020 deadline, while millions of computers are still running Windows 8/8.1 or even the much older XP.

For those of you still running a Windows 7 machine, we've outlined the steps you can take to carry on using it securely and effectively well past the support cut-off date (page 88). There's really no need to rush to upgrade to Windows 10 due to vendor pressure.

For those of you who decide to move on, we've got a free, simple way to upgrade to Windows 10, and different ways to repurpose your old Windows 7 machine. So whichever option you pick, you can reuse rather than discard.

Madeline

Madeline Bennett, Editor
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Issue 383 *January 2020*

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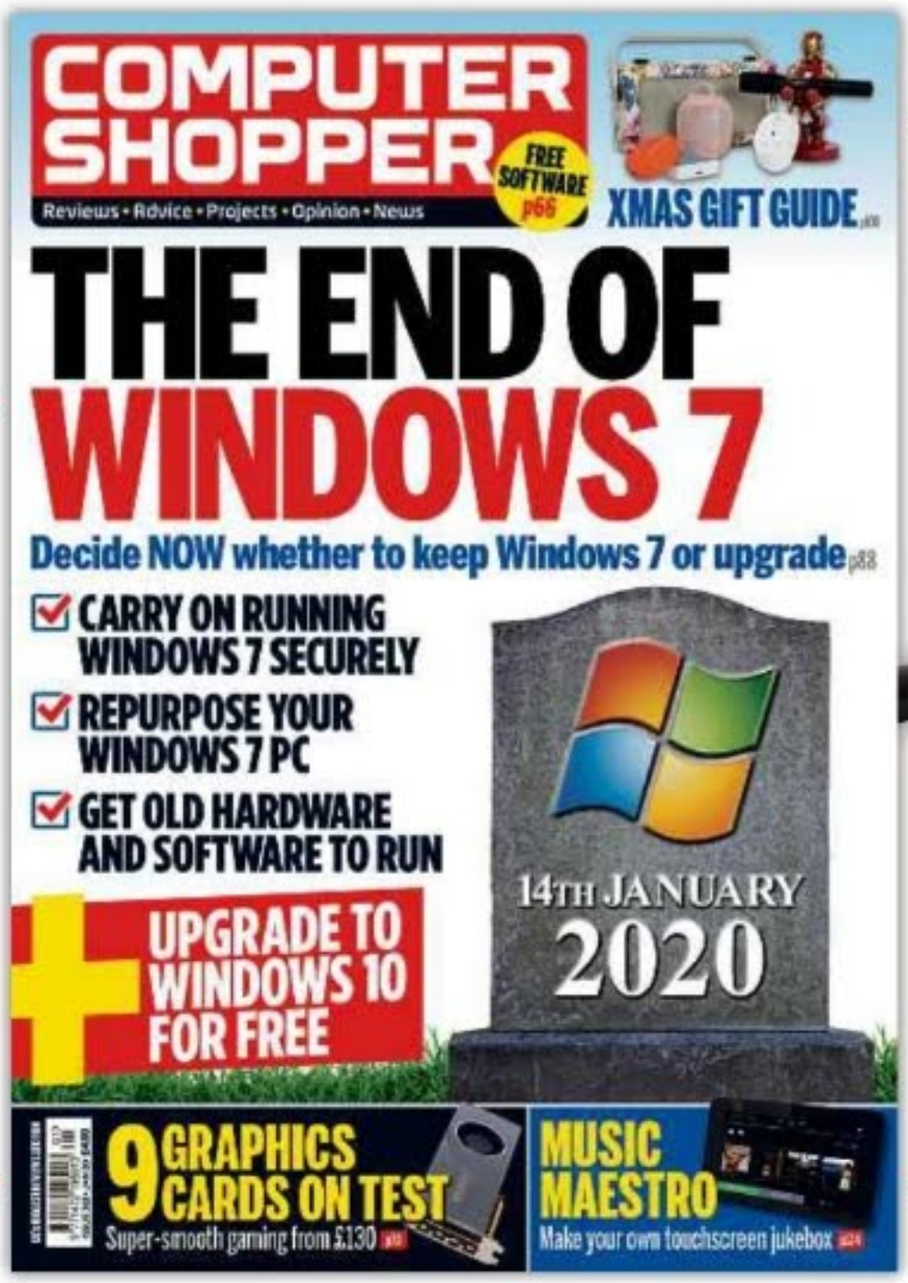

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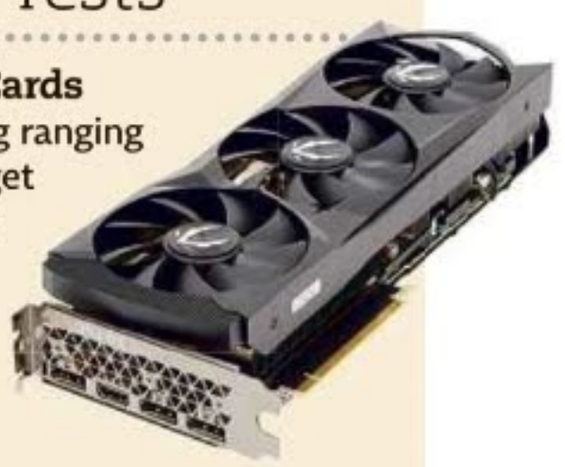

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With everything ranging from nifty budget models costing just £130 to the latest all-singing, all-dancing 4K super-powered GPUs, our round-up of the best AMD and Nvidia graphics cards means you'll be spoilt for choice when it comes to getting the best out of your games

Letters

We're running out of raw materials, but at least we've got cookies to keep us going

letters@computershopper.co.uk

Chemical effect

@Regarding Madeline Bennett's welcome letter (*Shopper* 381), the problem for the future is that all resources of the planet are being used up. All metals except a few such as sodium and iron will be gone in 50 to 150 years.

Electric cars use huge nickel batteries and cobalt for the magnets, mainly found in Congo. They will not happen.

I read the other day that lead will run out in 47 years.

Anyone for a dry cave? And a horse or two?

Tony Allsop (chemist)

The way the cookies crumble

@The internet experience is being ruined by pointless cookie warnings and video pop-ups. I am sure that everyone now realises that websites contain cookies, and if you want to go further you have to accept them on to your computer.

Is there any point in having to accept them every time? Even my Lloyds Bank account warns me every time I visit the site. You would think it would remember my previous acceptance.

News websites in particular put on videos that start playing with sound without asking. I think there is a setting to stop automatic playing, which I enabled once but seems to be back again. Not only that, but a duplicate small video appears at the bottom of the screen: pointless, annoying and impossible to stop.

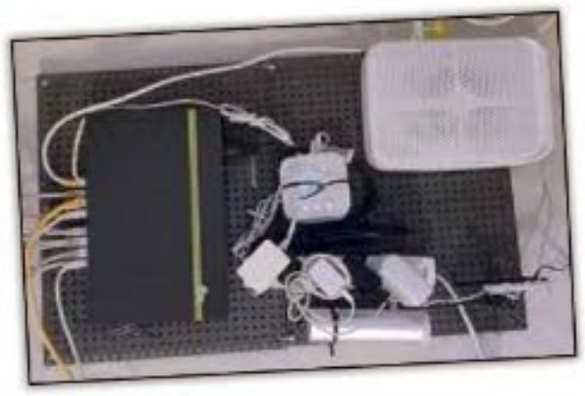
I think these web designers are trying to prove how clever they are, but they're aggravating the rest of us.

Peter Bradshaw

Pegging for mercy

@It has been an ongoing problem for me to organise all the boxes for my Hue, Netatmo, switch, router and so on. I do not think I am the only one with the problem.

However, my solution is to use a pegboard for tools and then use strips to fasten them. It is easily changeable when you get new equipment, and you do not have to drill new holes in the wall.



Ole Pedersen

Star letter

WhatsApp, doc?

@After reading your security article ('Reclaim your online privacy', *Shopper* 380) I checked up on the services I use and I'd already set them as recommended. However, there is an issue with WhatsApp.

I did a GDPR data request and received two files: one, a readable file that stated my name, email and a few other basic details in readable format. The other was a large file – portability.json – with a covering email that said it could be opened and read. It couldn't, because it was encrypted.

I then had a long-running email conversation with WhatsApp, asking what app or program I could use to read the file. Result, zero, complete stonewall.

By this time I had the feeling that there was information in this file it didn't want me to see, so I opened a complaint with the Information Commissioner. The end result was that WhatsApp claimed it was exactly the same information as the readable file but in a different format. The Commissioner accepted this and closed the case.

I'd had a previous conversation with WhatsApp when it introduced end-to-end encryption. Foolishly, I asked how I could turn it off, as it was totally unnecessary in my opinion. This was the first time I came across its stonewalling technique of pointing at irrelevant FAQs, asking for details of a phone number and ignoring emails. I realised that although WhatsApp wouldn't admit it, the encryption couldn't be turned off.

The GDPR was the final straw. Although WhatsApp was very useful, I deleted my account. I know that it will not affect WhatsApp in any way, but I couldn't accept its arrogance and complete contempt of me as a user.

VJ Paine

»Write in and win

Do you wish your computer was faster when booting and loading applications? Thanks to Crucial, you can achieve your dream of a faster PC or laptop with a 500GB MX500 SSD. The writer of our Star Letter will be awarded one of these solid-state devices, which can be installed in a desktop PC or a laptop.

This SSD is 45 times more energy efficient than a typical hard drive and has sequential reads/writes up to 560/510MB/s and random reads/writes up to 95K/90K IOPS, making it the perfect replacement for the ageing hard drive in your sluggish PC.

In the next issue

»Good things come in small packages

We test out the latest mini PCs to see which offer the best performance and value in their tiny package

»Divided we fall

Mel Croucher explores the digital divide, from a cashless society and the loss of basic services to measures we can all take to help bridge the gap

»Security for free

We round up the best security tools for everything from checking network security to encryption, and they're all available at no cost

COMPUTER SHOPPER ISSUE 384 ON SALE IN NEWSAGENTS FROM 6th DECEMBER

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Rebel appliance

New technology may be making slaves of us all, but **Mel Croucher** believes apps such as Deliveroo could finally allow mankind to throw off its chains

MEL CROUCHER
Tech pioneer and all-round good egg
letters@computershopper.co.uk

I'VE BEEN THINKING about apps and slavery. Not bad thoughts, like how humanity has become enslaved by apps, but good thoughts, like how apps can help slaves shake off the shackles of their oppressors.

Me? I'm a willing slave. I've uploaded over 200 apps on all sorts of devices. I like their little coloured icons, and I often rearrange them by colour or by function, which I find therapeutic. I don't actually use the apps, but I do obey all the prompts to update them as soon as they appear onscreen, which I admit is time-consuming. Come to think of it, what I really need is an app that tells me which apps I don't really need. A useful app to help me rebel against useless apps.

It was the Roman gladiator Spartacus who kicked off the most famous rebellion in history, and pioneered the global media struggle for workers' rights. Spartacus was the escaped slave who founded the #MeToo movement in that film with Kirk Douglas, and went on to dominate social media across the empire with the pithy domain name FutuereCrassus.org (use Google translate to work it out).

> Spartacus would have used apps such as Deliveroo to fight against slave labour

A couple of thousand years later, that wily old bird Ho Chi Minh delivered much the same message to the Yanks during the Vietnam War. Ho had learned his strategies witnessing the production of soup additives while working in the kitchens of posh hotels in London. That was before he became the president of North Vietnam, of course.

By then the world had moved on to electronic warfare as a means of oppression. When the Yanks installed a network of sophisticated listening devices in the jungles of Vietnam, they couldn't understand why their gizmos kept sending out false alerts of enemy movement, but no enemies could be found. It was only after expensive delays and replacements that they discovered the enemy to be red-shanked monkeys attracted to the spy-monitors by strategic pools of human urine.

Ho Chi Minh ordered his troops not to destroy the devices, but to exploit them by weeing wherever they were found. Which brings us to the Houthi rebels in Yemen taking the piss out of the Saudi Arabians.

BATTLE READIES

The Saudi war machine has an annual budget of $83bn, and it spends most of it trying to keep those uppity Houthis in check, even though the Houthis don't have any defence budget at all.

In fact, the rebels are so poor they had to resort to a discount sale on Amazon for half a dozen drones with strap-on GoPros for navigation. I expect they used Google Earth to pinpoint the coordinates of the world's largest oil-processing complex at Abqaiq, and take out half of all Saudi oil production. They're probably waiting for Deliveroo to gain popularity in their region, so they can deliver high explosives to the oilfields by bike. Pepperoni pizza with a Semtex deep-crust stuffing.

Spartacus would have spotted the obvious methods of using apps such as Deliveroo to fight against slave labour. Everybody knows that couriers employed in the gig economy get a rotten deal, and because virtual electronic bosses run the show, there's no human to complain to or take strike action against. But would that have stopped Spartacus? No, it would not. Here's what he would have done.

Obviously, the first action that any self-respecting slave rebellion must take is to set up a WhatsApp group. This does away with the old-fashioned rigmarole of chalking subversive messages on walls, organising rallies and getting your head kicked in.

The next vital step is for the rebels to pick a suitable hashtag. A good choice would be #IAmSpartacus. Then you must make your demands to the bosses, and be sure they are impossible to meet and guaranteed to provoke strike action by your fellow slaves. For example, if Deliveroo pays a courier £7.50 for an hour's worth of food deliveries, then Spartacus must get the Deliveroo slaves to demand £15 an hour, plus comfier saddles.

WHEELIE GOOD IDEA

Now we come to the clever bit. Spartacus peddles his delivery bike to an alleyway where the Deliveroo app forces its riders to congregate. This is most likely to be a discreet location where the restaurants and takeaway joints keep their wheelie bins. He then whips out his mobile and sets up a new Deliveroo account, taking advantage of the introductory special offer of a £4.99 meal with free delivery, and orders it to be couriered over to wheelie-bin alley.

As soon as the Deliveroo rider arrives with his meal, he gives the grub to the courier, and recruits them into the #IAmSpartacus revolution with the promise of double wages. The new recruit then pulls the same stunt for the next recruit. Before the night is out, every Deliveroo rider in town has joined the revolution, the system has been occupied, and the bosses are powerless to resist. There will be no strike-breakers, because every new recruit has the prospect of double wages tomorrow.

As for the app bosses, in the words of Ho Chi Minh, "You will kill 10 of us, we will kill one of you, but in the end, you will tire of it first." And as for me, as you already know, I am not Spartacus. I am a very naughty boy.

Learn Cobol, young coder

Chances are you've used technology based on Cobol in the last few weeks. So why, asks **Kay Ewbank**, is it seen as an archaic language that nobody wants to learn?

KAY EWBANK
Software guru and *Shopper* legend
letters@computershopper.co.uk

I USUALLY BASE these columns around what's fun, new and trendy in my area of computer use, and this month is no exception: the programming language Cobol has just celebrated its 60th birthday. OK, so Cobol isn't really fun, new or trendy, but what's odd is that it's still really important.

It was already seen as boring and unfashionable when I first learned it back in the 80s. These days, hardly any universities include Cobol on their courses, and most people in IT probably think of it as a historical curiosity.

So you might be surprised to learn that you've almost certainly interacted with a Cobol program recently. If you've got money out of an ATM, used online banking, interacted with a government department, sent or received a parcel, talked to a call centre, a Cobol program was likely involved.

Around 65% of active code still being used today is written in Cobol and, according to Reuters, around $3tn every day in the US is handled by Cobol systems.

> Around 65% of active code still being used today is written in Cobol, and around $3tn every day in the US is handled by Cobol systems

What's more, while we all think of computing as something where things are created new and sparkly all the time, many of the systems you've interacted with will have been creaking along since the 70s or 80s, possibly without anything being changed.

So how come we're still relying on code written so long ago? There are several reasons. First, the code still largely does what it's meant to. There's jazzy new stuff to make it look pretty, but the bits behind the scenes that make sure it's your bank account the funds are put into, that there's enough money in the account before you empty the cashpoint, the rules for that sort of thing don't change. What's more, the company you're dealing with won't make any more profit if they spend millions, or even billions, updating it.

COST ANALYSIS

If you think my estimates for the cost are unreasonable, do a quick web search for government computer system problems and take your pick of headlines such as 'Abandoned NHS system has cost £10bn', '£12bn government computer system scrapped' and so on. I don't know for sure that the systems being replaced were Cobol ones, but I bet they are. I do know that when the Commonwealth Bank of Australia rewrote its Cobol banking system in 2012, it took five years and over A$1bn (around £500m).

One reason for the high costs is that those old Cobol systems are often very complex. Back in the days when they were written, even a mainframe computer couldn't deal with a very large program, so to get an ATM system, for example, you might have several hundred smaller programs each doing a small part. Those separate programs are layered and convoluted, and changing them would be horrendous. You think the HS2 trainline people have problems? They're tiny by comparison, and while we all sigh if a new train line doesn't get built on time and on budget, if you open your online banking account and all your money has disappeared you'd do a lot more than grumble.

So the Cobol programs have to keep working, and that involves having Cobol programmers to maintain them. So here's a question: what happens when all the old Cobol programmers retire? Most of them have done so already, while a few are still coining it in even though they're well past retirement. One group in the US called Cobol Cowboys (with the tagline 'not our first rodeo') has part-time consultants, most over retirement age, who earn good money as consultants fixing problems or making sure new interfaces interact with the old systems. Most were originally employed in the same industries they now consult for, and are chosen because they're trusted.

GOLDEN OLDIES

Another example - not related to Cobol Cowboys – is of a US government department that has one elderly employee in his 70s, on oxygen, who remains vital because he's the only person who understands the system being used. According to a vice-president at IT company Unisys, the government department sends out a police car to pick the employee up and bring him in to work every morning, to make sure he and his oxygen mask get there OK.

What's needed is a new generation of programmers to keep things going, but the snag is that young programmers aren't interested in learning Cobol; it's seen as a language of old fuddy duddies, and the work is generally fairly tedious maintenance work. Things aren't all bad, however. IBM has launched training programs and fellowships for young developers to learn Cobol, and says it has now trained nearly 200,000 developers.

So would I be learning Cobol if I was starting my programming career right now? I'm not sure. Even the most enthusiastic supporters of Cobol give it a maximum lifespan of maybe being the major business language for the next 20 years. Then again, that was what they told me back in 1980, and look at Cobol now. CS

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RANTS & RAVES

Regrets, we've had a few – and not learning advanced Excel skills is one of the biggest. And we're also having second thoughts about upgrading to the latest phone every year

Madeline Bennett RAVES

ONE OF THE past criticisms of computing education has been that it focuses too much on 'dull' aspects such as spreadsheets, which puts off students from selecting technology subjects.

In my schooldays, we were fortunate to have a computer lab at all. But with around 20 PCs for 700 students, we didn't get to use it much. And as Microsoft had only recently launched its core Office apps when I was a schoolgirl, I never had the chance to sit through these 'dull' lessons, being taught how to master Excel spreadsheets.

And how I wish I'd had that opportunity. There have been countless occasions in my working life where advanced Excel skills would have been a boon. Instead, I've managed to pick up the basics by using spreadsheets over the years, but I'm aware that tasks that would take an Excel whizz a few seconds take me far too long.

I've also often had the nagging feeling that those of my colleagues who are great at Excel are almost like members of an exclusive club, getting invited to meetings and given opportunities to work on projects partly (or mainly) because of their spreadsheet skills. I've generally dismissed those thoughts as baseless, but a recent post on Twitter from an academic going by the name of Andyou R. Shocked confirmed my suspicions.

"Students often ask me what skills will help them in a job. Sometimes I tell them 'get good at spreadsheets'. They think I am joking. I am 100% not joking. Any industry. Any position. Being a spreadsheet god is transferable knowledge."

This led to several examples of people benefitting from being in this elite Excel club I'd imagined, including one whose firm "promoted someone to vice-president because of his ability to do pivot tables. (Seriously. That's what the announcement from HR said.)"

A clinician friend of mine was recently bemoaning his latest group of medical students, who were bemused by the idea of recording the core data they were gathering in a spreadsheet they had created themselves. They thought someone would just do that for them, pointing out it would take them ages to try and work out how to use Excel.

You can bet if one of that group was an Excel master, they would be inundated with job offers as soon as they'd qualified. All I need to do now is become a pivot tables genius, and expect to see me as VP of a major corporation some time soon.

Roland Moore-Colyer RANTS

LAST MONTH, MY colleague James Archer subtly threw shade at me for essentially claiming phones are symbols of status (*Rants & Raves*, *Shopper* 382). While I was referring to how having the latest phones is useful for a tech journalist wanting to appear with their finger on the pulse, I still believe phones are status symbols.

OK, they aren't as flashy as a Ferrari, but with the iPhone 11 Pro costing north of £1,000, they're no longer devices you get on a whim, unless you're suitably well-heeled or willing to go into debt. As such, having the latest flagship phone paid in full is definitely one way to showcase you're not lacking in the money department.

But despite this, I'm against this idea of needing the latest and greatest device every year. Where once the new iPhone or Samsung handset brought in desirable features and performance hikes, the current crop of flagship devices feels iterative. A slightly improved camera system is nice, but even budget phones offer decent smartphone photography these days, and serious pic snappers will likely opt for a DSLR anyway.

As such, I feel this 12- or 24-month upgrade cycle is somewhat depressing. And with Extinction Rebellion kicking up a stink over climate change, I'm getting increasingly keen on the idea that we don't need new phones, whether we buy them or not, to pop up annually.

I'd rather phone makers took longer to come up with devices that are really innovative, such as a proper modular phone that's full of recyclable and reusable parts. Or a device that boosts a phone's functions, allowing it to boot Windows 10 alongside Android to become a pseudo mini PC that can be plugged into a monitor.

There are plenty of patents that showcase potentially weird and wonderful additions, yet we never see them, probably because hardware makers are churning out yet another mild upgrade.

I know some innovation is limited by the demands of business and bottom lines. But if one looks at how the Xbox 360 and PlayStation 3 were pushed to their limits before being replaced, there's an argument the same could be done with phones, with increased life cycles leading to more innovation and less environmental impact. Status symbols, be damned.

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NEED TO KNOW

The biggest stories from the tech world, and what they mean for you

New Surface line-up shows design and chip innovation

SAY WHAT?

MICROSOFT RECENTLY UNVEILED a slew of new Surface devices, and *Computer Shopper* was among the few UK publications present at the showcase to gain an insight into the direction in which the range is heading.

Let's start with the arguably dull stuff first. The Surface Pro 7 is a minor refresh of the Surface Pro 6. It rather predictably sports Intel's latest 10th-generation Ice Lake 10-nanometre processors, which promise a decent boost in efficiency and graphics performance, and a USB Type-C port has finally been added into the mix, although it doesn't support Thunderbolt 3. There's also a rather snazzy looking reddish orange colour for the Type Cover keyboard.

It's basically the same story for the Surface Laptop 3 13, which also uses Ice Lake processors, comes with USB Type-C and has a slightly shallower key travel of 1.3mm. It promises a performance boost and faster charging than the Surface Laptop 2, and comes in an aluminium finish, but otherwise it's a minor bump up from an already excellent ultraportable.

You'll have clocked the use of '13' after the laptop's moniker - that's because Microsoft has a 15in Surface Laptop 3. As its name would suggest, this laptop has a larger 15in PixelSense display, which looks rather lovely from our first impressions.

Available in a grey and black aluminium finish, the interesting part of the Surface Laptop 3 15 comes from within that slick chassis. Microsoft has worked with AMD to create the Ryzen Surface Edition processors.

Coming in Ryzen 5 and Ryzen 7 variants, these are custom accelerated processing units (APUs), and come with Radeon RX Vega 9 and Vega 11 graphics respectively. A Microsoft representative told us the chips have been configured to deliver more CPU and GPU performance, and use specially designed drivers to ensure they run at their best with Windows 10.

The Ryzen 7 3780U Microsoft Surface Edition has four cores and eight threads, and runs from 2.3GHz to 4GHz. The Ryzen 5 chip has the same number of cores and threads, but runs from 2.1GHz to 3.7GHz.

The most interesting device revealed was the Surface Pro X (left). Essentially Microsoft's answer to the iPad Pro, the Surface Pro X is a slimmer, lighter take on the Surface Pro 7, yet thanks to slim bezels it manages to fit a 13in display into the same footprint.

A new Type Cover design has a divot on the top to hold Microsoft's new Surface Slim Pen, a rather neat stylus that feels a bit like a premium pencil. A trim yet solid kickstand and a pair of USB Type-C ports complete the Surface Pro X's minimalistic and svelte look.

Again, it's under the surface of the Surface Pro X that things get really interesting. The tablet doesn't use an Intel CPU like previous Surfaces; instead, it uses a custom SQ1 chip (right) based on a Qualcomm Snapdragon system-on-a-chip, but one that draws 7W of power rather than the typical 2W of many smartphone SoCs.

Nvidia aims to bring ray-tracing tech to classic titles

SAY WHAT?

RAY-TRACING IS ARGUABLY the current pinnacle of computer graphics rendering, with the technique involving the mapping of light around a virtual environment, including all the ways in which it can hit and refract off surfaces.

It's long been used in animated movies and special effects, notably by Disney Pixar. But in the PC gaming world, the rendering technique was so demanding it's been out of the reach of even the most powerful desktops.

That was until Nvidia came along with its GeForce RTX 20-series graphics cards, which harness Turing architecture to deliver ray-tracing rendering in compatible games using a single GPU, as opposed to a server-grade machine with multiple graphics cards.

However, there aren't a vast number of games that support ray-tracing at the moment. Shadow of the Tomb Raider, Metro Exodus and Battlefield V are the stand-out games, but other major ray-tracing titles are thin on the ground.

Nvidia looks to change that with the news that it's recruiting skilled workers for its Lightspeed Studios, with the aim of remastering classic games with ray-tracing technology. In theory, this could give old titles a fresh new look with cutting-edge realistic lighting, yet without the huge performance demands of implementing and running ray-tracing in the latest games.

"We're cherry-picking some of the greatest titles from the past decades and bringing them into the ray-tracing age, giving them state-of-the-art visuals while keeping the gameplay that made them great," Nvidia's job advert reads.

"The Nvidia Lightspeed Studios team is picking up the challenge, starting with a title that you know and love but we can't talk about here! We're building a team of talented, dedicated game developers who are ready to get going quickly."

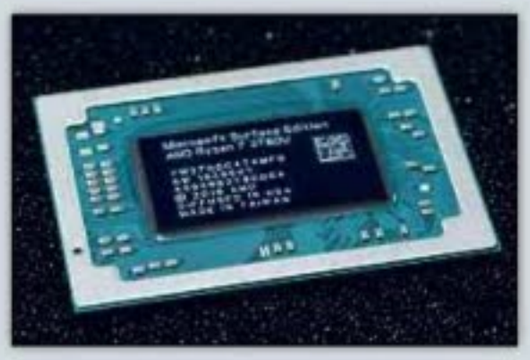
What those games will be has yet to be revealed, nor how Nvidia will go about re-working titles. But we've already seen Nvidia implement ray-tracing into the venerable Quake II with impressive results. Minecraft was recently given a dose of ray-tracing, which turned a minimal, blocky-looking game into something akin to moving modern art.

Since 2015, Lightspeed Studios has been working on remastering games to work on Android devices, notably Nvidia's Shield. So the company is no stranger to working with older games and adding more features to them.

As such, we can expect to see more ray-traced games pop up, even if they are from days gone by and not the latest triple-A titles.

SO WHAT?

THE SURFACE PRO X is an interesting rejig of the hybrid machines we've seen in recent years. Not only could it rival the iPad Pro as a device for creating and consuming content on the move, it could also challenge other Windows 10 laptops and even Microsoft's own Surface Pro 7 if it can deliver the performance it looks to have on paper.



It also shows an interesting statement of intent from Microsoft, which shows the company is willing to look at how Windows 10 can run on systems that aren't reliant on Intel or AMD CPUs.

While Windows 10 has run on Snapdragon chips before, under Microsoft's Always Connected PC initiative, performance and compatibility issues have held them back.

But with Microsoft getting more involved with the silicon in such devices, we could start to see more Windows 10 devices running on ARM rather than x86-based chips. That could in turn deliver devices that are lighter and more energy-efficient, yet still powerful.

Microsoft's work with AMD also shows the Redmond company is not wholly beholden to Intel, and will happily roll its sleeves up to work with other chip makers. This sets the stage for other PC and laptop makers to follow suit.

With prices ranging from £999 to over £2,000 for the new Surface devices, this top-notch engineering won't come cheap, so we'll have reviews in upcoming issues to tell you which Surfaces are the best bet.

From starting out with a slightly odd tablet-meets-laptop device, the Surface range has evolved into a suite of impressive devices. The showcase in New York demonstrated that Microsoft isn't just willing to refresh its most critically acclaimed Surface gadgets, but also look at innovative directions the Surface range can segue into (see *The Lowdown*, page 17, for an example).

That's all very promising for future Surface devices and their impact on next-generation Windows 10 machines.

SO WHAT?

THE HEFTY DEMANDS ray-tracing puts on even a costly GeForce RTX 2080 Ti means the light-rendering technique hasn't exactly been rampantly adopted by games in 2019. As the current crop of games consoles also lack support for ray-tracing, there's an argument that it's not going to be high on the priority list for developers making games that work across PlayStation 4, Xbox One and the PC.

> "We're cherry-picking some of the greatest titles from the past decades and bringing them into the ray-tracing age"
> *Nvidia job advertisement*

However, Nvidia's push to explore how ray-tracing could be added to older titles might change this. Patches that implement ray-tracing and can be applied to games that are already on the PCs of millions of people is one way to showcase the technique.

A card from the GeForce RTX line-up will still be needed, but Quake II can run with ray-tracing enabled on an RTX 2060, a more affordable GPU with onboard ray-tracing hardware. This could mean that ray-tracing could become more accessible to PC gamers, and thus interest in it rises. This could then make the effort of adding ray-tracing into games more compelling for developers.

It's also worth bearing in mind that the PlayStation 5 and next-generation Xbox may have ray-tracing support. As such, more work on ray-tracing is important so that developers can ready themselves for this upcoming generation.

Having a studio dedicated to ray-tracing work stands a strong chance of finding new ways to make ray-tracing more efficient and effective in games, and thus make it more accessible.

Nvidia's work should also spur AMD into adding more comprehensive ray-tracing support in its Radeon cards.

BOOTING UP

On the Spectrum

Eve, the company behind the Surface Pro-like, crowd-sourced Eve V, has tapped up its community to come up with the Eve Spectrum, a 4K monitor that takes the desires of its 2,000 members into account

Double duty

Google has revealed a pair of new Pixel phones, with the fourth-generation Android handset dropping the single-camera setup for a dual-camera array

Charging ahead

The Oppo Reno Ace handset can charge its 4,000mAh battery from empty to full in a mere 30 minutes thanks to a 65W SuperVOOC charger, potentially setting the standard for faster phone charging

Yee-core

Rockstar has revealed that its hit console title Red Dead Redemption 2 is coming to the PC and will tap into the power a gaming rig can bring to bear with enhanced graphics settings

Chip partnerships

Intel is killing off the Kaby Lake-G chips, which saw the chip maker team up with rival AMD to create a chip that mixed an Intel Core CPU with AMD Vega graphics, yielding some capable slices of silicon

Foul play

Game giant EA exposed the personal details of FIFA 20 players on its website when gamers signed up for the football game's Global Series competition

Auto motors

Nvidia has teamed up with Toyota and GM, among others, to work on chips for self-driving cars in the Autonomous Vehicle Computing Consortium, further paving the road ahead for a time when computers, not humans, will be the motorists of the future

Not Scot free

Two teenagers thought to have been involved in a hack on the Metropolitan Police's website and Twitter account have been arrested and charged in Scotland

CRASHING

FROM THE LAB

Vodafone trials experimental UK networking tech to boost rural broadband

RURAL BROADBAND BLACKSPOTS could become a thing of the past after Vodafone launched what it claims is experimental network-sharing technology to broaden the number of suppliers that can offer 4G access in less populated areas of the UK.

Collaborating with Intel, the network giant's system of open radio access networks (OpenRAN) is a project devised to release cutting-edge networking equipment from the stranglehold of a small number of companies, in what is believed to be the first of its kind in Europe.

With OpenRAN, Vodafone is hoping the design of hardware and software in networking infrastructure becomes standardised so that it

can be used by a wider number of providers to more easily deliver mobile data services to rural areas.

"OpenRAN improves the network economics enabling us to reach more people in rural communities, and that supports our goal to build digital societies in which no-one is left behind," said Vodafone's CEO Nick Read.

Trials will run in 120 rural locations in the UK, as well as abroad in countries including the Democratic Republic of the Congo and Mozambique.

Vodafone's announcement feeds into industry and public sector efforts to expand networking access to countryside locations, given the staggering infrastructure gap that exists in the UK between the nation's urban and rural areas.

Nvidia harnesses artificial intelligence to help keep medical data private

PROTECTING MEDICAL DATA is an important part of ensuring that sensitive information stays private. But such data can help deliver useful insights to the medical world to deliver better diagnosis and care.

Now Nvidia has joined forces with King's College London (KCL) to create artificial intelligence systems to extract insights from medical data without actually taking that information from its source.

The technique, known as federated learning, uses multiple parties to train a centralised deep neural network. Nvidia and KCL use this method for a central system, which contains the algorithms to analyse medical imaging data at a local hospital rather than sucking up data into a central server.

Instead, a client is installed on the hospital's systems, which processes the imaging data locally and only sends back what it has learnt from that information, rather than the data itself.

"The centralised server then takes multiple realisations of the model that have been trained on separate datasets and creates a consensus out of it," explains Jorge Cardoso, associate professor at KCL.

"This consensus is sent back to the hospitals, learns from data again and the updated models are sent back to the centralised server."

The process is repeated until the algorithm learns all that it can from the data, without discovering who the data belongs to or where it came from.

Tesla car-summoning feature hits a few bumps

TESLA HAS UNVEILED a feature that allows users to remotely 'summon' their car to their location. However, the tech has already run into problems, with cars crashing into objects and other vehicles.

Social media posts relating to the Smart Summon feature show Teslas driving into a garage door, being struck by a reversing vehicle and more.

The software update to the Tesla app was rolled out to select users on 26th September.

"With Smart Summon, customers who have purchased Full Self-Driving Capability or Enhanced Autopilot can enable their car to navigate a parking lot and come to them or their destination of choice, as long as their car is within their line of sight," said the company.

"It's the perfect feature to use if you have an overflowing shopping cart, are dealing with a fussy child, or simply don't want to walk to your car through the rain."

Smart Summon works by having a Tesla owner with a compatible car hold down a button in the Tesla app to summon the vehicle; releasing the button will cause the car to stop.

But in the week after the app update was released, problems started to arise. In one instance, an owner expected the car to detect oncoming cars at a junction and stop automatically, only to be disappointed.

"I took my finger off when I saw that it wasn't slowing down, but I'm not sure which kicked in first," said the owner.

SOUND BYTES

"We know people are dying on smart motorways… Understanding whether they are less safe, the same or safer – I want all of those facts and recommendations"

Transport secretary **Grant Shapps** is reviewing the safety of smart motorways, which use the hard shoulder for traffic at busy times

"Let's call up Jeff and talk about this"

Facebook boss **Mark Zuckerberg** is unhappy about his company's Amazon Web Services bill

"Ultimately, we think in a year or two we'll have games that are running faster and feel more responsive in the cloud than they do locally"

Google Stadia's **Majd Bakar** has big ambitions for the game-streaming service

"If we don't do something, this is not going to be an inclusive era"

IBM CEO **Ginni Rometty** warns that new tech could create an era in which some people won't be equipped to find work

"Does the owner of a home need to disclose to a guest? I would and do when someone enters into my home"

Google's **Rick Osterloh** says visitors should be warned about smart speakers

THE LOWDOWN

Surface Neo and Duo

We take a closer look at Microsoft's innovative new devices

MICROSOFT AND INNOVATION... REALLY?

OK, we know the Redmond-based company isn't exactly known for being an innovative company, though one might argue that having an operating system and software that's used across the globe in millions upon millions of devices is hardly dull.

But since Satya Nadella replaced Steve Ballmer as Microsoft CEO, the company has arguably been more innovative than ever. Put aside the work it's done with Xbox, cloud platforms and Windows 10, and take the Surface range as an example.

What started out as a neat hybrid laptop-meets-tablet has spawned a series of sleekly designed devices, from the excellent Surface Laptop to the creator-focused Surface Studio.

Now Microsoft has unveiled the Surface Neo and Surface Duo, dual-screen devices that demonstrate Redmond has as much innovation up its sleeve as Apple.

SURFACE NEO – WHAT'S THAT?

Take two iPad Mini-sized tablets, stick them together and essentially you have a Surface Neo. It's a dual-screened tablet, with the screens connected by a hinge that rotates 360 degrees. That means the Surface Neo can either be used as a single-screen device, with the two screens oriented side by side like an open book, or in a laptop form, with one screen acting as the base and the other as the main display.

In either form, the Surface Neo is effectively a compact Surface Pro – it's only 5.6mm thick – that plays nicely with the new Surface Slim Pen, a trimmed-down take on the Surface Pen that magnetically attaches to the back of the Surface Neo.

Speaking of magnets, the Surface Neo includes a magnetic keyboard that can be stuck on the back of the tablet when not in use. It can be attached to the bottom of the Neo in its 'laptop' orientation, taking up the lower part of the bottom screen (pictured, far right). The top part of that display shows what Microsoft calls the WonderBar, which provides extra information alongside the top display. The keyboard can also slide up to cover the WonderBar, allowing for the bottom part of the lower display to show a virtual trackpad.

To make sure the Surface Neo works with Windows 10, Microsoft has created Windows 10X, a version of its operating system specifically designed for dual-screen devices; expect it to be adopted by such gadgets from hardware makers in 2020 and beyond.

IT DOESN'T SOUND AS IF IT WILL BE VERY POWERFUL

It may be thin, but the Surface Neo is the first dual-screen device to use Intel's Lakefield chip. This miniscule 12x12x1mm chipset not only makes use of Intel's 10-nanometre process technology, but also uses the chip maker's Foveros tech.

In a nutshell, Foveros allows for chip components to be formed in 'chiplets' that can be stacked upon each other, thereby reducing the footprint of a chip without reducing its capabilities.

In the Surface Neo, the chip combines efficient Tremont cores to keep power consumption in check, then adds a Sunny Cove core into the mix to deliver compute performance. Other chips based on these architectures have yet to pop up so we can't say for sure how powerful they are, but given Lakefield comes with Intel's Gen11 integrated graphics, it should be a pretty capable chip.

WHAT ABOUT THE SURFACE DUO?

At first glance, the Surface Duo (above left) is effectively a smaller Neo without the magnetic keyboard. But it's different deeper down.

Rather than run a mobile version of Windows, the gadget uses Android, but what appears to be a heavily skinned take on Google's mobile OS, with Microsoft apps aplenty. It can also accept phone calls.

SO IT'S THE SURFACE PHONE?

Microsoft utterly avoided the words 'phone' or 'smartphone', but given its Android credentials, yes, it's pretty much the heavily rumoured Surface Phone.

Details around the Surface Duo's specs are thin on the ground. Both it and the Surface Neo are due out 'holiday 2020', aka Xmas time, so there's room for specifications, chipsets and even designs to change.

But we'd put our money on the Surface Duo coming with a Qualcomm Snapdragon-based chip, given Microsoft has worked closely with the chip maker on getting Windows 10 to work on ARM-based chips and instruction sets.

The likes of Samsung's Galaxy Fold and Huawei's Mate X, offering smartphones with folding displays, could arguably make the Duo look a little dated by the time late 2020 comes around. But the dual rather than foldable screen approach could make the Duo more durable than the aforementioned phones, especially the Galaxy Fold, which suffered screen problems and had its launch delayed this year.

> Given its Android credentials, the Duo is pretty much the rumoured Surface Phone

WHO ARE THESE SURFACE DEVICES FOR?

That's a good question. The Surface Neo could be seen as a companion Windows 10 device that pulls double duties as a tablet and a pseudo laptop in a smaller and more slick form than a Surface Pro. So someone could have a desktop or larger laptop setup at their desk or place of work, and then have the Surface Neo as a neat hybrid device for working and consuming media on the go. Whereas the specification of the Surface Pro 7 might be seen as a laptop replacement, the Surface Neo, to our mind, is definitely a secondary device.

The Surface Duo is a more tricky proposition. While it looks like a well-engineered device from Microsoft, it's arguably still an Android product, rather than a true Windows gadget.

Android is a very capable operating system, but it's no replacement for Windows in terms of getting stuff done. One could argue that the Surface Duo is effectively a companion device to the Surface Neo and other Surface devices, aimed at those who want to have a Microsoft machine for any occasion.

Otherwise, it's an Android tablet-meet-pseudo-phone. Given how many very good large-screen Android phones there are, such as the Galaxy Note 10+, the proposition of the Surface Duo is not necessarily as tantalising as the Surface Neo.

REVIEWS

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APPLE iPhone 11 Pro

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VERDICT

Apple's latest flagship phone is unbeatably fast, full of new features and has an unbelievably good set of cameras

EVEN THOUGH HE'S long gone from Apple, the design influence of Jony Ive can still be seen in the new iPhone 11 Pro, particularly in its set of three rear cameras. Contained within a large glass square, which is actually part of the backplate rather than a separate housing, the asymmetrically positioned lenses are an eye-catching feature in their own right.

Otherwise, however, this is a very familiar smartphone to last year's iPhone XS. There's the same abundance of glass, the same colour-matched stainless steel frame surrounding the edges, and the same wide notch. This last touch is still an incongruously large ingress into the screen, but at least it houses the Face ID setup, and the front-facing camera sensor has also been upgraded from seven megapixels to 12.

If you don't mind spending as much on a phone as on a second-hand car, this is the one to buy

LIT UP

Also like the iPhone XS, the iPhone 11 Pro meets the IP68 standard for dust- and waterproofing, so it will survive being dropped in a puddle, bath or even the deep end of a swimming pool. Conversely, 3D Touch has been removed, although this is no great loss: while innovative, it never felt as if Apple made enough use of it on previous iPhones.

The iPhone 11 Pro is equipped with a Super Retina XDR OLED display, with support for HDR10 and Dolby Vision. In plain English, this means little more than a boost to the overall brightness of the display. It's the same resolution as the iPhone XS, at 2,436x1,125.

How much brighter is it, then? With automatic brightness mode enabled, the screen on the iPhone 11 Pro will peak at up to 766cd/m² – up from 686cd/m² on the previous model – and when playing HDR video, that rises to an even brighter 1,200cd/m². Even if you're already familiar with the iPhone XS, however, you might struggle to tell the difference: we placed the two phones side by side and, although we could see slightly more clarity in the highlights on the iPhone 11 Pro, the difference wasn't night and day.

Regardless, this is still a delightful display. Contrast is perfect, thanks to the OLED panel, and it was spot-on in our colour calibration tests: 98.3% gamut coverage and an average delta-E of 1.01 is about as good as it gets.

UNDISPUTED CHAMPION

On the performance side, Apple didn't even need to come up with a new processor; the 12 Bionic chip that powers its 2018 line-up is still, today, more powerful than any Android-focused SoC. It's faster than the Qualcomm Snapdragon 855, the Kirin 980 and the Samsung Exynos 9820, all of which can currently be found in the fastest, and most expensive, Android smartphones.

Even so, the iPhone 11 Pro contains a new, hexa-core A13 Bionic, extending its performance advantage even further. In Geekbench 5, the newly released (and much more demanding) replacement for the Geekbench 4 benchmark, the iPhone 11 Pro scored 1,337 in the single-core test and 3,504 in the multicore test. By comparison, the iPhone XS sits at 1,119 and 2,818 respectively, while the Samsung Galaxy S10 (*Shopper* 379) is far behind with 823 and 2,271.

The iPhone 11 Pro is, in short, hugely powerful for everyday tasks, and even the most demanding games will barely cause it to break a sweat. The only limitation is the display's 60Hz refresh rate: GFXBench Manhattan recorded 60fps in the onscreen test, as well as a monstrous 170fps in the offscreen test.

SHOOTING RANGE

Where all this horsepower may come in useful is in niche, near-professional-level applications such as the forthcoming Filmic Pro app. This app, rather remarkably, will be able to record two streams of 4K 60fps video simultaneously from two of the three rear cameras, or one stream from the front and one from the back, again at the same time. With many modern phones only just beginning to get to grips with single streams of 4K video, the iPhone 11 Pro looks truly to be one step ahead.

Apple has established credentials in the performance stakes, however. Where it has struggled in recent years is battery life, with both the iPhone XS and XS Max (*Shopper* 371) falling short of their Android rivals. The good news is that the iPhone 11 Pro shows solid signs of improvement: it lasted for 17h 15m in our video playback test, comfortably longer than the iPhone XS's 12h 45. This remains one area in which the Android competition can do better – the Snapdragon 855-powered Xiaomi Mi 9, for instance, lasted for 22h 54m – but it's still a major improvement.

As is the rear camera arrangement. Apple hasn't just slapped on an extra lens and left it at that: it's also improved image quality across the board, added a night mode that currently beats Google at its own game, and boosted video quality as well.

First, the specs. The iPhone 11 Pro has three rear lenses, the newest 12-megapixel addition providing an ultrawide field-of-view equivalent to a 13mm lens on a full-frame camera.

The other two sensors are similar to those of the iPhone XS. There's a primary 12-megapixel f/1.8 camera with optical image stabilisation (OIS) and a field-of-view equivalent to a 26mm lens on a camera with a full-frame sensor. And finally, there's a 2x telephoto lens, also at 12 megapixels, with an aperture of f/2, OIS and a field-of-view equivalent to a 52mm lens on a camera with a full-frame sensor. All three cameras are capable of recording 4K video at 60fps.

Still image quality is downright superb. Photos we've taken with the iPhone 11 Pro were sharper and more detail-packed than those from both the iPhone XS Max and the Google Pixel 3 XL (*Shopper* 379), although the colour balance on the iPhone 11 Pro's shots is a little warmer than the XS Max.

Low-light performance takes a particularly big leap forward, thanks to the new night mode. Similar to Night Sight on Google's Pixel handsets, this is specifically for capturing higher-detail shots in the dark with minimal visual noise. And it works beautifully: colours are more naturalistic, details are sharper and there's less visual noise in finely textured areas than the Pixel 3 XL can deliver.

DIFFERENT VIEWPOINTS

Video quality is fantastic as well. Footage from the main camera is crisp, neutral in colour and packed with details, and video stabilisation works beautifully at 4K and 60fps. Apple has now extended the ability to switch between lenses as you zoom in as well, which is a feature that would previously only work at up to 30fps at 4K. As before, however, it hasn't been perfectly implemented. There's a clear jump-step as the view transitions from one sensor to the next, with an obvious change in colour balance and quality.

This is a small negative point, however, and it is possible to stop it from jumping between

cameras by using the Lock Camera mode in settings. Otherwise, video recording on the iPhone 11 Pro is the best you can get on a smartphone, especially now that Apple's extended dynamic range feature is available in the 60fps 4K video mode as well as 30fps.

In this mode, the iPhone 11 Pro's camera captures 4K video at 120fps internally, with each alternating frame shot at different exposure levels and then combined to produce a pseudo-HDR effect. It's subtler than you might expect, but it does balance out the bright and dark areas of footage in a surprisingly effective manner.

GAINING CONTROL

There have been improvements on the software side, too. As part of the upgrade to iOS 13, Apple has given the user interface a new lick of paint, with a new zoom graphic, while some of the photo options – aspect ratio and live photo, for instance – have moved from the top left of the screen to a new position, revealed by a simple swipe up from the bottom of the screen in the camera app.

Another nice addition here is the ability to have the camera capture images from the ultrawide and primary cameras simultaneously. Then, if you go in and edit the photo, you can recompose and recrop using the wider angle shot.

This is typical of the whole iOS 13 upgrade, in fact. There's nothing particularly dramatic in its list of upgrades and new features, but there are quite a lot of changes that have the potential to positively affect the way you use your phone on a daily basis.

One of our favourite tweaks is the ability, at last, to long-press on the Wi-Fi icon in the Control Centre menu for direct access to the Wi-Fi settings menu. You can switch between Wi-Fi networks here as well.

Face ID is supposedly faster, too, but we haven't noticed it being much quicker than previous generations. It still works pretty reliably, however, and we never felt the need for it to be any quicker. It would be nice to have at least the option of a fingerprint reader, but Apple is clearly sticking to its guns with Face ID, for the time being at least.

RICHES FOR RICHES

Ultimately, the only worry about the iPhone 11 Pro is the price: you can get Android handsets that are 90% as good for hundreds of pounds less. At the same time, however, there's no getting around it being an absolutely incredible smartphone, one with cameras and performance beyond compare and a battery life that finally stands up to its rivals.

If you're an Apple devotee and you don't mind spending as much on a phone as on a second-hand car, this is the one to buy.

Jonathan Bray

SPECIFICATIONS

PROCESSOR Hexa-core 2.65GHz Apple A13 Bionic • **SCREEN SIZE** 5.8in • **SCREEN RESOLUTION** 2,436x1,125 • **REAR CAMERAS** 12 megapixels, 12 megapixels, 12 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 144x71x8.1mm • **WEIGHT** 188g • **OPERATING SYSTEM** iOS 13 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** iPhone 11 Pro

See page 84 for performance details

PHILIPS

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VERDICT

Colourful and capable, the Titan Falcon is a very good-value Ryzen 7 system

THE TITAN FALCON is a prebuilt PC that takes advantage of AMD's brilliant 2019 output, with a Radeon RX 5700 XT graphics card and a Ryzen 7 3700X as the CPU. This octa-core chip also comes overclocked to 4.2GHz, up from its 3.6GHz base speed.

This performance is at first outshone by one of the most rainbow-heavy RGB settings we've ever seen. The case, the GPU, the motherboard and RAM sticks are all equipped with full-spectrum RGB lighting that gently but vividly rotates through different hues.

This is a bold design choice, which won't be to everyone's tastes. It's not an ugly PC: we like how the white interior chamber contrasts with the black exterior, and the tempered glass side window adds class even as several million LED colours are beaming through it.

CLIMATE CONTROL

The lack of an exhaust fan is unusual. There's a single 120mm case fan at the front, for introducing cold air to the system even if nothing is dedicated to venting it out, but it's positioned so low that the airflow is directed straight under the graphics card. The CPU cooler, a middle-sized air cooler, also has a lot of work to do with an overclocked processor on its hands.

Thankfully, there was no evidence of overheating or throttling in our performance benchmarks. The Ryzen 7 3700X, together with a healthy 16GB of RAM, scored 186 in the image test, 322 in the video test and 401 in the multitasking test, for a very strong 339 overall.

Compared to the CCL Paladin (*Shopper* 381), which has the same CPU but runs it at stock speeds, the Titan Falcon's overclock produces more of a modest improvement than a great one: its image test score was a few points lower in exchange for its video, multitasking and overall scores all being a few points higher. A win is a win, however, and while this particular chip doesn't have a lot of overclocking headroom, the Titan Falcon demonstrates that gains can be made.

The boosted clock speed also appears to help out in games, but while the Titan Falcon performs better than the Paladin – which again has a matching component in the RX 5700 XT – it's only by a practically invisible number of frames per second, usually between one and four. Regardless, this is good GPU performance for the money: Dirt Showdown managed a velvety 186fps at 1,920x1,080, only dropping to 181fps at 2,560x1,440 and 115fps at 3,840x2,160.

A score of 100fps at 1080p in Metro: Last Light Redux is nothing to be sniffed at either, and the Titan Falcon's 60fps at 1440p shows how well it can handle tough games at high resolutions. 4K is too high to continue using the best possible settings, with the frame rate falling to 26fps, but the usual trick of disabling SSAA bumps this all the way up to 53fps.

LITTLE BIRD

It also aced the SteamVR Performance Test, scoring 11, so there's no doubt this is a fine PC for high-end gaming, especially if you want to keep below the £1,500 mark. The CCL Paladin is £275 more expensive, so the Titan Falcon beats it on value as well as pure performance.

That said, one of the Paladin's biggest strengths was its superior storage: a massive 1TB NVMe SSD alongside a 2TB hard disk. The Titan Falcon takes a more economical route, with a 500GB SSD – this occupies one of the two M.2 slots, but only runs at SATA speeds – and a 1TB hard disk. As such, it doesn't come close on capacity, and SSD speed is well behind: we measured a sequential read speed of 427MB/s and a write speed of 435MB/s, both less than one-fifth of the Paladin's speeds.

At the same time, this dual-drive setup is decent enough for everyday use. You could also add a faster NVMe drive in the future, via the second, spare M.2 slot. There are also a couple of empty 2.5in and 3.5in drive bays apiece, although one of the latter is already occupied by the 1TB hard disk.

For other potential upgrades, there are two empty PCI-E x16 slots and one PCI-E x1 slot; there are actually three of these on the motherboard, but two are obscured by the graphics card. You can install x1 devices in the x16 slots, and with two spare RAM slots, there's room for extra hardware where it counts.

SAVING GRACE

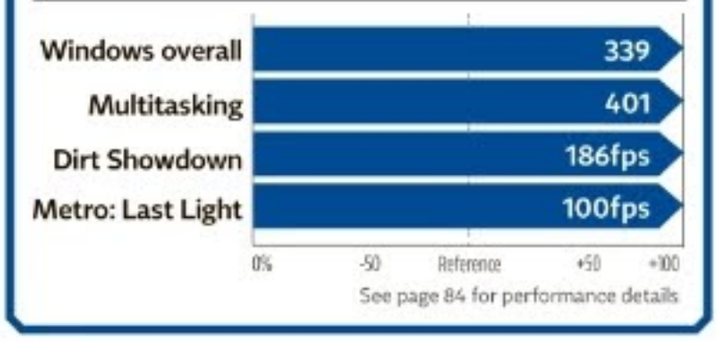
The motherboard also contributes a nicely equipped rear I/O panel, which offers five USB3 ports, two USB3.1 ports and a USB Type-C port, not to mention S/PDIF and C/SUB audio outputs for hi-fi speakers. There's no integrated Wi-Fi but Gigabit Ethernet is included, as is a legacy PS/2 port and – a few inches downwards – two HDMI and DisplayPort outputs apiece, courtesy of the graphics card. That's a good range overall.

We'd have liked better cooling, NVMe storage and possibly a touch less flashiness, but ultimately the Titan Falcon cuts the right corners in order to compete effectively with more expensive systems.

James Archer

SPECIFICATIONS

PROCESSOR Octa-core 4.2GHz AMD Ryzen 7 3700X • **RAM** 16GB DDR4 • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 5x USB3, 2x USB3.1, 1x USB Type-C • **GRAPHICS CARD** 8GB Sapphire Radeon RX 5700 XT Nitro+ • **STORAGE** 500GB SSD, 1TB hard disk • **DISPLAY** None • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years RTB • **DETAILS** www.overclockers.co.uk • **PART CODE** FS-1CT-EP



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WINDOWS 10 LAPTOP

ACER Swift 7

★★★☆☆

£1,749 • From www.currys.co.uk

VERDICT

Form beats function on the latest Swift 7, an amazingly portable yet underpowered Windows laptop

14in LAPTOPS SIMPLY don't come smaller than the Acer Swift 7. At 10mm thin, it's almost as slim as a smartphone, and it's noticeably short, too: just 192mm from front to back. That's not to mention its feathery weight of just 890g.

Unsurprisingly, however, some extreme slimming has some knock-on effects. Take the ultra-slim bezels: these look smart and help keep the total dimensions low, but because they don't leave room for a webcam, this has to be shunted on to the base. The Swift 7's camera thus has a pretty neat pop-up design, allowing for privacy when not in use, but the low angle shows more of the user's chest than their face.

We're also slightly concerned about how the base flexes slightly when picked up from a corner. A bit of bendiness is common on ultra-thin laptops, but that mainly occurs around the screen, not the base. That's not to say the Swift 7 is poorly made, as it comfortably endured multiple commutes, but its slimness does contribute to a certain lack of solidity.

More positively, Acer has found room for a fast and reliable fingerprint sensor. This is integrated into the power button, which sits just to the left of the keyboard.

SMALL TIME

This keyboard, admittedly, takes some getting used to. The keys are backlit and most are a decent size, but there are some major exceptions. A tilde key, for example, is crammed between Caps Lock and the A key, making the former infuriatingly undersized and difficult to land when touch-typing. Backspace also loses a chunk of itself to a Delete key, while Enter has been bisected to make room for a Backslash key.

It took us days to acclimatise to these quirks, and while it's true that we eventually did, this is still a case of the Swift 7's downsizing having an adverse side effect. The touchpad, which is exceedingly wide but very short, also initially seemed in danger of a similar fate. Thankfully, while we sometimes brushed a finger against the top edge, this isn't anywhere near as offputting as the keyboard's misshapen keys. The smooth surface and dependable responsiveness of this touchpad makes it perfectly fine as a primary input, even if it is somewhat squat.

The 1,920x1,080 touchscreen also meets a very high standard. The IPS panel confers both wide viewing angles and vibrant, yet accurate, colours: sRGB coverage is closer to good than great, at 93.4%, but we measured an average delta-E of just 1.42, so the colours you see are being reproduced faithfully.

A respectable peak brightness of 329.6cd/m² also helps alleviate the reflective effect of the screen's glossy finish, and the 1,502:1 contrast ratio isn't bad either. There's really nothing to complain about, display-wise.

SLOWLY DOES IT

Internally, the Swift 7 packs an Intel Core i7-8500Y CPU, 16GB of RAM and a 512GB SSD. To be blunt, £1,749 is an almost galling amount to ask for something with a dual-core Y-series processor, but then we suspect the Swift 7 is so thin that anything more powerful – in other words, anything that would require additional cooling – wouldn't fit.

Either way, don't expect to cruise through demanding productivity software. The Swift 7 managed a passable 65 in our 4K benchmarks' image test, but scores of 35 in the video test and a paltry 9 in the multitasking test brought its overall score down to 27. That represents a mere fraction of the performance offered by Intel U-series ultraportables such as the Dell XPS 13 (*Shopper* 376) and Asus ZenBook 14 UX433FA (*Shopper* 379).

It's hard to recommend running anything more demanding than browsers and basic office applications, as multithreaded applications will slow the Swift 7 right down. The integrated Intel UHD Graphics 615 can't cope with games, either, only averaging 15fps in Dirt Showdown, even at 720p, with only the High quality preset.

The 512GB SSD is also unremarkable by modern NVMe standards. Its capacity may be reasonable, but we only recorded sequential read and write speeds of 1,350MB/s and 687MB/s respectively.

Battery life is at least adequate. The Swift 7 lasted for 9h 17m in our video playback test. We noticed it draining a lot quicker when used at full brightness – our benchmark runs at 170cd/m² – so turn it down and you'll be able to eke out a few extra hours.

Another drawback of the skinny frame is the lack of connections: you only get two USB Type-C ports and a 3.5mm audio jack. To Acer's credit, both USB-C ports support Thunderbolt 3, so you've got video output capability, and there's also a little hub bundled in that includes a USB3 port, another USB-C port and a full-size HDMI output all in one.

Still, there's also the matter of the power cable connecting via one of those very same USB-C ports, so you'll always be down one when recharging.

SLIM AGAINST THE TIDE

Once the initial thrill of using a sub-900g laptop wears off, it's clear that the Swift 7 mainly suits a very specific type of user: one who will only be performing relatively basic tasks, but still wants something as thin and light as it's possible to get without massively reducing the display size.

There's nothing wrong with wanting that, and by extension there's nothing wrong with catering for it. For this much money, unfortunately, it's fair to expect more power and more connectivity than the Swift 7 delivers.

James Archer

SPECIFICATIONS

PROCESSOR Dual-core 1.5GHz Intel Core i7-8500Y • **RAM** 16GB • **DIMENSIONS** 192x317x10mm • **WEIGHT** 890g • **SCREEN SIZE** 14in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel UHD Graphics 615 • **TOTAL STORAGE** 512GB SSD • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** SF714-52T

See page 84 for performance details

WINDOWS 10 LAPTOP

DELL Latitude 3300

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£610 • From www.dell.com

VERDICT

Cheap, durable and surprisingly fast, the Latitude 3300 is a proficient studying aid

BACK-TO-SCHOOL season may have come and gone, but whether you're a parent looking to give your kid an advantage or a student yourself, it's not too late to pick up a suitable laptop. The Dell Latitude 3300, an affordable prospect even at the nearly-top-spec £610 model we've tested, is an excellent contender.

This configuration has a 13.3in, 1,366x768 HD display, an Intel Core i5-8250U CPU, 8GB of RAM and an all-plastic chassis that's about as inspiring as a calculator. For storage space, it uses a 256GB PCI-E SSD, and – unusually for such a cheap laptop – it runs Windows 10 Pro.

GREY MATTER

Dell has certainly gone for a utilitarian design with the Latitude 3300. The colour scheme is a mixture of dark grey and black, while the body itself is made of cheap-feeling plastic. An effort has been made to partially ruggedise it, however, with some nice rubber edges on the lid and base that provide added grip and drop protection. Even still, it's no tank, with a flimsy lid that bends a bit too much for our liking and a keyboard plate that depresses a tad too far.

Dell has spared most expense on the keyboard. Keys feel cheap, have little travel and produce a tinny, clicking sound during typing. The touchpad's surface is also a bit grainy, but sensitivity is fine, and palm rejection works well.

The 720p webcam is also surprisingly effective in low-light conditions, an area in which much pricier laptops can struggle. Unfortunately, the dual speakers are scratchy and unsuitable for music, although they're loud enough for watching YouTube videos.

Display quality is neither particularly impressive nor disappointing. The 13.3in LCD panel has an adequate maximum brightness of 215cd/m² and consistent brightness uniformity, although its contrast ratio of 269:1 leaves a lot to be desired. Add to that a poor overall sRGB colour gamut coverage of 53.5%, and it's a pretty drab affair. It's not the best platform for watching films or editing photos, but it's as good as it needs to be for a cheap education laptop. After all, it's mainly designed for writing text documents and the occasional spot of web browsing.

At least Dell has packed plenty of connectivity into the Latitude 3300. In addition to the proprietary power port and 3.5mm audio jack, it fits in two USB3.1 ports, a USB Type-C slot, an HDMI output and an Ethernet jack. There's also a microSD card slot thrown into the mix. For the average student, that's more than enough.

MAKING THE GRADE

The same can be said about the Latitude 3300's performance. With its quad-core Intel Core i5-8250U and 8GB RAM, it actually has pretty decent specs for the price. In our 4K benchmark, the Latitude 3300 achieved an overall score of 84 – remarkable for such an affordable laptop. That includes respectable individual scores of 107 in the image test, 90 in the video test and 72 in the multitasking test, so it's not terribly weak at multithreaded tasks, as budget clamshells often are.

With power like this, the Latitude 3300 is easily fast enough for multi-tab web browsing, office work, and even less demanding games and creative applications. Battery life is pretty good, too, as the Latitude 3300 survived for 9h 7m of video playback before giving up the ghost.

If £610 is still too high for your budget, there are cheaper configurations available: these start at just £395, for a model with a dual-core Intel Celeron 3865U processor. This obviously won't be nearly as powerful as any of the Core i5 specs, and while every model still comes with Windows 10 Pro, you'll also lose out on the 256GB SSD in exchange for a 64MB eMMC drive.

We'd therefore recommend stretching to the £610 model if you can. This looks especially good value when you consider what else is available at the budget end of the laptop market: the latest Acer Swift 3, for instance, is cheaper at £499 but only scored 32 in our benchmarks, and has significantly shorter battery life. The Avita Liber 14 (*Shopper* 382) also underwhelms, for the same reasons. The Liber 14 is a lot more stylish than the 3300, but we're not convinced that's a good trade for its much lower practicality.

In our 4K benchmark, the Latitude 3300 achieved an overall score of 84 – remarkable for such an affordable laptop

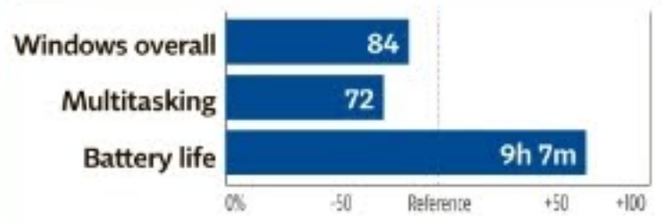
CLASS ACT

The Latitude 3300 is an unexciting but highly functional Windows machine that comes built to last and, crucially, outperforms the competition within its price range. If you're aiming to get equipped for school or university on a budget, this is exactly what you ought to be looking for. At £610, you'll struggle to do much better than the Latitude 3300 – and you could easily do far worse.

Tom Bruce

SPECIFICATIONS

PROCESSOR Quad-core 1.6GHz Intel Core i5-8250U • **RAM** 8GB • **DIMENSIONS** 231x330x22.3mm • **WEIGHT** 1.56kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel UHD Graphics 620 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Pro • **WARRANTY** One year RTB • **DETAILS** www.dell.com • **PART CODE** n013l330013emea



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WINDOWS 10 CONVERTIBLE

LENOVO ThinkPad X1 Yoga (2019)

★★★☆☆

£2,022 • From www.ebuyer.com

VERDICT

A few small steps forward aren't enough to make the ThinkPad X1 Yoga an essential convertible

ANOTHER YEAR, ANOTHER ThinkPad X1 Yoga. Lenovo's rotating 2-in-1 is now in its fourth generation, and outside of the expected internal upgrades, is a remarkably similar laptop to last year's model (*Shopper* 372).

That includes the design. There's no denying that the ThinkPad X1 Yoga looks classy, just as it did last year, and the year before that. The sturdy grey chassis is lovely if a tad dull, and it would be nice to see some more interesting colours on offer. Comprising aluminium and magnesium alloy, the case is light but strong, and the laptop's overall weight has been cut from 1.4kg to 1.34kg since last year. It's smaller too, measuring 218x323x15mm to the 2018 version's 229x333x17mm.

The model reviewed here is the top-spec model, with an IPS touch display. Powering the show is an Intel Core i7-8565U processor plus 16GB of RAM, and for storage, it uses a nippy 512GB PCI-E NVMe SSD. For added device protection, the ThinkPad X1 Yoga is equipped with a TPM 2.0 security chip that provides Core Isolation and Memory Integrity support. If you've bought a ThinkPad in the past, you'll know that this configuration won't come cheap, and even the most basic Core i5-8265U model costs £1,305.

TWIST AND SHOUT

As with any Lenovo convertible, the 360° hinge is superbly smooth, and the whole thing is pleasantly easy to carry about. The chassis is well balanced, and there's hardly any wobble when flexing the screen or pushing down into the base.

There's another improvement in the addition of an IR camera next to the 720p webcam. This enables facial recognition unlocking as an alternative to the fingerprint sensor, a feature that was missing on the previous model.

In terms of connectivity, the ThinkPad X1 Yoga is as versatile as any ultraportable on the market. On the left edge are two Thunderbolt 3-equipped USB Type-C ports, one of which doubles as the charging port, alongside a full-size USB3.1 port, an HDMI output and a 3.5mm audio jack. The right edge is similarly busy, with the self-charging ThinkPad Pen Pro stylus, the power button, another USB3.1 port and a Kensington mini lock slot.

Finally – and this one is easy to miss – there's a microSD/SIM tray on the rear edge. Pop a data SIM into this and you can make use of the X1 Yoga's 4G LTE connectivity.

MAKE SOME NOISE

Of all the new features on the fourth-gen Yoga X1, we were most excited to test the new Dolby Atmos speakers. Two of these are located above the keyboard, while the two woofers are on the underside of the base. Excitement soon turned to disappointment, however, because the volume and clarity of the quad-speaker setup are pretty underwhelming. It's a step up from the tinny stereo units of previous generations, but no match for the rotating Dolby Atmos 'soundbar' hinge on the Lenovo Yoga C930 (*Shopper* 377). Classical music sounds grainy where it ought to be smooth, while strings screech rather than sing. That said, there's just enough bass from the down-firing woofers to make poppier tracks listenable.

ThinkPads always have excellent keyboards, and this one is as dependable as any other. The chiclet-style layout hasn't changed from the previous model, while the keys are weighty, and elicit a satisfying thunk with every stroke. They're also subtly curved for added comfort. There are two levels of backlighting to choose from and, of course, there's that iconic TrackPoint joystick between the G, H and B keys.

We have no complaints about the touchpad, either. It's spacious, smooth and responsive, and we didn't need to fiddle with any of the sensitivity settings to make palm rejection work effectively. In accordance with the traditional ThinkPad design, the physical clickers sit above the touchpad, although if you're not a seasoned enterprise laptop user and find these out of place, you can left- and right-click with the diving-board touchpad as well.

As this is a Yoga model, the conventional inputs are joined by the touchscreen and the Pen Pro stylus. The latter is made of the same cheap-feeling plastic as always and it's not very grippy, but it's precise enough for taking notes and scrawling doodles, and it's tough to grumble when it's absolutely free.

GLEAM EFFORT

From certain angles, the 14in, 3,840x2,160 touchscreen on the X1 Yoga is stunning to behold;

its main weakness is a hyper-glossy finish that's more than a little too reflective. That's even with the high peak brightness of 440cd/m².

The contrast ratio also hits a vivid 1,208:1, and the 97.9% sRGB colour gamut coverage further helps with boldness and punchiness. If anything, it's almost too vivid: average delta-E comes in at 3.41, so it's fine for watching videos, but serious media editors will find it too inaccurate.

The annual CPU upgrade takes the form of Intel's Core i7-8565U. However, don't expect to see a major improvement over last year's Core i7-8550U model: in our 4K benchmarks, the new ThinkPad Yoga X1 scored 65 overall, just a handful of points over the preceding model's 59. Thermal throttling seems to have a hand in this, as we recorded core temperatures up to 99°C (the CPU's safe limit is 100°C).

The chassis also gets far too hot. Using an IR digital thermometer, we recorded highs of 53°C underneath the base and 45°C on the top row of the keyboard, and when it's that toasty you really don't want it directly on your lap.

The ThinkPad X1 Yoga isn't up to much for gaming, as it relies on its CPU's integrated Intel UHD 620 Graphics, but lightweight titles will run passably. In the Dirt Showdown 720p benchmark, running on High settings, it managed to crank out 36fps, close to double that of its predecessor.

Professional laptops need to open and save files at speed, and here the X1 Yoga excels. Its 512GB NVMe PCI-E SSD ploughed through the AS SSD storage performance test, clocking sequential file read speeds of 2,899MB/s and sequential write speeds of 2,273MB/s. Those are outstanding numbers, even by ThinkPad standards.

Alas, at the final hurdle the X1 Yoga falls flat on its face. In our standardised video playback battery test, it lasted for a meagre 4h 47m. That means it won't make it through a full working day, even if you turn the brightness right down and are frugal with wireless functionality. The 4K display is clearly a big drain on the 51Wh battery, as last year's ThinkPad X1 Yoga lasted for over six hours with its 2,560x1,440 display.

REMIXED UP

Short stamina aside, the ThinkPad X1 Yoga is a classy convertible that performs reasonably well, albeit far from exceptionally. Be warned, however, it's also about as incremental an upgrade as it's possible to imagine for a laptop, and not every change even has a wholly positive effect.

Short stamina aside, the ThinkPad X1 Yoga is a classy convertible that performs reasonably well

Like the 2018 model, this version has thermal issues that hamper performance and make it uncomfortable to use on the lap. That 4K display is a drain on battery life, it isn't colour-accurate and its new glossy finish only serves to distract. If you really want a flippy Lenovo laptop, it would be more sensible to go for either last year's ThinkPad X1 Yoga or the ThinkPad X1 Carbon (*Shopper* 370) instead. They're both notably cheaper, and will perform broadly as well.

Tom Bruce

SPECIFICATIONS

PROCESSOR Quad-core 1.7GHz Intel Core i7-8565U • **RAM** 16GB • **DIMENSIONS** 218x323x15mm • **WEIGHT** 1.34kg • **SCREEN SIZE** 14in • **SCREEN RESOLUTION** 3,840x2,160 • **GRAPHICS ADAPTOR** Intel UHD Graphics 620 • **TOTAL STORAGE** 512GB SSD • **OPERATING SYSTEM** Windows 10 Pro • **WARRANTY** One year RTB • **DETAILS** www.lenovo.com • **PART CODE** 20QF00ADUK

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WINDOWS 10 GAMING LAPTOP

ACER Nitro 7 (2019)

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£1,100 • From www.box.co.uk

VERDICT

Mid-range gaming laptops can be hard to get right, but the Nitro 7 finds a winning formula

AFTER THE BITTER disappointment of the underpowered, poorly made Nitro 5 (*Shopper* 375), Acer's affordable gaming notebook series was in need of redemption. Happily, that's exactly what the new Nitro 7 provides.

This is a pricier laptop than the £699 Nitro 5, but it's clearly cut from finer cloth. Metal covers on the lid, base and keyboard prevent the chassis from feeling too plasticky, and while the Nitro 7, like the Nitro 5, has a 15.6in display, it has a slightly slimmer profile at 260x363x23mm. However, it could be smaller still, were it not for some chunky top and bottom bezels, and at 2.5kg it's pretty heavy, too. A Razer Blade-style slimline gaming system, this is not.

HARD PRESSED

For connectivity, the left edge is home to two USB3 ports, one USB Type-C port, an HDMI output, an Ethernet jack and a Kensington lock slot, while the right side contains a 3.5mm audio jack, a USB2 port and the power jack. The lack of Thunderbolt 3 connectivity is a shame, but you still have a display output via the HDMI port, so all the bases are covered. Be prepared to use the 3.5mm jack in particular, as the built-in speakers are distinctly average.

The keyboard is an improvement over the Nitro 5: key travel and rigidity are both fine, and you can dim the backlight, instead of simply being able to turn it on or off. However, many of the same issues remain. They keycaps are made of noticeably cheap-feeling plastic, and the membrane design lacks the crispness of a mechanical keyboard.

Pushing down on the keyboard causes the plate to depress, a further indication of the cheap build. At least the touchpad works well, even if its surface lacks smoothness.

The Nitro 7's 15.6in, 1,920x1,080 IPS display has a fast refresh rate of 144Hz and includes Nvidia's G-Sync technology to regulate onscreen frame rates and prevent tearing. What's more, Acer has used a matt finish, which is preferable to the reflective gloss you often get with gaming machines.

The display quality is mixed, however. One positive is the maximum luminance of 344cd/m², which is bright enough even if you're playing games in a room with harsh lighting overhead. The contrast ratio could be better, however. At 940:1, it's considerably lower than the Acer Nitro 5's 1,159:1.

On the plus side, colour reproduction is decent: we measured the panel's sRGB gamut coverage at 89.5%. Darker colours tend to be slightly off the mark, especially greys, purples and reds, but the average delta-E of 1.86 suggests a high level of accuracy overall.

STAR PLAYER

It's performance where the Nitro 7 really shakes off the Nitro 5's failures. The hexa-core Intel i7-9750H CPU, together with 8GB of RAM, meant it blew through our 4K benchmarks with an image test score of 141, video score of 161, multitasking score of 158 and 156 overall. That's not as nippy as the HP Omen 15 (*Shopper* 374) and its score of 170, but when performing daily tasks you wouldn't notice much difference between them.

Gaming ability is also on a par with the HP Omen 17, despite the Nitro 7 being cheaper. This is the first laptop we've tested that includes the mobile version of Nvidia's GeForce GTX 1660 Ti, and it was able to run Metro: Last Light Redux at a slick 130fps at native 1080p resolution, albeit with SSAA disabled and the High preset being used instead of Very High. That's just 7fps behind the GTX 1070-powered Omen 15, another barely perceptible difference. For the money, the Nitro 7 delivers very impressive gaming performance, and the high refresh rate means well-performing games can look a lot smoother than on any 60Hz display.

Storage performance is decent, too, with AS SSD recording a sequential read speed of 1,580MB/s and a sequential write speed of 1,367MB/s. You only get a single 512GB SSD, not a combination of an SSD and a more spacious hard disk as on the Omen 15, but 512GB is enough to store a fair few games.

As with so many gaming laptops, sadly the Nitro 7 won't last long on the road. It could only endure 3h 20m of video playback – exactly the same as the Omen 15, funnily enough – so you should always keep the charging cable close by. This is easier said than done, too, as it includes a hefty power brick.

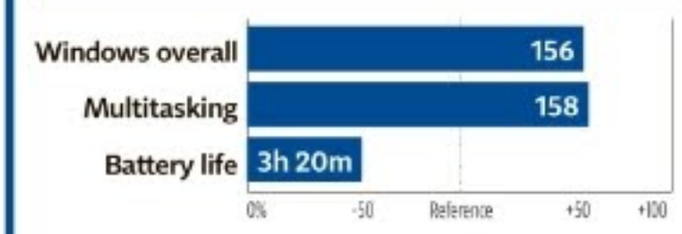
MADE AMENDS

Other than a few instances where it shows its budget origins – the keyboard especially – the Nitro 7 is a far more appealing choice of gaming laptop than the Nitro 5. Performance is massively improved, and the display looks better, too, with more vibrant colours and stronger brightness. As a comfortable middle ground between slow budget laptops and more finely crafted but much more expensive premium models, we can recommend it even in spite of its flaws.

Tom Bruce

SPECIFICATIONS

PROCESSOR Hexa-core 2.6GHz Intel Core i7-9750H • **RAM** 8GB • **DIMENSIONS** 260x363x23mm • **WEIGHT** 2.5kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** 6GB Nvidia GeForce GTX 1660 Ti • **TOTAL STORAGE** 512GB SSD • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** NH.Q5HEK.004



See page 84 for performance details

MECHANICAL GAMING KEYBOARD

ADATA XPG Summoner

★★★☆☆

£110 • From www.box.co.uk

VERDICT

An adequate mech board, but also one that doesn't fully develop its own features

STORAGE SPECIALIST ADATA is attempting a big push into enthusiast PC hardware at the moment, branching out from the usual SSDs with cases such as the XPG Invader and XPG Battlecruiser, alongside the XPG Summoner, a full-size gaming keyboard with mechanical Cherry switches.

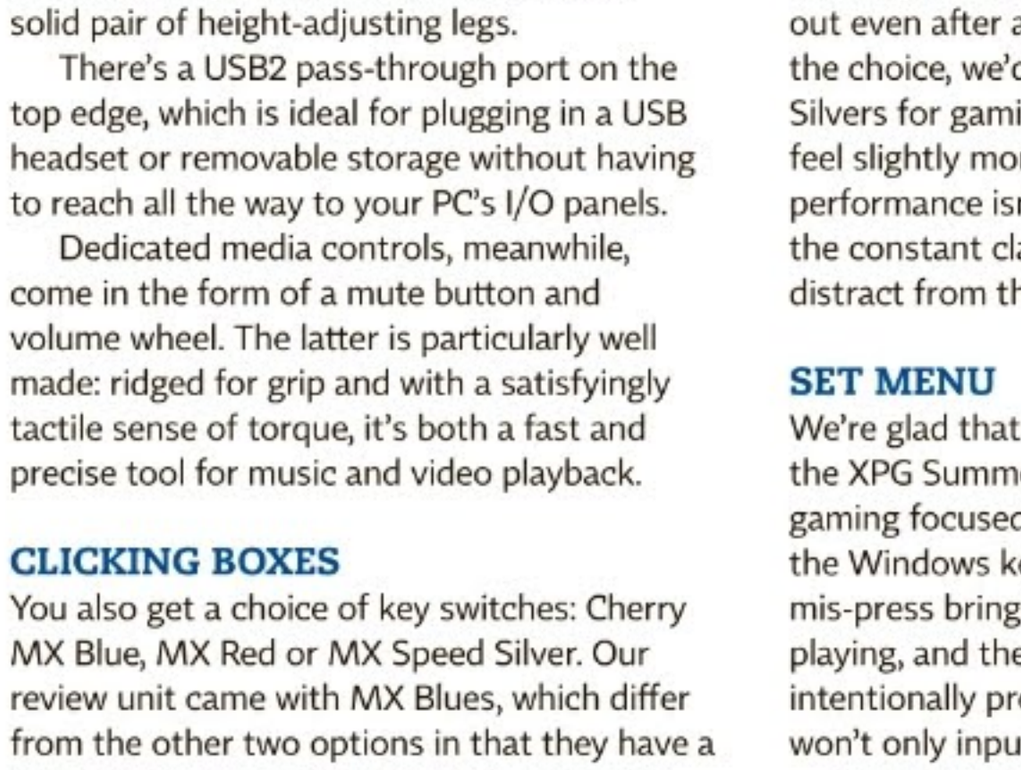
Design-wise, it's fairly simple – standard black keycaps sit on top of a grey metal plate, which in turn covers a plastic underside – but that's also just the foundation upon which Adata has made some nice additions. The biggest, literally, is the padded leatherette wrist rest, which can be quickly attached or detached via magnets. This is, as you can imagine, a lot comfier than any solid plastic wrist rest, and while it's easy to remove quickly, the magnetic grip isn't so loose that it slides about. The keyboard itself also plants a firm grip, with rubber feet and a solid pair of height-adjusting legs.

There's a USB2 pass-through port on the top edge, which is ideal for plugging in a USB headset or removable storage without having to reach all the way to your PC's I/O panels.

Dedicated media controls, meanwhile, come in the form of a mute button and volume wheel. The latter is particularly well made: ridged for grip and with a satisfyingly tactile sense of torque, it's both a fast and precise tool for music and video playback.

CLICKING BOXES

You also get a choice of key switches: Cherry MX Blue, MX Red or MX Speed Silver. Our review unit came with MX Blues, which differ from the other two options in that they have a tactile bump and an audible click, providing two forms of feedback to let you know an input has registered. This makes them better suited to heavy typing than Reds and Speed Silvers, which are both quiet and lack a bump. However, since a Blue switch requires 60cN of force to depress, compared to the 45cN of both Red and Speed Silver switches, some may find they feel slower and less conducive to fast-paced gaming.



The leatherette wrist rest, which can be attached or detached via magnets, is a lot comfier than a solid plastic wrist rest

We didn't have any objective issues playing on the XPG Summoner. It did feel as if we had to put more effort into each press, but only very slightly, and our fingers weren't worn out even after a few hours. That said, given the choice, we'd rather use Reds or Speed Silvers for gaming specifically: these switches feel slightly more agile, even if in-game performance isn't noticeably affected, and the constant clacking of Blue switches can distract from the game's audio.

SET MENU

We're glad that the choice is there, then, and the XPG Summoner has a couple of other gaming focused tricks, too: you can disable the Windows key, to prevent an accidental mis-press bringing up the Start menu while playing, and there's full N-key rollover so that intentionally pressing multiple keys at once won't only input a single one.

Unfortunately, this keyboard's other key features are more limited than its competitors' equivalents. The RGB lighting, for example, can't be fully customised: you can adjust brightness and enable a handful of pulsing or wavy effects, but the only way to switch to specific colours is to select one of the six profiles. Each of these has a single colour assigned to it, but you can't change the exact hue or shade of each profile, or set it up so that some keys are one colour and another set are a different colour. All of these profiles also disable the Windows key, so if you do actually want it enabled, you can only use the default, all-red profile.

The main purpose of these profiles is to organise user-set macros, which in itself is a welcome feature: you can record them on the fly, which is convenient, and being able to arrange them into different profiles means you can have different sets for different types of game, without them competing for button assignments.

MISSING PIECE

Nevertheless, this still means switching the backlighting to a colour you might not want, and there's no way of reviewing your macros or reassigning them to a different key without inputting the whole thing again. Both this handicap, and the lack of RGB customisation, can ultimately be traced back to how the XPG Summoner has no software utility – Asus, Razer, Cooler Master and many other mechanical keyboard manufacturers provide desktop software to facilitate customisation, but the XPG Summoner tries to do everything with the keyboard itself, and ends up stifling itself as a result.

For just £5 more, you could get the Asus ROG Strix Flare (*Shopper* 381), which is far more customisable and also offers a choice of Cherry MX switches. Its wrist rest isn't padded, but is still reasonably comfortable, and you also get a much wider range of dedicated media keys. The XPG Summoner has many of the component parts needed for a great keyboard, but doesn't currently fulfil its true potential.

James Archer

SPECIFICATIONS

KEYBOARD SHAPE Full size • **NUMBER PAD** Yes • **CONNECTION** 2x USB2 • **DIMENSIONS** 44x449x135mm • **MEDIA KEYS** Mute, volume dial • **USB PORTS** 1x USB2 • **WARRANTY** Two years RTB • **DETAILS** www.xpg.cpm • **PART CODE** SUMMONER4B-BKCWW

⬅ The XPG Summoner comes with a choice of three different Cherry MX switches

ENCRYPTED USB DRIVE

iSTORAGE datAshur Pro2

★★★★☆

£330 • From www.amazon.co.uk

VERDICT

This pin-protected drive is smart and fast, although with such high pricing it's best as a business expense

CONSIDERING HOW EASY it is to lose a USB stick, using them to store sensitive information can be a risky business – just ask the Heathrow staff member who famously misplaced a drive allegedly containing the Queen's travel and security details in 2017.

Even if you don't routinely deal with matters of national security, you can at least make sure lost or stolen USBs go unread by using one with built-in, PIN-protected encryption. iStorage has been a big producer of such devices, spanning the USB-based datAshur range as well as the diskAshur series of external hard disks.

Its newest flash drive, the datAshur Pro2, cuts an imposing figure. Like the original datAshur Pro, its integrated keypad bulks everything up, but this time the whole drive is coated in a black epoxy resin. This both toughens it up and acts as an anti-tampering measure, as it's impossible to remove the internal storage without visibly damaging the coating. There's also a handy metal sheath and a keyring loop, for better portability.

There's no way to prevent malicious actors from wiping the drive by simply hammering in enough wrong PINs

CODE CLUB

The idea, in case it's not obvious, is that you set a PIN (seven to 15 digits on this model) and must enter it every time you pop it into a USB port; if you don't, the drive can't be read, and any data on it will be scrambled by 256-bit AES-XTS encryption. That's a milspec standard that's very tough to crack, and although any common thief will likely be foiled by the PIN protection well before the type of encryption becomes an issue, it's a reassuring degree of protection nonetheless.

In line with previous datAshur and diskAshur drives, there's also an impressive array of user options and backup protections. You can set both an admin PIN and a separate user PIN, for example, as well as a recovery PIN that allows you to reset a forgotten code. There are two levels of brute force protection, too: 10 inaccurate user PIN entries will force a reset that can only be performed by entering the admin code first, and 10 inaccurate admin PIN entries will essentially cause a self-destruct, with all PINs and stored data being deleted permanently.

We have only two issues with all this, and one won't apply as much if you have smaller fingers: the keypad buttons are very small and require extremely careful pressing to avoid accidental inputs. Then again, it's better to be slowed down slightly than be prone to botched inputs, and the buttons have to be tiny to prevent the whole drive becoming cumbersomely fat.

More concerning is that there's no way to prevent malicious actors from intentionally wiping the drive by simply hammering in enough wrong PINs. For most users this will be a rarer occurrence than someone trying to merely access the data, but it's worth being aware that the most drastic anti-brute force measure can cut both ways.

STICK OFF THE MARK

Performance wise, the datAshur Pro2 has received a major write speed upgrade from the datAshur Pro: iStorage quotes it maxing out at 116MB/s, up from 43MB/s. The official read speed has somehow dropped from 139MB/s to 130MB/s, although that's still pretty good for a USB3-based flash drive.

These numbers largely stood up in our testing, too. CrystalDiskMark's sequential benchmarks produced a 127MB/s read speed and a 116MB/s write speed, although these dropped to 16MB/s and 11MB/s respectively in the much more demanding 4K random test. Still, that's faster overall than the mechanical HDD-based diskAshur Pro2 (*Shopper* 355).

It was also nicely fast in our Windows file transfer tests, albeit mainly by USB stick standards. The datAshur Pro2 even hit its advertised maximum read speed in the huge file test, averaging 130MB/s, and its write speed of 114MB/s wasn't far behind. What's more, these results barely dropped in the more challenging large files test, reading at 129MB/s and, again, writing at 114MB/s.

In the small files test, the datAshur Pro2 only fell to a 111MB/s read speed and a 91MB/s write speed. With all three file sizes, it was consistently faster than the diskAshur Pro2, which might be great news if you want the same PIN protection features in a much smaller package.

GOING FOR BROKE

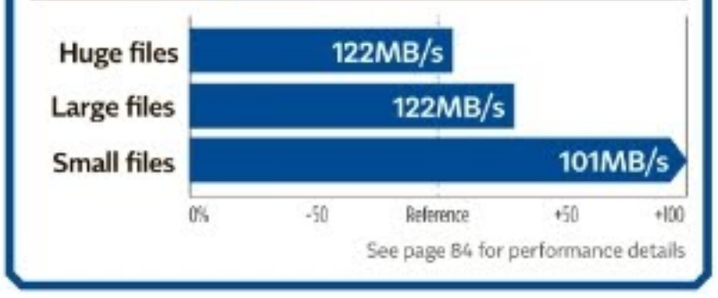
Unfortunately, the price might also be enough to put you off. There are eight different capacity options (ranging from 4GB to 512GB), and every one is scarily expensive; the 256GB model we tested, for instance, works out at £1.29 per gigabyte. Only the 512GB model comes under £1 per gigabyte – 85.3p, to be precise – but that still means you're paying £437 for a thumb drive; the model with the lowest outlay, the 4GB version, is a laughable £14.62 per gigabyte.

The vast majority of PC and laptop owners will therefore be better off spending six times less on a standard, unencrypted USB drive. Only those who handle genuinely sensitive files should invest in the datAshur Pro2, although in fairness, it performs its role well, however niche and costly it is.

James Archer

SPECIFICATIONS

CAPACITY 256GB • **COST PER GIGABYTE** £1.29p • **INTERFACE** USB3 • **CLAIMED READ** 130MB/s • **CLAIMED WRITE** 116MB/s • **WARRANTY** Three years RTB • **DETAILS** istorage-uk.com • **PART CODE** IS-FL-DP2-256-256



See page 84 for performance details

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APPLE DESIGN AWARD WINNERS

Editors' Choice ★★★★★ worldwide customer rating

WI-FI 6 ROUTER

NETGEAR
Nighthawk AX8

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£283 • From www.amazon.co.uk

VERDICT

A very fast router that's ready for the future, but you'll need to pay a premium for it today

WITH WI-FI USAGE ever increasing and broadband speeds on the up, the challenge for router manufacturers has been to create products that deliver more throughput and better cope with more devices. After pushing the 802.11ac standard (Wi-Fi 5) to its limits, it's time for a new standard: 802.11ax, or Wi-Fi 6. The Netgear Nighthawk AX8 is the first 802.11ax router we've seen, designed to be future-proof.

GO FASTER

Before we get into the router itself, here's a quick primer on Wi-Fi 6. The new standard isn't just about delivering faster speeds; it's also designed to make the most of the capacity available, so that multiple devices can play nicely together. However, while Wi-Fi 6 will work with Wi-Fi 5 and older devices, you will only get the true improvements when using Wi-Fi 6 devices. Devices are now starting to appear, with the Samsung Galaxy S10 (*Shopper* 379) supporting it; expect Wi-Fi 6 to become standard in laptops and phones over the coming year.

So, how is Wi-Fi 6 better than Wi-Fi 5? Besides increasing speeds by sending more data in one go – Wi-Fi 5 can send eight bits simultaneously, Wi-Fi 6 can send 10 – there's also an increase in channel width. Wi-Fi 6 offers 160MHz on the 5GHz band, although the 2.4GHz band sticks at the current 40MHz. Next, Wi-Fi 6 uses orthogonal frequency-division multiple access (OFDMA), which lets the router sub-divide a channel to serve multiple clients at once. Think of it like having a truck loaded up with multiple packages going to different people.

Wi-Fi 6 also boosts MU-MIMO for both upstream and downstream connections, unlike Wi-Fi 5, which could only support it downstream. This technology lets the router divide its bandwidth into spatial streams, giving clients a dedicated connection to the router. The number of streams depends on the router, with the Nighthawk AX8 having eight: four 2.4GHz and four 5GHz. Importantly, Wi-Fi 6 routers can also use OFDMA and MU-MIMO together.

Improvements also apply to both 2.4GHz and 5GHz bands; with 802.11ac, the 5GHz band was improved, but the 2.4GHz band ran the older 802.11n technology.

BUSINESS AS USUAL

While the Nighthawk AX8 may use Wi-Fi 6, configuration and set up is business as usual. First, you fold the wings to get the antennas in the right place, turning the AX8 into something that looks like a stealth bomber. Then you connect it to your modem via the Gigabit Ethernet WAN port (there are five Gigabit ports for network devices, too) and power it on, configuring the router using your phone and the Nighthawk app. This has the same interface as the excellent Netgear Orbi system.

By default, the Nighthawk AX8 separates the 2.4GHz and 5GHz networks, but you can combine them under one name, which makes sense: this lets the router direct connecting devices to the best network based on features, range and performance.

There's also a web interface available, which is a touch easier for some of the more advanced features, such as turning on BT YouView IGMP proxying (required if you want to watch YouView internet channels such as BT Sport), and for configuring port forwarding. Currently, however, there are no parental controls or advanced security tools.

For testing, we used both an older Wi-Fi 5 laptop and a Dell Latitude 5490 upgraded with an Intel AX200 Wi-Fi 6 adaptor. Starting out with the Wi-Fi 5 laptop, we saw upload speeds of 693Mbit/s and download speeds of 656Mbit/s at close range; moving to the first floor, putting a wall and floor between us and the router, upload speeds dropped to 224Mbit/s and download speeds fell to 331Mbit/s. On the second floor, we saw upload speeds of 325Mbit/s and download speeds of 383Mbit/s. This makes the Nighthawk AX8 the fastest router we've tested, although not by a huge amount.

THE JOY OF SIX

Next, we switched to the Latitude 5490, to see what Wi-Fi 6 could do. The same close range test produced upload speeds of 750Mbit/s and download speeds of 708Mbit/s. On the first floor, we saw upload speeds of 358Mbit/s and download speeds of 343Mbit/s, and on the second floor we got upload speeds of 377Mbit/s and download speeds of 402Mbit/s. All in all, that's a considerable improvement over the Wi-Fi 5 speeds.

Arguably, however, the true test for this router will come with more congested networks all running Wi-Fi 6 network adaptors. That makes the question of whether should you buy this router more difficult.

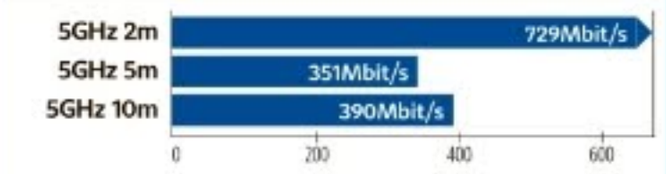
Largely, it will come down to what kind of system you have already. If you're running a mesh system, such as the Netgear Orbi, there's less incentive to upgrade now; having multiple satellites means to an extent you're already spreading the strain on your network.

If you have a single router, then there's no doubt that the Nighthawk AX8 will improve your network speeds. Although it might take your home a few years to get all Wi-Fi 6 devices, buying in now means that you're future-proofed if you're happy to pay the premium for this router. If you're not, a standard 802.11ac router, such as the excellent D-Link DIR-1960 (*Shopper* 381), will still do the job for a good few years to come.

David Ludlow

SPECIFICATIONS

MODEM Gigabit Ethernet • **WI-FI STANDARD** Wi-Fi 6/802.11ax • **STATED SPEED** 4,800Mbit/s (5GHz), 1,200Mbit/s (2.4GHz) • **USB PORTS** 2 • **WALL MOUNTABLE** Yes • **WARRANTY** Two years RTB • **DETAILS** www.netgear.com • **PART CODE** RAX80



See page 84 for performance details

MESH POWERLINE SYSTEM

DEVOLO Magic 2 WiFi

★★★☆☆

£161 • From www.amazon.co.uk

VERDICT

A smart idea for where traditional mesh systems won't reach, but the app and interface are frustrating to use

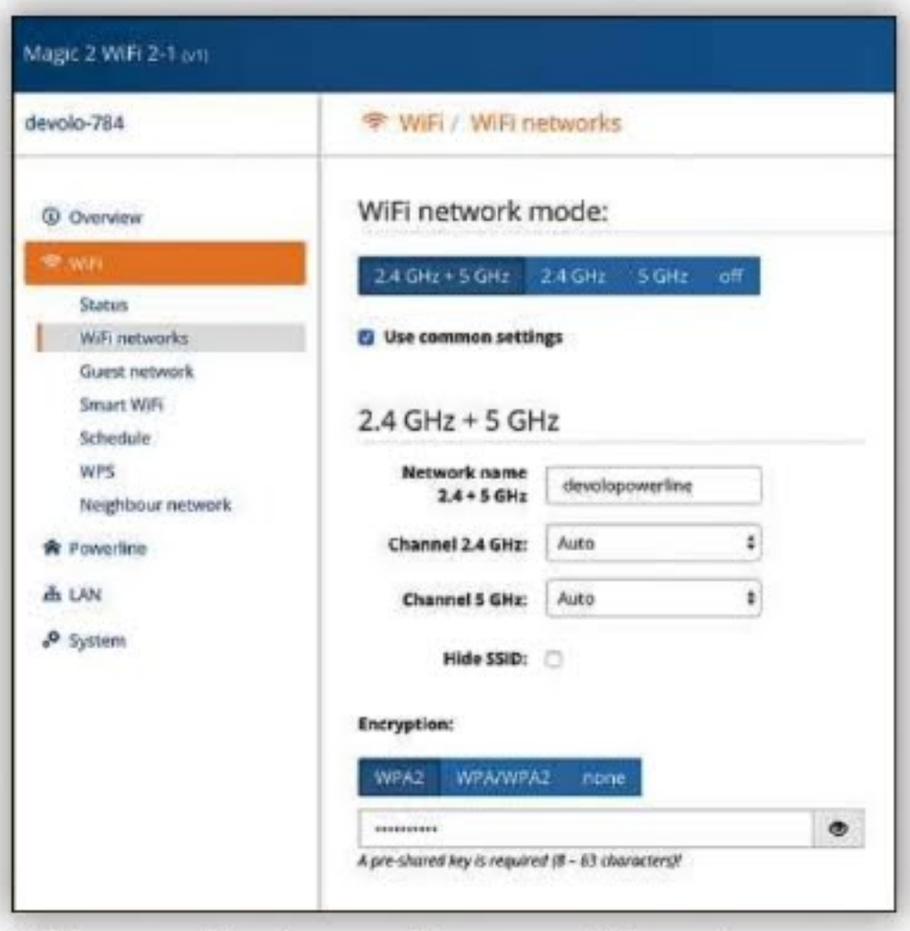
WHILE WIRELESS MESH networks can improve the signal throughout your home, they're typically only any good if you have a decent Wi-Fi or Ethernet connection between the wireless satellites. The Devolo Magic 2 WiFi is designed to be different, using Powerline networking to connect the Wi-Fi satellites around your home, producing, in theory, a more stable connection.

PLUGGING AWAY

The Devolo Magic 2 WiFi is available in two kits. Both have a single Powerline adaptor with a single Ethernet port that plugs into your home router. The difference is that the Starter Kit (£161) has a single Wi-Fi adaptor, while the Whole Home kit (£263) has two Wi-FI adaptors to give you greater coverage. Both kits work in the same way; it's merely a question of how much coverage you want.

All kits come pre-paired, so you just need to plug in the adaptors and you should be good to go. We say 'should', as it's important to connect the adaptors in the right order: start with the wireless adaptors first, then plug in the Powerline adaptor that connects to your router. If you don't, you can end up with an adaptor that doesn't work, as we found out. Once all the lights on all the adaptors are white, the network is ready and you're good to go.

On the back of the wireless adaptors, you get a wireless key, which is the default password for the wireless network. If you've bought a kit, then you get two different passwords, which is a touch confusing. The system takes the password from the main device, which would appear to be the adaptor that you plug in first, although the quick start guide isn't clear on this. Luckily, we managed to enter the correct password the first time around, purely by luck.



⬆ Management is via an app, if you can get it to work

POWER OFF

Once you've got the Magic 2 running, you're supposed to be able to manage it using the smartphone app or the Devolo Cockpit software for Windows or Mac. We found that on our iPhone, the software wouldn't discover any of the Powerline adaptors. Switching to the Mac version, we discovered one adaptor but not all three, which was strange, as they were all definitely working and connected.

In the end, the easiest option was to connect directly to each adaptor's IP address using a web browser. To get the IP addresses, we had to connect to our router and look at the list of connected devices for any Devolo products.

The device you connect to defines the options available. Connect to the standard Powerline adaptor and you don't get any wireless options. If you want to adjust the wireless settings, you have to connect to one of the wireless adaptors; it doesn't matter which.

For some reason, selecting the Wireless option in the web management page automatically jumps you to the Guest network, rather than the main settings. That's a little confusing, as is the fact that Devolo calls the wireless password 'Key' under the guest network settings and 'Encryption' under the main network settings.

Under the main wireless network settings, you can change the name of the network and the password, and you can manually change the wireless channels used by both the 2.4GHz and 5GHz networks. Changes made to any wireless adaptor are changed on all of them.

As with other mesh systems, Devolo uses roaming to push devices to the strongest wireless adaptor and band steering to direct incoming devices to the best network. There's an option to schedule when the entire Wi-Fi network is available but you miss out on some of the more advanced features, such as user profiles for advanced parental controls.

GOT THE POWER

The Powerline network runs at up to 2,400Mbit/s, but your wiring will affect that. Testing with a laptop plugged into a wireless adaptor's Gigabit Ethernet, we saw upload speeds of 47Mbit/s and download speeds of 72Mbit/s. That's fine for streaming video, but far slower than using an Ethernet cable.

The Magic 2 has 5GHz speeds of 867Mbit/s with two streams, and 2.4GHz speeds of 300Mbit/s with two streams. Again, it's worth pointing out that the final speed limit will be limited by the overall speed of the Powerline network to your router. In our home, the best we managed to get was upload speeds of 44Mbit/s and download speeds of 73Mbit/s.

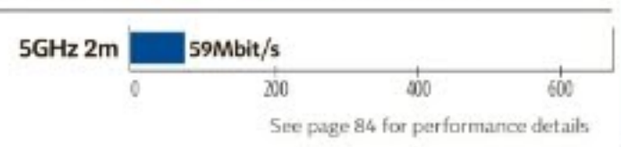
Plugging the Magic 2 adaptors into the same ring main, we saw slightly improved results of 78.3Mbit/s upload and 97.4Mbit/s download, so the quality of wiring makes a difference.

If you need to push Wi-Fi out to a dead spot, the Devolo Magic 2 will do the job, but it's a conventional mesh system will be better for most people. For similar money as the Starter Kit, you can get the Netgear Orbi RBK20 (*Shopper* 375), which is faster, and has both parental controls and optional network security. For the cost of the Magic 2 Whole Home kit, the Netgear Orbi RBK50 (also *Shopper* 375) is even more powerful.

David Ludlow

SPECIFICATIONS

MODEM None • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 867Mbit/s (5GHz), 300Mbit/s (2.4GHz) • **USB PORTS** 0 • **WALL MOUNTABLE** No • **WARRANTY** Two years RTB • **DETAILS** www.devolo.com • **PART CODE** Magic 2



See page 84 for performance details

MULTIFUNCTION PERIPHERAL

EPSON Expression Photo XP-8600

COMPUTER SHOPPER BEST BUY ★★★★★

£119 • From uk.insight.com

VERDICT

There are cheaper home MFPs than the XP-8600, but few can touch it when it comes to photo printing

EPSON'S EXPRESSION PHOTO XP-8600 is a compact inkjet multifunction peripheral (MFP) aimed at creative home users – and if shiny black plastic is your thing, you're going to love it. Business users, on the other hand, should look elsewhere: this MFP misses out key home office features such as a fax modem or an automatic document feeder.

Instead, the XP-8600 focuses on home and creative users, and photographers in particular will be delighted by its balance of features. At the front, for example, there's a huge colour touchscreen with SD card and USB interfaces to support direct printing from digital devices. In the base are cassettes for 100 sheets of A4 and 20 sheets of up to 5x7in photo paper. There's also a single-sheet tray, letting you print on special media without having to reload the printer. Perhaps most importantly, the six-ink print engine includes light cyan and magenta, which should improve shade control and reduce the appearance of grain in photos.

The expensive look is backed up by an expensive feel, with sprung and damped covers, and whisper-quiet scans and prints. However, this only served to show up the harshness of the powered paper output tray. While it's easier to use than on previous models, with a dedicated button on the home screen, after a few cycles ours would only close; we had to pull it out again manually.

COLOUR FAST

This glitch aside, the Expression Photo XP-8600 is excellent. It's not the fastest at mono printing, but it did well in our colour graphics test, managing 4.4 pages per minute (ppm). At its standard quality, it could produce black text at only 8.6ppm, but this almost doubled to 16.9ppm in draft mode.

Photos were pretty quick at the highest quality setting, with each 6x4in print complete in about 70 seconds, and a 10x8in print despatched in two-and-a-half minutes. In black or colour, photocopies completed in about 20 seconds. Scanning was fast, too, with a preview needing just six seconds, and even a 1,200 dots-per-inch (dpi) capture of a 6x4in photo completing in 44 seconds.

Print quality ranged from good to superb. On plain paper, text was fairly crisp and legible even in draft mode, but while graphics were glitch-free, they were undersaturated, lacking the punch we expect from the best results. Photocopies were quite strong, however, preserving plenty of detail from the originals.

On photo paper, the XP-8600 came alive, delivering exceptionally crisp and detailed prints. Black and white prints were notable for their contrast and neutral shade; not always a given from colour inks. Fine shade control and accurate colour reproduction meant that portraits popped off the page, yet they looked natural. Happily, the XP-8600 also has a very capable scanner, which captured sharp images with accurate colour and shade reproduction.

PHOTO FINISH

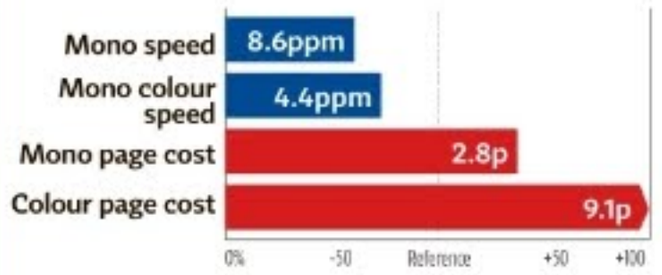
This MFP has few weaknesses, but it is tightly focused on its photo remit: if you want an all-round home MFP, look elsewhere. However, if you need a device with excellent scans and photo printing, the XP-8600 justifies both its purchase price and its steep 11.9p per page running costs. It's a Best Buy.

Simon Handby

⬆ The Expression Photo XP-8600 lacks home office features, but is great for creative users

SPECIFICATIONS

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 5,760x1,440dpi • **MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH)** 1,200x4,800dpi (24-bit) • **DIMENSIONS** 142x349x340mm • **WEIGHT** 6.7kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.epson.co.uk • **PART CODE** C11CH47401



See page 84 for performance details

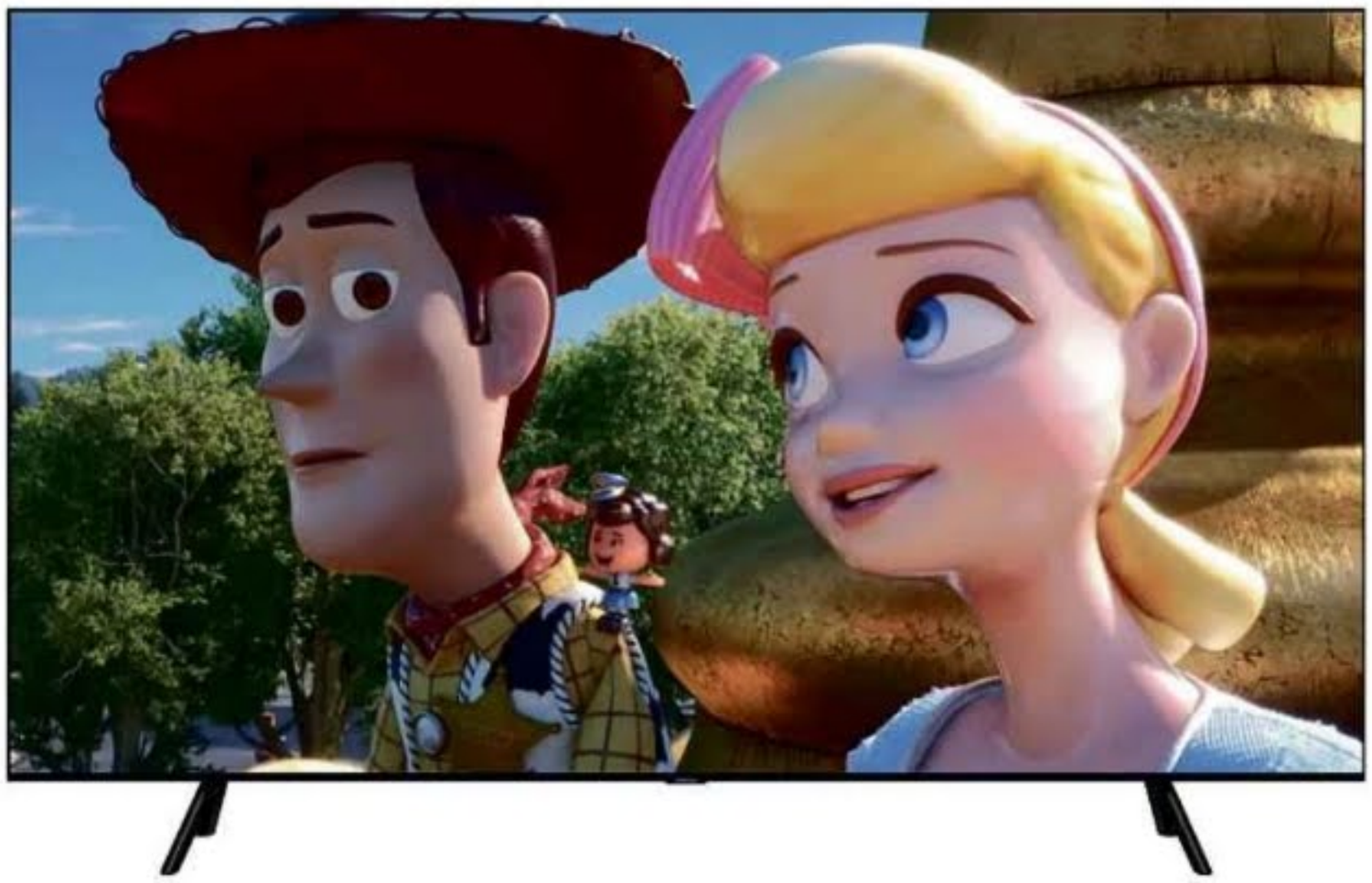
55in QLED TV

SAMSUNG
QE55Q70R

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£1,699 • From www.currys.co.uk

VERDICT
A capable QLED TV for fairly sensible money, although it cuts some corners to achieve this



SITTING BELOW THE Q90R, Q85R and Q80R series, Samsung's Q70R range aims to deliver QLED magic for less cash than its stablemates.

We tested the 55in QE55Q70R, but whether you choose this or the 49in, 75in or 82in variants, they all have the same high-end panel tech. These are also the cheapest Samsung QLED TVs to use full array local dimming (FALD) backlighting, giving them an advantage over sets that use basic edge-lit backlighting.

Admittedly, FALD comes in a simpler form here – there are just 50 lighting zones, not hundreds as there are on the Q80R range and above – and the Q70R series also misses out on Samsung's Ultra Viewing Angle and Ultra Black Filter features.

LEADEN THE LOAD
FALD also makes the QE55Q70R thicker than it would be otherwise, and combining this with some very widely spaced feet, you'll have to make sure your stand is big enough before buying. There are advantages to the chunky chassis, however. Sound quality is strong, with the internal speakers producing impressive bass and volume; the downward-firing speaker arrangement means that sound directionality is below par, but the powerful sound more than makes amends. It's markedly superior to your average TV audio.

All four HDMI 2.0b ports are all located on the rear, and once you've got a source device hooked up you can choose between the two bundled remote controls: a traditional remote, or the more modern Smart Remote. The latter is perfect for browsing the slick Tizen interface: this includes access to HDR-enabled apps for Netflix, Amazon, YouTube and BBC iPlayer, and the Prime Video app supports HDR10+ dynamic metadata. Apple users will be very pleased to see that AirPlay support is present alongside the Apple TV app, too.

Only the lack of Freeview Play gives cause for some minor disappointment.

The QE55Q70R's screen is a VA-type LCD panel, which means you can expect deep blacks and great contrast, or at least you can if you sit in the right seat. One of the limitations of VA technology is that viewing angles aren't particularly wide, so you'll lose colour fidelity and contrast as you move off-centre. The lack of Ultra Viewing Angle does hurt here, and the QE55Q70R's semi-glossy sheen is simply not as effective as the reflection-absorbing finish of, say, the QE55Q80R (*Shopper* 380).

BRIGHT FUTURE
It's great to see that FALD is present and correct, however, even with the lower number of independent zones. Samsung adapts for this by tailoring the local dimming algorithm to suit, sacrificing shadow detail and dimming brighter objects to maintain deep blacks and reduce blooming or haloing artefacts. This generally works well in practice, too, and while the top and bottom letterbox bars aren't as black as they are on the flagship Q90R range, they're impressively dark.

All that said, we did notice brightness fluctuation in subtitles, seemingly caused by the small number of FALD zones. If you regularly use subtitles, or are a fan of foreign cinema, it might be worth investing in a higher-end QLED TV, or just an OLED.

Colour accuracy could be better, too. It is possible to massage the picture settings to produce a more natural-looking picture, but this is a TV more concerned with visual impact than out-and-out accuracy.

The QE55Q70R's picture processing delivers high-quality upscaling of SD and HD content, so it's a shame to see it doesn't get a completely clean bill of health in other areas. Motion controls are comprehensive, but enabling them tends to introduce microstutter in 50Hz interlaced broadcast content, and this is most noticeable from the internal Freeview tuner. The TV's Black Frame Interpolation feature suffers from similar issues, too, with motion interpolation artefacts becoming visible on 50Hz content.

We also noted dirty screen effect on full-field grey slides and a mild blue tint across all four borders of the screen, although these slides test picture uniformity to the extreme, and as such it's seldom visible in everyday use.

Performance is respectable otherwise. After calibration, peak brightness reaches 700cd/m² on a 10% window, and 410cd/m² on an all-white screen. This means you can expect a bold, impactful HDR experience.

Gaming puts the QE55Q70R right in its element. Auto Low-Latency Mode support means that the TV automatically switches to the low-latency Game mode when connected to a compatible games console, and Variable Refresh Rate keeps screen tearing at bay. We measured input lag at a mere 15ms, which is about as low as it gets for TVs. Game Mode sacrifices a little bit of the QE55Q70R's picture-processing oomph, but it's worth it for the lower latency.

ONE TO WATCH
The QE55Q70R is another fine QLED TV from Samsung that puts in a respectable all-round showing. HDR performance is good, and while the images the Q70R produces aren't strictly accurate, we suspect most people won't care: the overall impact is thrilling.

LG's OLED sets, including its affordable B8 and C8 series, have been trickling down in price to the point where they could undercut the Q70R family, but it can still be worth opting for QLED, especially if you're keen to avoid the risk of OLED burn-in.

Vincent Teoh

SPECIFICATIONS

SCREEN SIZE 55in • **NATIVE RESOLUTION** 3,840x2,160 • **VIDEO INPUTS** HDMI, RF • **TUNER** Freesat • **DIMENSIONS** 708x1,231x62mm • **WARRANTY** One year RTB • **DETAILS** www.samsung.com • **PART CODE** QE55Q70R

CONNECTION PORTS

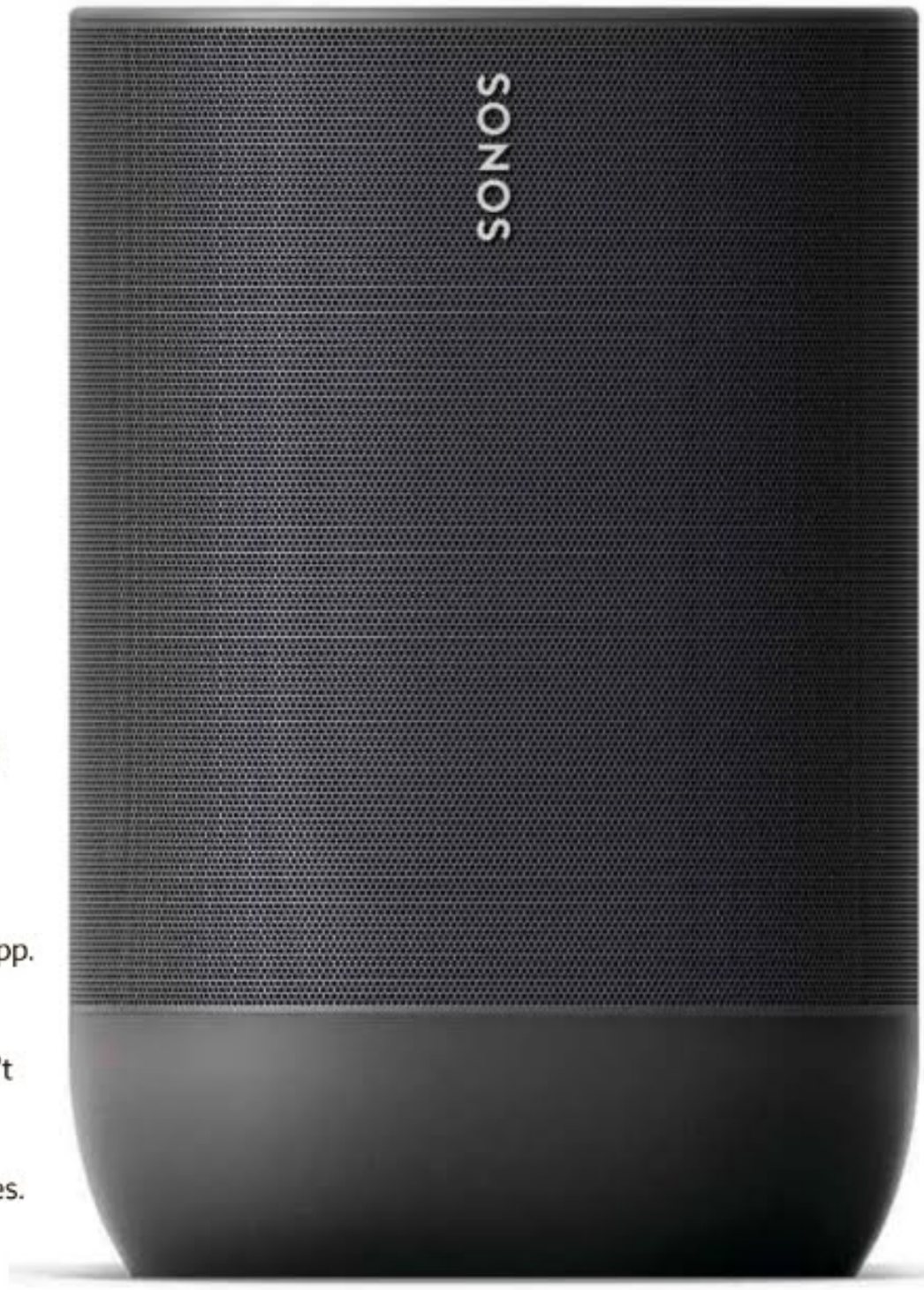
HDMI x4 • USB3 x2 • Optical S/PDIF • Ethernet • Satellite x2 • CI • RF

WIRELESS SMART SPEAKER

SONOS Move

COMPUTER SHOPPER BEST BUY ★★★★★

£399 • From www.currys.co.uk



VERDICT

It's heftier than most portable speakers, but the Sonos Move has the smarts and audio quality to make up for it

A PORTABLE BLUETOOTH speaker has long been the missing piece of Sonos's multiroom catalogue. That changes with the Sonos Move, which also brings smart speaker capability via Amazon Alexa and Google Assistant.

The design is a departure, too. Unlike the squat Sonos One (*Shopper* 378), the Move is tall and elegant, with an oval top plate and a profile that tapers at the bottom end. All the main controls sit on the top panel, which also plays host to the speaker's far-field microphone array. The controls are touch-sensitive, which can sometimes spell trouble, but these work reliably and quickly; they comprise a microphone on/off button, a play/pause button and a pair of controls for adjusting the volume up and down.

BIG LUG

At the rear is a scooped-out hollow containing the power button, the join button (for connecting the speaker to Wi-Fi or an existing network of Sonos speakers) and another button for switching between Bluetooth and Wi-Fi. There's also a carrying handle, which you'll need given the Move's considerable size and 3kg weight. This is definitely the kind of wireless speaker that's better for taking on short trips down the garden, rather than long excursions.

Even so, it's sturdy and well made, even meeting the IP56 standard for dust resistance and waterproofing. That doesn't mean you can dunk it in the bath, but it will shrug off a rain shower.

Battery life isn't bad, either, at 10 hours of continuous playback. The battery is replaceable, too, although pricing and availability for spare units is yet to be revealed.

Elsewhere, the Sonos Move is equipped with the same features we've come to love in the Sonos One: support for both Amazon Alexa and Google Assistant; a fantastically easy-to-use app with fully integrated support for Spotify, Tidal, Qobuz and more than 100 other streaming services; and the ability to pair two Sonos Moves together to produce stereo sound.

It's worth noting, however, that you can't use Alexa and Google Assistant interchangeably, which is a shame. Instead, you have to switch between them in the app. And, in keeping with other third-party smart speaker manufacturers, the Move can't make use of some key Alexa features, such as the useful drop-in and phone call features.

That's mildly frustrating, but the Move has the major advantage over Amazon and Google's own smart speakers by being able to form part of a Sonos multiroom network. If you already own a network of Sonos speakers – perhaps a Sonos One in the kitchen and bedroom and a Sonos Beam in the living room – just press the join button on one of your already connected Sonos speakers, then the join button on the Move, and they're all linked together.

SPATIAL AWARENESS

The Move also supports Trueplay, which tunes the speaker's frequency response to suit the room you're listening in. On previous Sonos speakers, this has required a somewhat tedious setup process, but the Move does it all automatically by using its own microphones to test how the sound bounces around the environment. It works beautifully, except in Bluetooth mode, where Trueplay is disabled.

There's nothing particularly fancy about the driver arrangement inside the Sonos Move. A single, downwards-firing tweeter sits at the top of the speaker, sending high-frequency audio down against a 'waveguide' that then disperses the sound outwards and upwards. Mid and bass tones are handled by a larger, forward-facing mid-woofer, and both drivers are coupled with a pair of digital amplifiers.

The results sound great, and with Trueplay engaged the Move becomes the best-sounding smart speaker on the market. We've used it indoors and outdoors, next to walls and on the floor, placed on shelves and sitting in corners, and the Sonos Move consistently punches out audio in a controlled, considered and detailed manner, with high volume potential and plenty of strong, impactful bass.

GOING PLACES

In short, the Sonos Move is an excellent smart speaker. We were initially surprised at how big and heavy it was, and unlike the UE Megablast (*Shopper* 362) it's not something that can be easily carried around on foot. Still, if you want the best sound quality, you're going to have to accept some compromises, and the Move's battery power still grants it flexibility in where you can listen to it.

At the same time, it's making some steps forward for Sonos as a whole. Besides filling a gap in its multiroom family, automatic Trueplay tuning is a significant improvement, one we're hoping to see as standard on future speakers.

The Move is therefore the most complete and sumptuous-sounding smart speaker yet, and is well worth its high price.

Jonathan Bray

SPECIFICATIONS

DRIVERS 2 • **RMS POWER OUTPUT** Not stated • **DOCK CONNECTOR** None • **WIRELESS** 802.11n Wi-Fi, Bluetooth SBC • **DIMENSIONS** 240x160x126mm • **WEIGHT** 3kg • **WARRANTY** One year RTB • **DETAILS** www.sonos.com • **PART CODE** MOVE1UK1BLK

SMART DISPLAY

GOOGLE Nest Hub Max

COMPUTER SHOPPER BEST BUY ★★★★★

£219 • From store.google.com

VERDICT

The Nest Hub Max is just a bigger version of the Google Home Hub, but that's no bad thing

DON'T LET THE new Nest branding throw you off; this is a direct successor to the Google Home Hub (*Shopper* 372), one of our favourite smart displays. The Nest Hub Max is therefore a familiar device, albeit a significantly larger one – its display is 10in diagonally, up from 7in – and with a camera nestled in the top bezel.

For those who fear the privacy implications of this, there is a switch round the back that disables both the camera and the two far-field microphones. It's a pity there's no switch for turning off the camera while leaving the microphones on, although you can do this on the display with a swipe upwards.

WIDER WORLD

The benefits of a larger screen should be pretty obvious: everything is bigger and easier to see or touch. And, while a 10in screen still isn't massive in an age of 6in phones and 55in TVs, it's still more than enough to service the Nest Hub Max's core functions.

The extra size also calls for a resolution boost, going from 1,024x600 on the older model to 1,280x800. That's a modest increase, and the effect is largely absorbed by the greater dimensions, meaning that things look pretty similar to how they did on the original Home Hub: it isn't hugely sharp, but the colours look rich and largely accurate, and that's pretty much all you need for something that will be viewed from further away than your average phone or tablet. It is, however, somewhat reflective, so be sure to place it well away from direct sunlight.

As with all smart displays, the touchscreen isn't always essential: Google Assistant can use voice commands alone to respond to queries and tinker with smart home equipment. It can come in handy, however. For example, if you own a Nest video doorbell, you can see who's at your door without having to consult your phone. Place the Nest Hub Max in the kitchen, and you can also look up recipes and YouTube cooking tutorials without having to touch anything.

It even has Chromecast support built-in, meaning you can push videos to the screen, including those you have saved on a personal Plex server. Being able to see and control all your smart home devices on a single screen is also nice, and you can even link it to Google Photos to be a digital photo frame when it's sleeping.

OCULAR IMPLANT

The camera, although likely to be a controversial addition, has its benefits too. A bright green light makes it clear when the camera is active, and it allows for facial recognition, so as you approach the screen it will only show information that's pertinent to you specifically. We haven't had any issues with accuracy, either.

The camera also enables a new feature called Quick Gestures, whereby you control the Nest Hub Max with hand signals instead of voice commands or the touchscreen.

This works surprisingly well: holding a hand up in a 'stop' gesture reliably paused any music the device was playing, so that we could input voice commands without having to shout.

Even more useful is the Nest Hub Max's ability to act as a smart security camera, if a relatively basic one. It comes with a free month's trial of Nest Aware, which means it can capture video when you're away.

Once this trial expires, you're looking at a subscription cost of at least £5 per month if you want to keep it going, although on the free tier it will still send notifications and take a photo, albeit one that isn't kept for very long. The extra cost feels a little cheeky, but given security camera functionality is very much a bonus feature of the Nest Hub Max, it can be ignored.

The Nest Hub Max's larger footprint also means the speaker gets an upgrade. The new model comes with a 75mm, 30W woofer and two 38mm, 10W mid-high drivers, and the sound quality is pretty reasonable, although no match for the best smart speakers, such as the Sonos Move (opposite). It distorts quite unpleasantly at higher volumes, although this is a loud speaker to begin with, so you shouldn't need to crank it up too far in everyday use.

You can control the Nest Hub Max with hand signals. Holding a hand up in a 'stop' gesture pauses any music

NEST PLEASE

The Google Nest Hub Max takes everything that was great about the Home Hub and makes it a little bigger. That means it's still a great product, but only you can really say whether you need to spend the extra £80 on an extra three inches of screen real estate, slightly beefier sound and a camera. Both models, however, are excellent products.

Alan Martin

SPECIFICATIONS

DRIVERS 3 • **RMS POWER OUTPUT** Not stated • **WIRELESS** 802.11ac Wi-Fi, Bluetooth 5.0 • **DIMENSIONS** 183x250x101mm • **DISPLAY** 1,280x800 • **WEIGHT** 1.3kg • **WARRANTY** One year RTB • **DETAILS** store.google.com • **PART CODE** Nest Hub Max

ANDROID 9.0 SMARTPHONE

ONEPLUS 7T

★★★☆☆

£550 • From www.amazon.co.uk

VERDICT

The OnePlus 7T introduces a host of improvements, but its new camera proves to be a fundamental flaw

T-BRANDED ONEPLUS PHONES tend to only present minor upgrades on their non-T counterparts, so the 7T is an exciting change of tact: there are so many changes and additions here, it's hard to know where to start.

On the rear, for example, the vertically stacked dual cameras on the OnePlus 7 (*Shopper* 380) have been replaced by three lenses arranged horizontally. Granted, it's not the most attractive piece of design – the black housing surrounding the lenses is huge, and pokes out too far from the back – but on the whole, this is still a very good-looking handset, and the display has been improved, too.

GO RATE AHEAD

Besides being slightly bigger than the OnePlus 7's screen, at 6.55in diagonally, this display has inherited the higher 90Hz refresh rate of the OnePlus 7 Pro (*Shopper* 379). The result is that everything from website and menu scrolling to panning around in Google Maps feels ultra-slick. It's so smooth, in fact, that going back to using a regular smartphone with a 60Hz display (that's most of them) feels a little odd.

Although the Full HD resolution remains unchanged, there have been other display improvements, too. We measured peak brightness at 650cd/m², up considerably from the OnePlus 7's 428cd/m², and the amount of blue light that the screen emits has been reduced.

As with previous OnePlus phones, you get the choice between several different colour profiles in the display settings: Natural, Vivid and Advanced. Natural seems to be calibrated to reproduce the sRGB colour space, which is the best mode for use while browsing the web, while Vivid is closest to the DCI-P3 colour space used in HDR TV and movie content. Advanced allows you to choose from sRGB and DCI-P3 presets and tweak the white balance, but you're best off just sticking with the main two modes.

In these modes, the OnePlus 7T's display performs well, and it's pretty much spot on with the target colour gamuts. There are no particularly problematic areas for colour accuracy either, and the use of an AMOLED panel ensures perfect contrast.

The OnePlus 7T hasn't entirely ditched the original model's Qualcomm Snapdragon 855 chip, but here it's the Snapdragon 855+, the plus suffix merely denoting overclocked core speeds, up to a maximum of 2.96GHz.

Since the OnePlus 7 could reach 2.84GHz, the performance difference is tiny: the 7T's Geekbench 4 single-core result of 784 is only slightly higher than the 7's 733, and its multicore result of 2,738 is actually lower than the 7's 2,805. The two handsets also tied in GFXBench's Manhattan onscreen test, scoring 60fps apiece, although the 7T pulled ahead with 113fps in the offscreen test.

The change in processor speeds hasn't changed battery life, either, as the OnePlus 7T lasted 21h 13m in our video rundown test, a mere two minutes longer than the OnePlus 7. You could possibly complain about the lack of big steps forward, then, but ultimately the OnePlus 7T is a powerful and long-lasting Android phone; you don't need to make major improvements when the OnePlus 7 did so well in these tests to begin with.

SHORT SIGHTED

Going back to that camera arrangement, the new rear camera comprises a 48-megapixel primary lens, a 12-megapixel 2x telephoto lens and a 16-megapixel ultra-wide-angle lens. These new tools are utilised in some clever ways: the telephoto lens enables an impressive macro shooting mode, and video shot with the wide-angle lens can be stabilised by dynamically cropping pixels around the edge. Unfortunately, these neat tricks are overshadowed by some very serious problems.

48-megapixel shots are heavy afflicted with artefacts, effectively forcing you to use the main lens for 12-megapixel shots instead, and when you switch to the 2x telephoto lens, the camera often goes mad and completely oversaturates the image.

The wide-angle lens also has a patch in the centre where it noticeably distorts the image. In stills, this takes the form of a small bulge in the centre, which, if you're shooting subject matter with straight lines, will be immediately obvious. Shift into the stabilised video mode and, because the footage crops into the central area of the sensor, the issue becomes even more obvious.

SHUTTER SHAMBLES

The only thing that works perfectly here is the video recording from the main and telephoto cameras. You can record in 4K at up to 60fps, the footage is both detail-packed and very stable, even without the wide-angle lens's Super Stable mode enabled, and the zoom is pretty smooth, too.

Sadly, this isn't enough to redeem the camera, which is so wracked with issues that we can't recommend the OnePlus 7T even with its welcome improvements elsewhere.

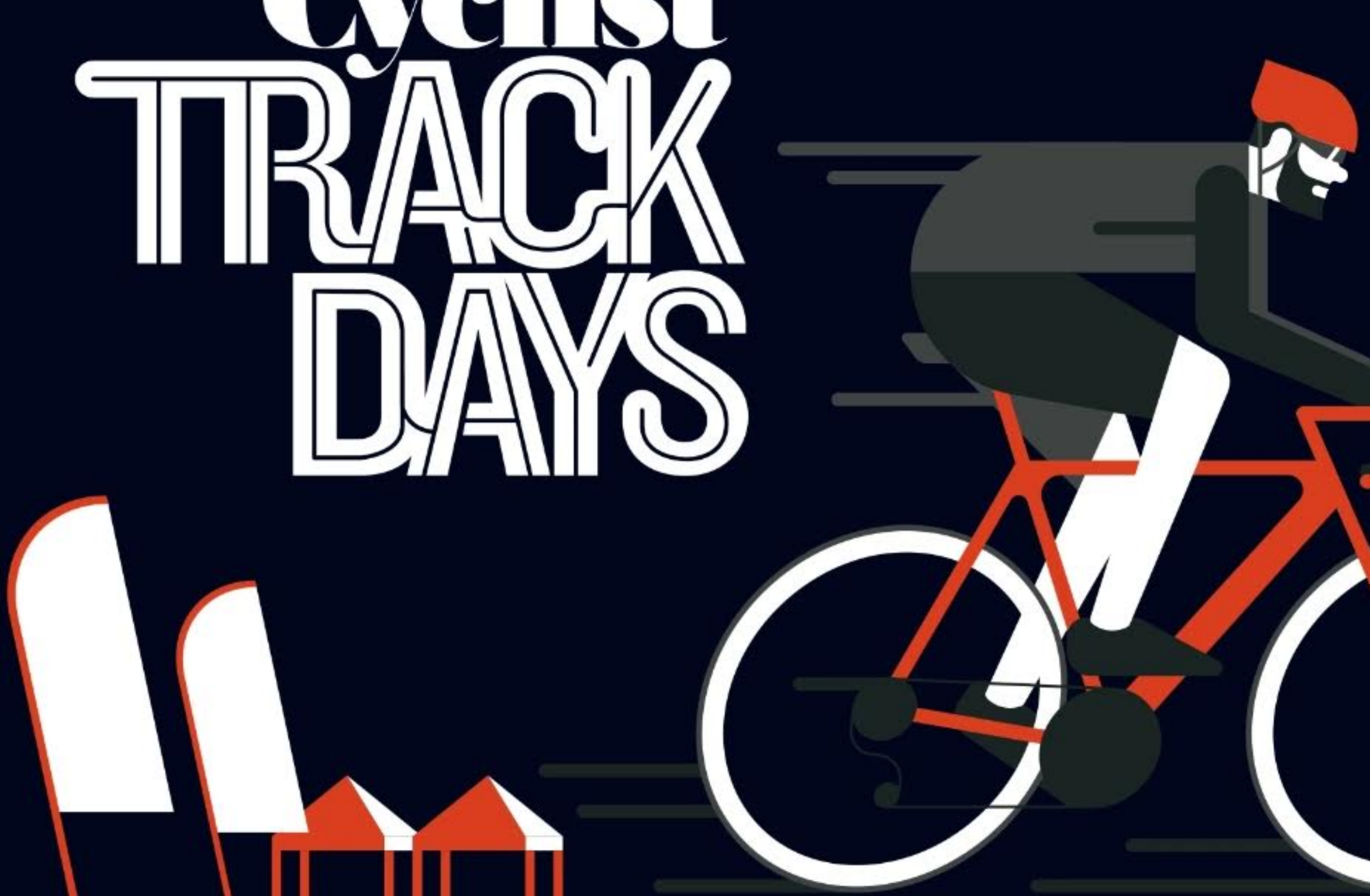
Nathan Spendelow

SPECIFICATIONS

PROCESSOR Octa-core 2.9GHz Qualcomm Snapdragon 855+ • **SCREEN SIZE** 6.55in • **SCREEN RESOLUTION** 2,400x1,080 • **REAR CAMERAS** 48 megapixels, 12 megapixels, 16 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 161x74x8.1mm • **WEIGHT** 190g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.oneplus.com • **PART CODE** 7T

See page 84 for performance details

Cyclist TRACK DAYS



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ANDROID 9.0 SMARTPHONE

XIAOMI Redmi 7A

COMPUTER SHOPPER RECOMMENDED ★★★★★

£99 • From www.amazon.co.uk

VERDICT

For its tiny price, it's hard to find ways in which the Redmi 7A disappoints

HOW GOOD CAN a £99 phone be? Obviously there are limits, but Xiaomi has form for crafting a quality product for relatively little cash: just look at the Pocophone F1 (*Shopper* 373).

The Redmi 7A is an even cheaper proposition, but it's also a showcase of how far budget smartphones have come over the years. This is a handset that's every bit as handsome as the iPhone 5c was back in the day, and while you'd be unlikely to mistake it for one of the latest flagships, the gap between top-end and budget models has narrowed considerably in terms of looks.

AFFORDABLE HOUSING

Like most recent phones, the whole thing is dominated by a large screen – in this case, a 5.45in IPS panel. The bezels are there, but not obnoxiously; there's no physical home button and just the standard volume rocker and power switch on the right-hand side.

The back casing is a smooth, rounded polycarbonate affair, and comes in black, blue or gold. It feels very nice in the hand: solid and with enough grip not to worry about droppage. Build quality is excellent, too, with no flex at all in the body. You get the feeling that it would last a few tumbles, if you're a butterfingered type.

You can forget about niceties such as wireless charging and waterproofing, although both are reasonable omissions at this price. What is disappointing is the lack of a fingerprint reader; the Vodafone Smart X9 (*Shopper* 377) proved this is an attainable feature even below £100.

Still, the Redmi 7A earns points in other areas. It has a 3.5mm headphone jack, and it also lets you expand the storage by an extra 256GB via microSD if you like.

The display is another area where Xiaomi sensibly cuts costs without taking away from the overall quality of the device. It's only a 720p panel, but it's a good one considering the low cost of entry.

Although slightly reflective, the screen has solid viewing angles, and reaches a respectable peak brightness of 419cd/m². Colour accuracy is also decent, covering 87% of the sRGB gamut on its standard colour profile.

The only slight letdown is a pretty low contrast of just 525:1, which leads to images and icons that aren't quite as sharp as they could be, but overall it's hard to complain about a screen this good on a £99 handset.

RUN OF PLAY

Likewise for performance: the Redmi 7A was never going to be an absolute powerhouse, but its Qualcomm Snapdragon 439 processor makes it feel nimble enough, and surprisingly snappy in day-to-day use.

In Geekbench 4, it scored 864 in the single-core test and 3,109 in the multicore test, putting itself even with the Nokia 4.2. That's to be expected when the two phones share the same processor, but the Redmi 7A is £50 cheaper, so that's a win for Xiaomi. Its single-core power is also slightly ahead of the Smart X9, although Vodafone's device counters with superior multitasking.

The Redmi 7A is better for gaming. In the GFXBench Manhattan benchmark, it scored 25fps in the onscreen test and 10fps in the 1080p offscreen test, so while it will struggle with more intensive 3D games, it will cope visibly better than the Smart X9, which scored 9fps in both tests.

On battery life it's slightly above average, too. 13h 24m in our video test represents enough stamina to get you through a day of regular use, and only the vast 5,000mAh battery on the £180 Moto G7 Power (*Shopper* 376) really pulls clear. The Smart X9 and Nokia 4.2, meanwhile, both ran dry before the Redmi 7A did.

On the back of the Redmi 7A, you'll find a single 13-megapixel camera with an aperture of f/2.2. While some budget cameras put in a second lens for the price, it's almost always a depth sensor, which doesn't add a great deal; we'd rather there was a focus on getting one lens right.

That's exactly what Xiaomi has done here: the camera's results might not be spectacular, but they are respectable enough. Even on a moody grey day, outdoor shots are detailed and colourful, and even low-light performance is surprisingly competent. Again, it's not exactly cutting edge, but shots capture plenty of detail for the most part, only going blurry in the darkest areas.

For £99, the Redmi 7A never seriously puts a foot wrong. It looks nice, feels well built and takes a reasonable picture

SEEING RED

For £99, the Redmi 7A never seriously puts a foot wrong. It looks nice, feels well built and takes a reasonable picture: qualities that are by no means easy to find at such a low price.

The Smart X9 is a good alternative, especially if you want a fingerprint reader, but otherwise the Redmi 7A is a brilliant budget phone.

Alan Martin

SPECIFICATIONS

PROCESSOR Octa-core 2GHz Qualcomm Snapdragon 439 • **SCREEN SIZE** 5.45in • **SCREEN RESOLUTION** 1,440x720 • **REAR CAMERA** 13 megapixels • **STORAGE** 16GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 146x70x9.6mm • **WEIGHT** 165g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.mi.com • **PART CODE** MZB7813EU

See page 84 for performance details

SMARTWATCH

APPLE Watch Series 5

COMPUTER SHOPPER BEST BUY ★★★★★

£399 • www.apple.com/uk

VERDICT

The Apple Watch Series 5 is the best smartwatch out there, if only for iPhone users

EVEN BY APPLE'S conservative standards, the Apple Watch Series 5 is a small update. Besides extra storage space, a magnetic compass and an upgraded altimeter, the biggest change between this and the Series 4 (*Shopper* 371) is the always-on display.

When you're not looking directly at the watch, the display dims and the data shown on complications and during workouts refreshes more slowly. Turn your wrist, and it brightens instantly. However, for now, this feature only works on the main watch face and Apple's Workout app. With other apps, the display blurs and a simple digital time is shown when not in use.

The design is otherwise largely unchanged, with no difference in weight between the GPS-only and GPS+Cellular variants. The aluminium watch weighs 30.8g for the 40mm model without a strap, and 36.5g for the 44mm, with both measuring 10.7mm thick – slightly slimmer than the 11.4mm Apple Watch Series 3, but no different to the Series 4. As before, the new Watch can also only pair with iPhones; Android support remains missing.

PATHFINDER'S KEEPERS

If you ever use the Apple Watch to navigate your way around town, the new compass should prove a very useful addition. Instead of the simple blue dot showing your position in the Maps app, you can now see which direction you're facing, making following routes much easier.

Apple has also tweaked its Health smartphone app to be better at showing useful information at a glance, with a new summary section of your day, and highlights of your recent activity, including recent workouts. It would be nice to see some of this data make its way on to the Watch itself; it would be great to be able to view recent workouts in detail from your wrist.

When it comes to sports tracking, you can pick from basically any app you want to use on the Watch itself. Strava, Nike+ Run Club, Endomondo and many more are all there, which is one of the great strengths of Apple compared to its rivals. However, since the always-on screen is only available in the native Workouts app, that's the one most people will use, and it's far from perfect.

The GPS tracking, in particular, is where the Workout app stumbles, with corners being 'smoothed' and sections of runs being missed entirely at times. Indeed, during one 30km run that included only six turns, the Watch cut 0.8km from the total distance.

However, we found that this happened only when the Watch was piggybacking off our smartphone's GPS. When we turned off Bluetooth, or left the phone behind, the Watch's distance readings matched up well with a Garmin running watch linked to a calibrated footpod. The heart-rate monitor is also extremely accurate, logging readings within a beat or two of a chest strap.

Another complaint is that the Workout app still won't interface with other apps such as Strava natively. You can get around this through the use of a third-party app such as RunGap, which you have to pay for, but you really shouldn't need to.

LOOK NO HANDS

However, the always-on screen works well, dimming and reducing the amount of info shown when you're not looking directly at it – the workout duration doesn't show milliseconds, for example. This is a major improvement, because during exercise it's not always easy to turn and hold the screen in place for a second to wake it up. Whether you're running, cycling or holding a plank position, being able to glance at the screen from any angle is a major plus.

Apple has expanded its health-tracking features with watchOS 6 by adding in both menstrual health tracking and a noise monitor. The latter is useful in showing the decibel level of the environment you're in, and whether it poses a risk to your hearing. You can also access a dedicated App Store directly from the Watch itself, although it's generally easier to search and browse with a smartphone's larger screen and keyboard.

The Apple Watch 5 has the same 64-bit dual-core processor as the Series 4 – although confusingly, it's been renamed as an S5 chip – and it's brilliantly smooth and fast to use at all times. Switching between apps is snappy, and even when tracking a run with music playing from the Watch, there was no lag when jumping between apps.

LONG STORY SHORT

Battery life, unfortunately, takes a hit, most probably because of the always-on display. Both the Series 4 and Series 5 claim 18 hours of use, but we found the newer model drains faster: at the end of a day we'd usually end up with 40-50% charge left on the Series 4, but only 30-35% on the Series 5. Nightly recharges are a necessity, which is unfortunate considering how many smartwatches can go for days at a time.

At least this battery life drop is in service of a better user experience. Apple might not have made sweeping changes to the Series 5, but it has made some genuine improvements to what was already a great blueprint.

Nick Harris-Fry

SPECIFICATIONS

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.78in • **RESOLUTION** 448x368 • **OS SUPPORT** iOS • **BATTERY LIFE** 18 hours • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** Apple Watch Series 5

FITNESS SMARTWATCH

FITBIT Versa 2

★★★★☆

£199 • From www.currys.co.uk

VERDICT

The Fitbit Versa 2 is a well-judged update, although the lack of GPS holds it back

THE ORIGINAL VERSA (*Shopper* 365) almost single-handedly turned around a beleaguered Fitbit's fortunes, so it's no wonder the firm is looking for repeat success with the sequel.

The Versa 2 is every bit as attractive as the old model, with its sleek square face, gentle rounded edges and single, unobtrusive button.

TRICKS OF THE TRADE

It's actually quite remarkable how stylish it looks on the wrist, because to some extent its good looks are an optical illusion. First of all, it's 12mm thick, which doesn't sound like a lot, but that's actually close to twice as thick as the average smartphone. Because of the way it tapers inwards, however, it looks a lot thinner than it is.

Second, if you look closely you'll see the Versa 2 has a pretty thick bezel all the way around the screen, but because the background is black on every menu, you only really spot this in bright sunlight. In short, Fitbit has done a masterful job of hiding aesthetic imperfections. It's comfortable, too, with straps that can be replaced should you want to mix things up a bit.

Finally, it's worth saying something about the new screen technology. The move to OLED is a masterstroke as it adds two important additions. First is an always-on display, which means you don't need to move your wrist to read the time or see your steps at a glance. It's not on by default, because Fitbit says it reduces battery life by a day, but that brings us to the second point: OLED means the battery lasts longer anyway, from about four days on the Versa to five days on the Versa 2.

It's a good screen, too. The 300x300 resolution is more than sharp enough to show off the watch's bright and breezy array of icons, and you can always see what's on the screen at a glance.

Those good vibes continue into performance, with the Versa 2 diligently tracking your activity as you go along. Steps are counted, notifications buzz through and, if you want to interact more with it, then music, exercises, breathing and other apps are just a swipe away. The Fitbit Versa 2 is generally seen and not heard, and that's absolutely fine.

It even finds room to bundle Amazon's virtual assistant Alexa in this time, too, enabled by a microphone on the side of the watch. Hold down the button and the Alexa logo will pop up to show it's listening. Ask a question and then, after a short 'thinking…' message, the answer to your question will be written on the screen for you to read.

There are limitations to this. You can't ask it to play music on Spotify, for example, even though the app is there on the watch. You can, however, get it to set timers and even control smart home kit. Even if it sounds silly, it works: we had no issues using the Versa 2 to switch smart light bulbs on and off.

OUT OF POSITION

The same button can also be reprogrammed to activate Fitbit Pay instead, but this remains an extremely minor feature as so few UK banks support it; the only major one at the moment is Santander.

App support is growing, however, and it's good to see Fitbit bundling both Strava and Spotify alongside its own first-party apps, although the latter is a remote control for phone playback, rather than a fully built-in music player. Then again, given the lack of GPS, you'll need to take your phone with you for running and cycling anyway, so that shouldn't be a dealbreaker.

Even when piggybacking, however, the Versa 2 wasn't very accurate at measuring distances. The watch itself logged a precisely 5km-long run as 5.25km, then revised this to 5.15km when synced to the Fitbit app. That's an improvement, but still not right.

This inaccuracy goes the other way as well, underestimating another 5km run as 4.74km. This time it was a lot easier to see why: the mapping data had the impression we were significantly cutting corners. This could be blamed on our phone's GPS rather than the Versa 2, but it still shows the missed benefits of an integrated, dedicated GPS chip.

> The Versa 2 comes frustratingly close to being amazing, but without GPS it's much less attractive as a fitness tracker

TWO TIME

As a result, the Versa 2 comes frustratingly close to being amazing, but without GPS it's much less attractive as a fitness tracker. It's a shame Fitbit doesn't make this an optional extra, because the Versa 2 is far nicer to look at and use than the Fitbit Ionic (*Shopper* 360).

That being said, if you are confident in your phone's GPS accuracy, and you don't mind taking it with you on a run, you'll still appreciate the Versa 2 as a sporty smartwatch. The OLED screen in particular makes it a worthy successor to the wearable that put Fitbit back on the map.

Alan Martin

SPECIFICATIONS

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.3in • **RESOLUTION** 300x300 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** Five days • **WARRANTY** One year RTB • **DETAILS** www.fitbit.com • **PART CODE** FB507RGPK

MIRRORLESS CAMERA

OLYMPUS PEN E-PL9

★★★★☆

£522 • From www.amazon.co.uk

VERDICT

This entry-level model from Olympus is a fun camera for vlogging and holiday snaps

A BASIC MODEL at the bottom of Olympus's mirrorless line-up, the PEN E-PL9 is designed to tempt those looking to upgrade from their smartphone's integrated camera. It includes a full complement of automatic and creative modes, as well as more advanced options.

Olympus has gone big on styling, with the E-PL9's gorgeous retro look making it as much a fashion statement as a photographic tool. It doesn't represent a huge upgrade from the older E-PL8: many of its specs and features are identical, including a 16.1-megapixel Micro Four Thirds sensor, 3-axis in-body image stabilisation and the 3in tilting touchscreen.

4K video is a big addition, and it's facilitated by an upgrade to Olympus's TruePic VIII image processor, the same used by some of Olympus's higher-end cameras.

BLOCKING THE VIEW

The E-PL9 has roughly the same dimensions as the E-PL8, although the grip is deeper, making it a little more comfortable. The mode dial has also been slightly enlarged, and the flash is now integrated; a small, inconvenient external flash was supplied with the E-PL8. This comes at a price: there's still a hotshoe for a beefier external flash, but the accessory port is gone, so unlike the E-PL8, you can't add the optional electronic viewfinder.

The size of the camera – just 117mm wide and 68mm tall – means it pairs well with Olympus's compact 14-42mm retractable zoom lens, as well as some of the smaller primes in the Olympus line-up, such as the 17mm f/1.8 lens. It's a Micro Four Thirds mount, so you can attach Panasonic lenses, too.

As there's no option to attach a viewfinder, the tilting touchscreen is the only way to compose, so it's a good thing the 3in, 1.04 million pixel display is decent. It can be pushed to face all the way forward, making it handy for selfie composition, although because the screen faces forwards underneath the camera, you can't simultaneously mount it on a tripod.

A range of different exposure modes can be accessed via the mode dial on the top of the camera, including fully automatic, semi-automatic and manual. A new mode for the E-PL9 is the 'advanced photo' mode, which gathers together a number of creative options, such as multiple exposure, HDR, focus bracketing and so on. Frustratingly, silent mode is only to be found here; there's no way to shoot silently in the normal modes.

Unlike some cameras aimed at travellers, the E-PL9 doesn't feature USB charging, which seems a bit remiss. Instead, you need to use the dedicated charger that comes in the box.

More happily, the E-PL9 has more autofocus (AF) points than the E-PL8, which is good news for catching off-centre subjects. The E-PL9 uses contrast detection – rather than the faster phase detection – AF, but it's pretty snappy in most instances, perhaps taking just a little longer in darker conditions. Beginners may prefer to leave the camera to choose an appropriate AF point and, in our tests, the E-PL9 generally got it right.

FLEXIBLE WORKING

The E-PL9 can produce some very nice shots, especially in good conditions. Image quality is slightly improved over the E-PL8, perhaps thanks to the newer image processor, but it's not something you're likely to notice unless pixel peeping to the extreme.

In good light, images are bright and punchy, with a pleasing level of saturation resulting in attractive colours. In lower light, the smaller sensor reveals itself compared to cameras with bigger sensors.

The 14-42mm kit lens is adequate as a walk-around lens, and if your main concern is grabbing holiday snaps, it's fine. Get a bit more into your photography, and you'll crave additional lenses. Apart from anything else, better lenses will get more from the sensor, as well as allowing you to fit lenses with bigger apertures for better low-light performance.

There are also some nice creative options. The multiple exposure mode is easy to use and quick to get to grips with, while the digital filters are pretty fun. Being able to quickly use things such as focus bracketing and create long exposures is great for those new to photography who want to try what might otherwise be difficult-to-crack techniques.

As for that newly added 4K video, the camera can produce good footage, but the best results come if you swap the kit lens for something better. There's also no microphone input, which will limit the E-PL9's appeal to more serious videographers.

HIT THE ROAD

There's a lot to criticise about the E-PL9. No viewfinder, no USB charging and a relatively modest set of specs may have some sneering. Remember, however, that this is specifically targeting smartphone users who might never have owned a serious camera; a viewfinder is hard to miss if you've never used one before. Its small size and weight also makes it great for those travelling light, while still allowing users to expand with additional lenses.

This is a great little camera for those who are new to photography, or those who have a little more experience but want something ultra-light and portable for their travels.

Dave Stevenson

SPECIFICATIONS

SENSOR RESOLUTION 16.1 megapixels • **SENSOR SIZE** 17.3x13mm • **FOCAL LENGTH MULTIPLIER** 2x • **VIEWFINDER** None • **LCD SCREEN** 3in (1.04 million dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE** N/A • **WEIGHT** 380g • **DIMENSIONS** 68x117x39mm • **WARRANTY** One year RTB • **DETAILS** www.olympus.co.uk • **PART CODE** V205092BE000

See page 84 for performance details

MIRRORLESS CAMERA

SONY A9

COMPUTER SHOPPER ★★★★★
RECOMMENDED £3,399 •
From www.wexphotovideo.com

VERDICT

A combination of smart design and technical trickery, the Sony A9 is the pinnacle of stills cameras

THE TOP END of the mirrorless camera market is a very different place to the bottom: exotic sensor technology is blended with immense processing power, producing incredible images than can withstand aggressive reproduction.

The Sony A9 is a prime example. It has a 24.2-megapixel, full-frame sensor, and is capable of shooting up to 20fps. Impressively, this number includes mid-burst autofocus and auto-exposure adjustment, theoretically allowing you to track subjects not only as they move through space, but also as they move through different light. There's also in-body image stabilisation, all housed in a weather-sealed, magnesium-alloy body designed to survive all but the most wilful abuse.

AT YOUR FINGERTIPS

Despite all this premium tech, the A9 is far from bulky – it's pleasantly small, if anything – and it's also extraordinarily practical. The mode dial, drive mode, autofocus mode and exposure compensation all get their own physical controls, along with two variable-use dials within easy reach of your index finger and thumb.

The 3in touchscreen doesn't rotate, but can be angled up and down, and it's more than bright and sharp enough to review shots. The electronic viewfinder (EVF) is also a stellar example of its type, being indistinguishable in its display of fine detail from an optical viewfinder, but with the added benefit of live exposure simulation.

The sensor might not be the last word in resolution, but it's not short on pixels, either, and can pull off some impressively fast tricks. The headliner is its maximum continuous raw frame rate, which at 20fps is most of the way to cinematic frame rates and, amazingly, is faster than the Canon EOS-1D X Mark II's 14fps (16fps in its electronic shutter mode) by 6fps.

It helps that the sensor is the first full-frame CMOS sensor with a stacked design, in which the pixel sites are bonded to image processing and DRAM layers, allowing the sensor to read out data extremely quickly. Yet it doesn't just shovel raw data quickly: because autofocus and exposure are performed on the sensor, the A9 is continuously able to calculate both up to 60 times per second, even while the camera is shooting. Both in theory and in practice, that makes the A9 much better at staying focused on a moving subject.

The A9's technical qualities are all for naught if it can't take decent pictures, but Sony's sensational snapper doesn't trip up here either. We tested with Sony's FE 16-35mm F2.8 GM wide-angle lens, and were impressed by the overall sharpness, colour rendition and contrast, straight off the camera.

The results of our ISO tests were frankly ridiculous. With the image zoomed out, our test shots were indistinguishable from each other between the A9's lowest ISO and – incredibly – ISO 12,800. Even with our tests zoomed in all the way, between ISO 100 and ISO 3200 there was no telling images apart.

This all means it's possible to shoot a huge range of shutter speeds or apertures in less than ideal light. Our test images remained broadly acceptable until ISO 25,600, and were just about tolerable at ISO 102,400. The absolute maximum ISO of 204,800 is a party piece best avoided, but make no mistake: the A9 is a low-light beast.

The A9's versatile Sony E-mount also makes it compatible with a huge range of lenses, including Sigma's professional-grade Art line.

The closest thing this camera has to a weakness is its set of video features, albeit only in the sense that these are good rather than great. Footage quality is excellent, and you can shoot in 4K, but unlike a lot of other high-end mirrorless cameras, there's no LOG mode, so you can't shoot flat footage to be graded later.

LEAD IMAGE

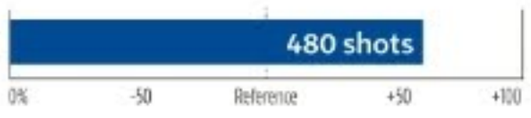
As a stills camera, however, the A9 is remarkable. Whereas lesser cameras can cost you shots with limitations in frame rates, autofocus points and body controls, the only thing acting as a ceiling here is the skill of the user. It's blazingly fast, takes fantastic photos, has extremely tenacious autofocus and is easy to use even with a relatively low number of physical controls.

It's expensive, of course, but when it comes to sheer photography power, it's hard to think of anything technically better.

Dave Stevenson

SPECIFICATIONS

SENSOR RESOLUTION 24.2 megapixels • **SENSOR SIZE** 35.6x23.8mm • **FOCAL LENGTH MULTIPLIER** 1x • **VIEWFINDER** Electronic (3.68 million dots) • **LCD SCREEN** 3in (1.44 million dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE** 0.77x (100%) • **WEIGHT** 588g • **DIMENSIONS** 96x127x63mm • **WARRANTY** One year RTB • **DETAILS** www.sony.co.uk • **PART CODE** N_ILCE9.CEC



See page 84 for performance details

Choosing a... **PC system**

01 A basic PC costing around £350 will be able to run everyday office, multimedia and education software and will easily cope with surfing the internet. It might even be able to run some modern games.

Many PCs can be sold either with or without a monitor. If you don't like the display the manufacturer is offering, you can always use your current one, or buy another one separately.

02 If you want to play games, you'll have to upgrade the graphics card. Budget cards such as the Nvidia GeForce GTX 1050 will cope well with many 3D games, but to play the latest 3D games smoothly (and enjoy the best-quality graphics) it's worth upgrading to a more powerful card such as the Nvidia GeForce GTX 1070.

03 All modern PCs come with at least a dual-core processor and are capable of most tasks. Anyone who regularly undertakes demanding tasks such as video editing and encoding should consider a hexa-core or even an octa-core processor.

04 There are plenty of good reasons to upgrade the PC's memory or hard disk. If you'll use your PC for gaming, video editing or other demanding tasks, you'll need at least 8GB of RAM and a large hard disk; 1TB should suffice. Many new PCs have an SSD, which speeds up the time it takes for your PC to boot and for programs to load.

05 Having plenty of USB ports is always useful, as most computer peripherals attach to these ports. Most new PCs come with USB3 or the latest USB3.1 ports, which provide faster data transfers when used with supported devices than the older USB2 standard.

06 Most new PCs now come with Windows 10 pre-installed. Don't be too easily swayed by the inclusion of other software, though, as it may be that you'll never use it.

07 While most PCs come in cases of a similar size, some have more compact mini tower or mini PC cases. These smaller PCs will fit under your TV or on your desk more easily, but bear in mind that they're significantly harder to upgrade than full-size machines.

PCs

RASPBERRY PI 4 Model B

★★★★★

£34 • thepihut.com

COMPUTER SHOPPER BEST BUY

A faster processor, quicker networking and dual HDMI outputs make the Pi 4 a much better desktop computer than previous Pi models, and it hasn't lost any appeal as a cheap hobbyist board, either. 4K video implementation could be better – we had issues getting smooth playback in Raspbian – but that's the only noteworthy concern.

PROCESSOR 1.5GHz quad-core Broadcom BCM2711 • **RAM** 1GB • **USB PORTS** 1x USB Type-C (power), 2x USB2, 2x USB3 • **STORAGE** MicroSD card slot • **DISPLAY** None • **OPERATING SYSTEM** Raspbian • **WARRANTY** One year RTB • **DETAILS** www.raspberypi.org • **PART CODE** Pi 4 Model B • **FULL REVIEW** Sep 2019

ACER Chromebox CXI3

★★★★★

£528 • uk.insight.com

COMPUTER SHOPPER RECOMMENDED

An absolutely tiny Chrome OS system, the Chromebox CXI3 is compact enough to attach to the back of a monitor. Even better, it has more power than most Chromeboxes, thanks to its Core i5 processor, and is loaded with useful ports in spite of its minimal size. It's cheap, too, although we'd recommend investing in a better mouse and keyboard than the bundled peripherals.

PROCESSOR Quad-core 1.6GHz Intel Core i5-82500U • **RAM** 8GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 3x USB3, 1x USB Type-C • **TOTAL STORAGE** 64GB SSD • **DISPLAY** None • **OPERATING SYSTEM** Chrome OS • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** DT.ZOSEK.001 • **FULL REVIEW** Aug 2019

CCL Paladin

★★★★★

£1,625 • www.cclonline.com

COMPUTER SHOPPER BEST BUY

The Paladin is stuffed with AMD's latest technology, including the excellent octa-core Ryzen 7 3700X CPU and a 4K-capable Radeon RX 5700 XT graphics card. Storage is another highlight: the SSD isn't a PCI-E 4.0 model, which the motherboard is compatible with, but it's still very fast and offers an enormous 1TB of space by itself.

PROCESSOR Octa-core 3.6GHz AMD Ryzen 7 3700X • **RAM** 16GB • **FRONT USB PORTS** 2x USB2, 2x USB3 • **REAR USB PORTS** 2x USB2, 2x USB3, 2x USB3.1, 1x USB Type-C • **TOTAL STORAGE** 1TB SSD, 2TB hard disk • **GRAPHICS CARD** 8GB AMD Ryzen 7 3700X • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years collect and return • **DETAILS** www.cclonline.com • **PART CODE** GAME-PBME 0202 0304 0100 0200 0200 0000 0000 0200 01 • **FULL REVIEW** Nov 2019

PALICOMP AMD Abyss

★★★★★

£700 • www.palicomp.co.uk

COMPUTER SHOPPER BEST BUY

At this price, you'd seriously struggle to find a more comprehensively capable desktop system than Palicomp's AMD Abyss. It can multitask with serious applications just as well as it can run games, and with its large, fast NVMe SSD, it won't be slowed down by storage. There's a lot of room for future upgrades, too.

PROCESSOR Hexa-core 3.6GHz AMD Ryzen 5 2600X • **RAM** 8GB • **FRONT USB PORTS** 2x USB2, 1x USB3 • **REAR USB PORTS** 2x USB2, 2x USB3, 2x USB3.1, 1x USB Type-C • **TOTAL STORAGE** 512GB SSD, 1TB hard disk • **GRAPHICS CARD** 8GB AMD Radeon RX570 Armor 8GB OC • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years RTB • **DETAILS** www.palicomp.co.uk • **PART CODE** RYZ6 • **FULL REVIEW** Apr 2019

Choosing a... **Laptop**

01 A basic laptop costing around £300 will run everyday office, multimedia and education software, but it won't be suitable for 3D gaming or processor-intensive tasks such as video editing. Many laptops at this price have a 15.6in screen and weigh over 2kg, so they're best used around the house and for occasional journeys.

02 If you want to play modern games, you'll need a laptop with a dedicated graphics chip such as the Nvidia GeForce GTX 1060M. Good gaming laptops tend to have large 15.6 or 17in screens and weigh around 3kg, so they're best suited to use at home.

03 If you want a laptop that you can take everywhere, look for a model that weighs less than 2kg. For the best portability, buy one that has a 13.3in or 14in screen. In general, the smaller and lighter the laptop, the more expensive it is, especially if it has plenty of processing power.

04 Battery life is extremely important for a laptop, particularly if you'll be carrying it around. We'd expect all but the biggest and heaviest to last for at least five hours on a single charge, but for an ultraportable that you carry everywhere, eight hours and above is more desirable.

05 Laptops use mobile versions of processors to conserve power, and these lag behind desktop chips when it comes to performance. For a budget Windows laptop, an Intel Core i3 processor will do the job, but if you want better performance, you should look for an Intel Core i5 or Core i7 model instead. We recommend a minimum of 4GB of RAM, although 8GB is better for multitasking.

06 Most budget and mid-range laptops use a mechanical hard disk for storage. You'll want at least 500GB, but 1TB or more is better. Solid-state drives (SSDs) have faster performance, making your computer quicker to boot and more responsive. They have lower capacities, though. You'll need at least 128GB.

07 Convertibles and 2-in-1 laptops can change from laptop mode to tablet mode. We've listed our favourite models later on in this guide in the Tablets section.

LAPTOPS

HP Envy 13

★★★★★

£749 • store.hp.com

COMPUTER SHOPPER BEST BUY

There are plenty of great ultraportables available these days, but most of them cost well over £1,000. The Envy 13 is an extremely attractive alternative: it's slim and light, weighing just 1.2kg, but it has plenty of power and high-end features including a fingerprint reader and dedicated graphics, and what's more, it's relatively affordable.

PROCESSOR Quad-core 1.6GHz Intel Core i5-8250U • **RAM** 8GB • **DIMENSIONS** 307x212x14.9mm • **WEIGHT** 1.2kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Nvidia GeForce MX150 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.hp.com • **PART NUMBER** ah0001na • **FULL REVIEW** Sep 2019

ACER Aspire 5

★★★★☆

£598 • www.amzn.to/2MS5lqc

COMPUTER SHOPPER RECOMMENDED

The Aspire 5 is the epitome of the sensible mid-range laptop. It's not ultra-stylish and it doesn't have a professional-quality display, but for the price it offers reliable performance in a variety of workloads, and it will last a full day on battery power without much trouble.

PROCESSOR Quad-core 1.6GHz Intel Core i5-8250U • **RAM** 8GB • **DIMENSIONS** 382x263x21mm • **WEIGHT** 2.2kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** A515-51-50YS • **FULL REVIEW** Oct 2018

HUAWEI MateBook 14

★★★★★

£1,500 • consumer.huawei.com

COMPUTER SHOPPER BEST BUY

The MateBook 14 is the biggest and best of Huawei's 2019 ultraportables. Like the more expensive MateBook X Pro, it can be equipped with a Core i7 processor, but an airier chassis means that performance isn't compromised to prevent heat build-up. Other highlights include long battery life and Nvidia's updated MX250 GPU.

PROCESSOR Quad-core 1.8GHz Intel Core i7-8565U • **RAM** 16GB • **DIMENSIONS** 308x224x15.9mm • **WEIGHT** 1.5kg • **SCREEN SIZE** 14in • **SCREEN RESOLUTION** 2,160x1,440 • **GRAPHICS ADAPTOR** Nvidia GeForce MX250 • **TOTAL STORAGE** 512GB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** Two years RTB • **DETAILS** consumer.huawei.com • **PART CODE** KLV-W29 • **FULL REVIEW** Jun 2019

ASUS ROG Strix Scar III

★★★★☆

£2,599 • www.amzn.to/2Mxdeoy

COMPUTER SHOPPER RECOMMENDED

The ROG Strix Scar III compromises nothing in its pursuit of top-quality portable gaming. While this means a high price, it also means a 240Hz display, an incredibly powerful Core i9 processor and Nvidia's high-end RTX 2070 GPU. Despite not being a true thin-and-light gaming laptop, it's not too heavy and unwieldy, either.

PROCESSOR Octa-core 2.3GHz Intel Core i9-9980H • **RAM** 32GB • **DIMENSIONS** 360x275x24.9mm • **WEIGHT** 2.57kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** 8GB Nvidia GeForce RTX 2070 • **TOTAL STORAGE** 1TB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.asus.com • **PART CODE** G531GW-AZ055R • **FULL REVIEW** Oct 2019

Choosing an... Internal hard disk

01 A basic 1TB internal hard disk should cost around £40. This will be fast enough for general use and will provide enough storage for most users.

Make sure the hard disk you choose has the appropriate interface type for your PC. Most hard disks and solid-state drives (SSDs) use the SATA3 interface, which enables faster speeds than the older SATA2. Pretty much every motherboard released in recent years will have multiple SATA3 ports, allowing you to connect several storage drives at once.

02 SSDs can make the most of SATA3's high bandwidth for fast file transfers. They use flash memory similar to that found in USB flash drives, and although they tend to provide less capacity than mechanical hard disks, they're significantly faster. More expensive SSDs use the NVMe standard, which is even faster than SATA3, but require an M.2 slot on the motherboard.

03 Buy a hard disk that provides more capacity than you think you need, as your storage requirements are likely to grow. A 2TB disk strikes the best balance between capacity and low cost per gigabyte.

04 If you want more disk space or you want to protect your data against disk failure, think about buying several hard disks to create a RAID array. These use multiple hard disks to create one large logical disk with better performance, or to duplicate your data for better protection. RAID arrays require hard disks of the same size. In theory, they can be from different manufacturers, but it's better to buy identical disks if you can.

05 A hard disk's spindle speed determines how quickly it can transfer data. A spindle speed of 7,200rpm is common in desktop drives and is fast enough for most purposes. Desktop hard disks with 5,400rpm spindle speeds are quite slow but use less power and generate less heat and noise.

To strike the best balance between speed and storage capacity, use an SSD as your system disk and store your files on a larger mechanical disk.

STORAGE

SYNOLOGY DiskStation DS418j

★★★★★

£284 • www.broadbandbuyer.com

COMPUTER SHOPPER BEST BUY

When a tiny two-bay NAS won't cut it, the fast, high-capacity DiskStation DS418j is an excellent upgrade, especially as it can automatically convert old hard disks to be compatible with this NAS's hardware and features.

3.5in HARD DISK BAYS (FREE) 4 (4) • **NETWORKING** 1x 10/100/1,000 Ethernet • **DLNA MEDIA SERVER** Yes • **PRINT SERVER** Yes • **DIMENSIONS** 184x168x230mm • **WEIGHT** 2.21kg • **WARRANTY** Two years RTB • **DETAILS** www.synology.com • **PART CODE** DS418j • **FULL REVIEW** Jan 2018

INTEL Optane Memory 32GB

★★★★☆

£60 • www.currys.co.uk

COMPUTER SHOPPER RECOMMENDED

An interesting twist on M.2 SSDs, Optane Memory isn't so much a dedicated storage drive as a large cache for your existing hard disk, accelerating its read speeds to NVMe levels at a much lower price.

CAPACITY 32GB • **PRICE PER GIGABYTE** £1.88 • **INTERFACE** M.2/NVMe • **WARRANTY** Five years RTB • **DETAILS** www.intel.com • **PART CODE** MEMPEK1W032GAXT • **FULL REVIEW** Sep 2017

ADATA XPG SX8200 Pro 1TB

★★★★★

£131 • www.cclonline.com

COMPUTER SHOPPER BEST BUY

The Adata XPG SX8200 Pro is outrageously good value for the performance it delivers. It's as fast as or faster than top-tier SSDs from Samsung and WD, but costs far less across all its capacity options.

CAPACITY 1TB • **COST PER GIGABYTE** £0.13p • **INTERFACE** M.2/NVMe • **WARRANTY** Five years RTB • **DETAILS** www.xpg.com • **PART CODE** ASX8200PNP-1TT • **FULL REVIEW** Apr 2019

ADATA SD600Q 480GB

★★★★☆

£64 • www.alternate.co.uk

COMPUTER SHOPPER RECOMMENDED

Put aside your fears about external SSDs being too expensive compared to hard disks – this 480GB drive is excellent value, and decently quick.

CAPACITY 480GB • **COST PER GIGABYTE** £0.13p • **INTERFACE** USB3 • **CLAIMED READ** 440MB/s • **CLAIMED WRITE** 430MB/s • **WARRANTY** Three years RTB • **DETAILS** www.adata.com • **PART CODE** ASD600Q-480GU31-CBL • **FULL REVIEW** Aug 2019

SAMSUNG Portable SSD X5 1TB

★★★★★

£439 • www.scan.co.uk

COMPUTER SHOPPER BEST BUY

For when you absolutely need to shift files as quickly as possible, there's the X5. Its use of the Thunderbolt 3 interface makes it the fastest external SSD ever.

CAPACITY 1TB • **COST PER GIGABYTE** £0.44p • **INTERFACE** Thunderbolt 3 • **WARRANTY** Three years RTB • **DETAILS** www.samsung.com/uk • **PART CODE** MU-PB1T0B/WW • **FULL REVIEW** Dec 2018

KINGSTON A2000

NEW ENTRY

★★★★★

£114 • www.scan.co.uk

COMPUTER SHOPPER BEST BUY

The A2000's maximum speeds don't look all that hot, but this SSD performs exceptionally well in the kinds of non-sequential transfer tasks you're more likely to actually undertake in your day-to-day computing.

CAPACITY 1TB • **COST PER GIGABYTE** £0.11p • **INTERFACE** M.2/NVMe • **CLAIMED READ** 2,200MB/s • **CLAIMED WRITE** 2,000MB/s • **WARRANTY** Five years RTB • **DETAILS** www.kingston.com • **PART CODE** SA2000M8/1000G • **FULL REVIEW** Dec 2019

Choosing a... **Graphics card**

01 You don't have to spend much to buy a decent graphics card that can drive multiple monitors. The AMD Radeon RX 550 costs about £100, for example, and while it isn't suited to playing the latest games in Full HD, it is perfect for watching videos, browsing the web and playing basic games.

02 You'll need to spend more money if you want to play the latest games. A good mid-range gaming graphics card is the Nvidia GeForce GTX 1060, which is powerful enough to play all modern games at Full HD resolution.

High-powered cards tend to be more expensive, so expect to pay over £400 if you want to play games in Ultra HD at the highest quality settings.

03 Check that your chosen card has the graphics outputs you need. Only low-end cards now have VGA outputs, but many come with a DVI-to-VGA adaptor. Depending on your monitor, you may also want an HDMI output or even DisplayPort connection.

Bear in mind that AMD's Eyefinity triple-monitor gaming mode requires at least one DisplayPort monitor, which means your AMD graphics card must have at least one DisplayPort output. Nvidia's Surround three-monitor mode needs only DVI and HDMI ports.

04 The amount of memory a card has is important if you want games to look their best at high resolutions. Unless you're on a tight budget, get a card with 4GB of RAM, as this should allow you to select the highest-quality textures in games.

05 A card's size, noise output and power requirements are the final considerations. Make sure your PC's case has enough room to accommodate your chosen card. Double-slot cards with large fans tend to be quieter than single-slot cards with small fans but will block other expansion slots on your motherboard.

Also check that your power supply can provide the power the card needs and that it has the right connectors. Many cards require a six-pin PCI Express power connector, and some also need an additional eight-pin connector.

COMPONENTS

AMD Ryzen 9 3900X

★★★★☆

£550 • www.ebuyer.com

COMPUTER SHOPPER RECOMMENDED

Forget the Intel Core i9-9900K – this 12-core monster of a CPU performs far better for similar money. There is a drawback, in that it's not very overclocking-friendly, but that's partly because it's so fast to begin with. Pair it with some good RAM, and you're already most of the way to a capable home workstation.

SOCKET AM4 • **CORES** 12 • **FREQUENCY** 3.8GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** 100-100000023BOX • **FULL REVIEW** Nov 2019

AMD Radeon RX 5700

★★★★★

£290 • shop.amd.com

COMPUTER SHOPPER BEST BUY

AMD's 7nm GPU is cheaper than the GeForce RTX 2060 and the RTX 2060 Super, yet is just as comfortable with gaming at 1080p and 1440p. This price only seems to apply for the reference design rather than partner versions, but the blower-style cooler is the only real downside.

GPU AMD Radeon RX 5700 • **MEMORY** 8GB GDDR6 • **GRAPHICS CARD LENGTH** 268mm • **WARRANTY** One year RTB • **DETAILS** www.amd.com • **PART CODE** Radeon RX 5700 • **FULL REVIEW** Oct 2019

AMD Ryzen 7 3700X

★★★★★

£313 • www.amzn.to/2nFtHMC

COMPUTER SHOPPER BEST BUY

This octa-core chip has all the single-core strength of the Ryzen 9 3900X, with mutlitasking power that still puts it well beyond its Intel rivals. Low pricing and power efficiency are additional highlights: the Ryzen 7 3700X only draws up to 65W, a tiny amount for this many cores.

SOCKET AM4 • **CORES** 8 • **FREQUENCY** 3.6GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** 100-100000071BOX • **FULL REVIEW** Dec 2019

THERMALTAKE View 37

★★★★★

£109 • www.scan.co.uk

COMPUTER SHOPPER BEST BUY

A spacious, feature-rich chassis for both ATX- and EATX-based builds, the View 37 comes with a gull-wing side window that's perfect for showing off your handiwork.

CASE TYPE Mid-tower • **MOTHERBOARD TYPE** ATX, EATX, microATX, Mini-ITX • **SUPPLIED FANS** 2x 140mm • **MAX DRIVE BAYS** 7x 3.5in, 11x 2.5in • **DIMENSIONS** 525x261x538mm • **WEIGHT** 11.8kg • **WARRANTY** Three years RTB • **DETAILS** www.thermaltake.com • **PART CODE** CA-1J7-00M1WN-00 • **FULL REVIEW** Dec 2018

ASUS ROG Strix Flare

★★★★★

£120 • www.game.co.uk

COMPUTER SHOPPER BEST BUY

Besides being a comfortable and responsive gaming keyboard, thanks to its reliable Cherry MX Red switches, the ROG Strix Flare is loaded with useful features and extras: there's a set of dedicated media controls and a USB2 pass-through port, among others.

KEYBOARD SHAPE Full size • **NUMBER PAD** Yes • **CONNECTION** 1x USB2 • **MEDIA KEYS** Pause/play, mute, skip, volume • **USB PORTS** 2x USB2 • **WARRANTY** One year RTB • **DETAILS** www.asus.com/uk • **PART CODE** 90MP000MO-BOEA00 • **FULL REVIEW** Oct 2019

MSI MPG Z390 Gaming Edge AC

★★★★★

£140 • www.scan.co.uk

COMPUTER SHOPPER BEST BUY

From built-in 802.11ac Wi-Fi and Bluetooth to high-end audio connectivity, the MPG Z370 Gaming Edge AC is stuffed with features. Add in a good price, easy overclocking and a well-designed BIOS, and it's perfect for premium Intel-based builds.

PROCESSOR SOCKET LGA1151 • **DIMENSIONS** 305x244mm • **CHIPSET** Intel Z390 • **MEMORY SLOTS** 4 • **PCI-E x16 SLOTS** 3 • **PCI-E x1 SLOTS** 3 • **PCI SLOTS** 0 • **USB PORTS** 2x USB2, 2x USB3, 1x USB3.1, 1x USB Type-C • **VIDEO OUTPUTS** 1x HDMI, 1x DisplayPort • **WARRANTY** One year RTB • **DETAILS** www.msi.com • **PART CODE** MPG Z390 Gaming Edge AC • **FULL REVIEW** Apr 2019

Choosing a... **Custom PC spec**

01 Building your own PC is often cheaper than buying a pre-made system, and gives full control over the components. You don't need any special computer knowledge: just a few spare hours, a screwdriver and your choice of parts. Even things such as liquid-cooling systems can be found in user-friendly, easy-to-install packages, and for the most part it's as simple as inserting each component into a particular slot.

02 Arguably the most important component is the CPU. These days you can get a quad-core chip even on a tight budget, which should provide more than enough brainpower for simple tasks such as web browsing, but hexa-core and octa-core chips are better for tougher jobs such as media editing, gaming and content creation.

The CPU will also determine which motherboards you can choose from. Intel CPUs will only work with boards that use an Intel chipset, like Z390, Z370 and B360, while AMD processors need AMD chipsets, such as X470 and B450.

03 When choosing a motherboard, think about both the size of the PC's chassis (smaller cases won't fit larger ATX or EATX boards, for instance) and how many additional components you'll want to install. For systems with a lot of expansion cards (such as graphics cards, sound cards or Wi-Fi cards), it's best to go with ATX motherboards and larger. For simpler builds, microATX or Mini-ITX boards could well provide all the connectivity you need. Keep in mind, too, that if you want to try overclocking, only certain Intel chipsets will support it, such as Z370 and Z390. AMD is more relaxed, enabling overclocking on all its Ryzen-compatible chipsets, except A320 and A300.

04 While CPU integrated graphics will suffice for everyday browsing, a dedicated graphics card is essential for high-quality gaming. These can be installed in a PCI-E x16 slot on your motherboard, and have the bonus of adding more display outputs to use – just make sure the card will fit inside your chosen case.

05 On the subject of cases, personal taste will factor highly here: nobody wants an ugly PC. That said, picking a chassis with adequate space for components is vital. As already mentioned, an ATX motherboard likely won't fit in a mini-tower case, and if you want to install a lot of hard disks, you'll need a case with sufficient drive bays.

06 Every PC requires RAM and a PSU. Performance doesn't vary much between specific models, but generally you should aim for 8GB of RAM for a basic build and 16GB for higher-end systems, and at least a 550W, Bronze-certified PSU. It's better to buy a higher-wattage PSU than you strictly need, as it will allow you to add more components in the future. Also, check which RAM is compatible with your motherboard before buying, although for all current models it's probably going to be DDR4.

07 Our recommended storage setup comprises both an SSD and a larger mechanical hard disk. By installing Windows (and a few choice applications) on the SSD, you can ensure fast booting and loading times, while the HDD is a cost-effective way of storing lots of files. Alternatively, you could buy a hard disk, and then install an Intel Optane Memory module to accelerate its write speeds to SSD levels, although since SSDs are barely more expensive than Optane drives, this is perhaps better for situations when you want to upgrade from an existing hard disk, rather than when you're building a whole new system. In the latter case, an SSD/HDD combo is better all round. See page 58 for our recommended storage drives.

BUDGET PCs

AMD Ryzen 3 2200G

★★★★☆

£77 • **www.amzn.to/2TImlHh**

COMPUTER SHOPPER RECOMMENDED

This plucky quad-core chip is decently fast, comes bundled with its own cooler and – unlike most Ryzen chips – includes integrated Radeon RX Vega graphics. It's therefore particularly ideal if you don't need the added power of dedicated graphics.

SOCKET AM4 • **CORES** 4 • **FREQUENCY** 3.4GHz • **INTEGRATED GRAPHICS** AMD Radeon RX Vega 8 • **WARRANTY** Three years RTB • **DETAILS** www.amd.com • **PART CODE** YD2200C5FBBOX • **FULL REVIEW** Jul 2018

ASROCK Fatal1ty AB350 Gaming-ITX/ac

★★★★★

£98 • **www.cclonline.com**

COMPUTER SHOPPER RECOMMENDED

Tiny it may be, but the AB350 makes the most of what space it has available. Multiple display outputs, a rear-mounted M.2 port and onboard Wi-Fi mean it almost has the specs of a respectable ATX model.

PROCESSOR SOCKET AM4 • **DIMENSIONS** 170x170mm • **CHIPSET** AMD B350 • **MEMORY SLOTS** 2 • **PCI-E X16 SLOTS** 1 • **PCI-E X1 SLOTS** 0 • **PCI SLOTS** 0 • **USB PORTS** 2x USB2, 2x USB3, 1x USB Type-C • **VIDEO OUTPUTS** 2x HDMI • **WARRANTY** One year RTB • **DETAILS** www.asrock.com • **PART CODE** 90-MXB5P0-A0UAYZ • **FULL REVIEW** Jul 2018

SILVERSTONE Precision Series PS15

★★★★☆

£40 • **www.scan.co.uk**

COMPUTER SHOPPER RECOMMENDED

As long as you work within its limit as a microATX chassis, the PS15 is a great fit for budget builds. Despite costing a pittance, it's well designed and can take a multitude of fans and radiators, so all-in-one watercooling is a possibility for future upgrades.

CASE TYPE Mini tower • **MOTHERBOARD TYPE** MicroATX, Mini-ITX • **SUPPLIED FANS** 1x 120mm • **MAXIMUM DRIVE BAYS** 1x 3.5in, 3x 2.5in • **DIMENSIONS** 381x192x351mm • **WEIGHT** 3.5kg • **WARRANTY** One year RTB • **DETAILS** www.silverstonetk.com • **PART CODE** SST-PS15B-G • **FULL REVIEW** Aug 2019

ASUS ROG Strix RX 570 OC

★★★★★

£130 • **www.awd-it.co.uk**

COMPUTER SHOPPER BEST BUY

Although this is an older GPU, it's cheaper than a lot of the more recent 'budget' cards and, crucially, more powerful, too. It therefore comes highly recommended if you want to take a step up from integrated graphics without having to spend much.

GPU AMD Radeon RX 570 • **MEMORY** 4GB GDDR5 • **GRAPHICS CARD LENGTH** 240mm • **WARRANTY** Two years repair and replace • **DETAILS** www.asus.com • **PART CODE** ROG-STRIX-RX570-O4G-GAMING • **FULL REVIEW** Jan 2020

MID-RANGE PCs

AMD Ryzen 7 2700X

★★★★★

£174 • www.amzn.to/2JvaEyC

COMPUTER SHOPPER BEST BUY

AMD's second generation of Ryzen processors gets off to an auspicious start with the mighty Ryzen 7 2700X. It's faster than Intel's equivalent Core i7-8700K at stock speeds, despite being cheaper, and temperatures stay nice and low even when overclocking.

SOCKET AM4 • **CORES** 8 • **FREQUENCY** 3.7GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** YD270XBGAFBOX • **FULL REVIEW** Aug 2018

MSI B350M Mortar

★★★★★

£100 • www.amzn.to/2zuBbF1

COMPUTER SHOPPER BEST BUY

A near-perfect motherboard for AMD Ryzen-based microATX systems. It's remarkably well equipped for connectivity and upgradability, and comes close to much more expensive mobos in performance benchmarks.

PROCESSOR SOCKET AM4 • **DIMENSIONS** 244x244mm • **CHIPSET** AMD B350 • **MEMORY SLOTS** 4 • **PCI-E X16 SLOTS** 2 • **PCI-E X1 SLOTS** 2 • **PCI SLOTS** 0 • **USB PORTS** 2x USB2, 3x USB3.1, 1x USB Type-C • **VIDEO OUTPUTS** 1x HDMI, 1x DisplayPort, 1x DVI-D • **WARRANTY** One year RTB • **DETAILS** www.msi.com • **PART CODE** B350M Mortar • **FULL REVIEW** Jul 2018

AMD Radeon RX 5700

★★★★★

£290 • shop.amd.com

COMPUTER SHOPPER BEST BUY

AMD's 7nm GPU is cheaper than both the GeForce RTX 2060 and the RTX 2060 Super, yet is just as comfortable with gaming at 1080p and 1440p. This low price only seems to apply for the reference design rather than partner versions, but the blower-style cooler is the only real downside.

GPU AMD Radeon RX 5700 • **MEMORY** 8GB GDDR6 • **GRAPHICS CARD LENGTH** 268mm • **WARRANTY** One year RTB • **DETAILS** www.amd.com/uk • **PART CODE** Radeon RX 5700 • **FULL REVIEW** Oct 2019

COOLER MASTER MasterBox K500

★★★★☆

£75 • www.scan.co.uk

COMPUTER SHOPPER RECOMMENDED

Great looks, a full set of pre-installed fans, high build quality and a spacious interior: the MasterBox K500 is a commendable all-rounder. It's not the best on storage capacity, but you can still add at least a couple of SSDs and hard disks each.

CASE TYPE Mid-tower • **MOTHERBOARD TYPE** ATX, microATX, Mini-ITX • **SUPPLIED FANS** 3x 120mm • **MAX DRIVE BAYS** 3x 3.5in, 2x 2.5in • **DIMENSIONS** 260xx190x280mm • **WEIGHT** 6.2kg • **WARRANTY** Two years RTB • **DETAILS** www.coolermaster.com • **PART CODE** MCB-K500D-KGNN-S00 • **FULL REVIEW** Jan 2019

PREMIUM PCs

AMD Ryzen 9 3900X

★★★★☆

£550 • www.ebuyer.com

COMPUTER SHOPPER RECOMMENDED

Forget the Intel Core i9-9900K – this 12-core monster of a CPU performs far better for similar money. There is a drawback, in that it's not very overclocking-friendly, but that's partly because it's so fast to begin with. Pair it with some good RAM, and you're already most of the way to a capable home workstation.

SOCKET AM4 • **CORES** 12 • **FREQUENCY** 3.8GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** 100-100000023BOX • **FULL REVIEW** Nov 2019

ASUS ROG Strix Flare

★★★★★

£120 • www.game.co.uk

COMPUTER SHOPPER BEST BUY

Besides being a comfortable and responsive gaming keyboard, largely thanks to its always-reliable Cherry MX Red switches, the ROG Strix Flare is loaded with useful features and cool extras: there's a set of dedicated media controls and a USB2 pass-through port, among others.

KEYBOARD SHAPE Full size • **NUMBER PAD** Yes • **CONNECTION** 2xUSB2 • **MEDIA KEYS** Pause/play, mute, skip, volume • **USB PORTS** 2x USB2 • **WARRANTY** One year RTB • **DETAILS** www.asus.com/uk • **PART CODE** 90MP000MO-BOEA00 • **FULL REVIEW** Oct 2019

THERMALTAKE View 37

★★★★★

£109 • www.scan.co.uk

COMPUTER SHOPPER BEST BUY

A spacious, feature-rich chassis for both ATX- and EATX-based builds, the View 37 comes with a gull-wing side window that's perfect for showing off your handiwork.

CASE TYPE Mid-tower • **MOTHERBOARD TYPE** ATX, EATX, microATX, Mini-ITX • **SUPPLIED FANS** 2x 140mm • **MAXIMUM DRIVE BAYS** 7x 3.5in, 11x 2.5in • **DIMENSIONS** 525x261x538mm • **WEIGHT** 11.8kg • **WARRANTY** Three years RTB • **DETAILS** www.thermaltake.com • **PART CODE** CA-1J7-00M1WN-00 • **FULL REVIEW** Dec 2018

AMD Radeon RX 5700 XT

★★★★☆

£329 • shop.amd.com

COMPUTER SHOPPER RECOMMENDED

The standard RX 5700 is better value for lower resolutions, but if you want to play at 4K without the expense of Nvidia's top RTX graphics cards, the RX 5700 XT's higher core count and clock speeds make it a great choice.

GPU AMD Radeon RX 5700 XT • **MEMORY** 8GB GDDR6 • **GRAPHICS CARD LENGTH** 272mm • **WARRANTY** One year RTB • **DETAILS** www.amd.com/uk • **PART CODE** Radeon RX 5700 XT • **FULL REVIEW** Oct 2019

Choosing a... **Display**

01 A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to sit straight on for the best picture quality. Its colour accuracy may not be very good, either.

02 A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analogue or analogue-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

Many DVI and all HDMI connections support HDCP, which lets you watch protected video content, such as Blu-ray movies. DisplayPort is becoming more popular, but you'll need a graphics card with a DisplayPort output (mini or full-size) to use this input on your monitor.

03 A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have a resolution of at least 1,920x1,080 (1080p), which provides lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You'll need a graphics card with a dual-link DVI output and a dual-link DVI cable or either HDMI or DisplayPort to use a monitor at these resolutions.

04 If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don't have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don't be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

DISPLAYS

LG 34GK950F

★★★★★

£1,150 • www.overclockers.co.uk

COMPUTER SHOPPER BEST BUY

LG's curved ultrawide monitor is as versatile as it is vibrant. HDR is supported (if only to the DisplayHDR 400 standard), colours are accurate, and both AMD FreeSync and Nvidia G-Sync can smooth out games.

SCREEN SIZE 34in • **RESOLUTION** 3,440x1,440 • **REFRESH RATE** 144Hz • **SCREEN TECHNOLOGY** IPS • **VIDEO INPUTS** HDMI, DisplayPort • **WARRANTY** Three years collect and return • **DETAILS** www.lg.com • **FULL REVIEW** Jun 2019

IIYAMA G-Master Black Hawk G2530HSU-B1

★★★★☆

£130 • www.box.co.uk

COMPUTER SHOPPER RECOMMENDED

A fine alternative monitor to the AOC G2460VQ6, also with a 75Hz refresh rate as well as FreeSync support for tear-free gaming on AMD graphics cards. The slim-bezel design is good for the money, too.

SCREEN SIZE 24in • **RESOLUTION** 1,920x1,080 • **SCREEN TECHNOLOGY** TN • **VIDEO INPUTS** HDMI, DisplayPort, VGA • **WARRANTY** Two years onsite • **DETAILS** www.iiyama.com • **PART CODE** G2530HSU-B1 • **FULL REVIEW** Mar 2019

EIZO ColorEdge CG279X

★★★★★

£1,699 • www.wexphotovideo.com

COMPUTER SHOPPER RECOMMENDED

This professional-quality monitor benefits from automatic calibration, ensuring practically perfect colour accuracy and wide coverage of the sRGB, DCI-P and Adobe RGB gamuts. It's a worthwhile investment for editing photos and videos.

SCREEN SIZE 27in • **RESOLUTION** 2,560x1,440 • **SCREEN TECHNOLOGY** IPS • **REFRESH RATE** 60Hz • **VIDEO INPUTS** VGA, HDMI, DisplayPort, DVI, USB Type-C • **WARRANTY** Five years RTB • **DETAILS** www.eizoglobal.cpm • **FULL REVIEW** Jun 2019

AOC CQ32G1

★★★★★

£340 • www.box.co.uk

COMPUTER SHOPPER BEST BUY

AOC has a habit of making great-value, large-screened VA monitors, and the CQ32G1 is another to add to the list. A 144Hz gaming display first and foremost, it's as fast and good-looking as it needs to be, and supports both AMD FreeSync and, unofficially, Nvidia G-Sync.

SCREEN SIZE 31.5in • **RESOLUTION** 2,560x1,440 • **SCREEN TECHNOLOGY** VA • **REFRESH RATE** 144Hz • **VIDEO INPUTS** HDMI, DisplayPort • **WARRANTY** One year repair and replace • **DETAILS** eu.aoc.com • **FULL REVIEW** Nov 2019

ACER Nitro VG270UP

★★★★★

£370 • uk-store.acer.com

NEW ENTRY

COMPUTER SHOPPER BEST BUY

A great all-round gaming monitor without the premium price. Both FreeSync and G-Sync are supported, and the IPS panel combines a 144Hz refresh rate with vibrant colours, high accuracy and the kind of responsiveness you'd normally only get from a TN panel.

SCREEN SIZE 27in • **RESOLUTION** 2,560x1,440 • **SCREEN TECHNOLOGY** IPS • **REFRESH RATE** 144Hz • **VIDEO INPUTS** HDMI, DisplayPort • **WARRANTY** Two years RTB • **DETAILS** www.acer.com • **FULL REVIEW** Dec 2019

IIYAMA ProLite XUB2792UHSU

★★★★☆

£380 • www.amzn.to/2TTlMac

COMPUTER SHOPPER RECOMMENDED

If you don't need all the bells and whistles of a curved ultrawide, the ProLite XUB2792UHSU nails the basics at a very attractive price. 4K sharpness, high brightness and full sRGB colour gamut coverage add up to a superb monitor.

SCREEN SIZE 27in • **RESOLUTION** 3,840x2,160 • **SCREEN TECHNOLOGY** IPS • **REFRESH RATE** 60Hz • **VIDEO INPUTS** DisplayPort, HDMI, DVI • **WARRANTY** Three years onsite • **DETAILS** www.iiyama.com • **FULL REVIEW** Nov 2019

Choosing an... Inkjet printer

01 You should be able to buy a decent inkjet printer for less than £40. High-quality printing is possible on such a printer, but it will be slow. The actual print speed of an inkjet can be half the quoted (maximum) speed for text documents, and even slower when printing graphics. Budget inkjet printers such as these are designed only for light use and can be expensive to run.

02 For £80 to £90 you can buy a more capable printer that's either faster and better built or better at reproducing photos. If documents are your priority, you'll want a high minimum speed and low print costs. Look for inkjets that can handle all your office media, such as envelopes and labels.

03 If photos are your priority, speed is less important. Choose a printer that reproduces subtle tones well. You can't determine this by looking at the specifications – only hands-on testing will do, so remember to check our reviews before you buy.

Borderless printing (up to the edge of the paper) should also be possible. Pay particular attention to running costs: photos use three times as much ink as regular colour documents.

04 Heavy-duty office inkjets can cost up to £1,000 and their build quality is improving. They use large individual ink tanks, which can cut running costs. Printers with automatic duplex (double-sided) printing or A3 capabilities are now much more affordable.

05 Pricier photo printers let you print from memory cards plugged straight into the printer, so you don't need to use a PC. An LCD preview screen offers greater control for this method of printing. Many inkjet printers now have a PictBridge USB port, which you can use to print images directly from most digital cameras.

06 If you're really serious about photography, consider buying an inkjet that can produce borderless prints up to A3 size. The best devices can print photos that look nearly as good as those from professional labs.

PRINTERS & SCANNERS

EPSON WorkForce WF-7710DWF

★★★★★

£155 • www.amzn.to/2JVaD3B

COMPUTER SHOPPER BEST BUY

The WorkForce WF-7710DWF allows you to print at the larger A3+ paper size, as well as fax and scan at A3, so it's great for home office users who require a bit more flexibility from their MFP.

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x2,400dpi • **DIMENSIONS** 340x567x452mm • **WEIGHT** 18.7kg • **MAXIMUM PAPER SIZE** A3+ • **WARRANTY** One year RTB • **DETAILS** www.epson.co.uk • **PART CODE** C11CG36411 • **FULL REVIEW** Nov 2018

EPSON EcoTank ET-M3180

★★★★☆

£398 • www.printerland.co.uk

COMPUTER SHOPPER RECOMMENDED

If you need to pump out black-and-white documents, the ET-M3180 is a great alternative to a bulky laser MFP. This ADF-equipped printer and scanner is impressively fast and, like the rest of the EcoTank range, has incredibly low per-page running costs.

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 2,400x1,200dpi • **DIMENSIONS** 375x347x346mm • **WEIGHT** 7.2kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** Three years onsite • **DETAILS** www.epson.co.uk • **PART CODE** C11CG93402BY • **FULL REVIEW** Nov 2019

HP OfficeJet Pro 7720

★★★★★

£150 • www.currys.co.uk

COMPUTER SHOPPER BUSINESS BUY

The OfficeJet Pro 7720 strikes a fine balance between price, performance and features, making it ideal for home offices and small businesses – especially those that could use A3 printing.

TECHNOLOGY Thermal inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x1,200dpi • **SCANNER RESOLUTION** 1,200x1,200dpi • **DIMENSIONS** 307x445x585mm • **WEIGHT** 15.5kg • **MAXIMUM PAPER SIZE** A3 (print only) • **WARRANTY** Three years RTB • **DETAILS** www.hp.co.uk • **PART CODE** Y0S18A • **FULL REVIEW** Dec 2017

CANON Pixma TS205

★★★★☆

£29 • www.ebuyer.com

COMPUTER SHOPPER RECOMMENDED

It has a basic feature set and isn't very fast, but the Pixma TS205's print quality makes it a bargain. Replacement ink cartridges are the biggest expense, but that's fine if you're only printing at home occasionally.

TECHNOLOGY Thermal inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x1,200dpi • **DIMENSIONS** 131x426x255mm • **WEIGHT** 2.5kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** 2319C008 • **FULL REVIEW** Sep 2019

CANON imageFormula DR-C230

★★★★☆

£267 • www.ebuyer.com

COMPUTER SHOPPER RECOMMENDED

This sheet-fed document scanner is perfect for getting through stacks of documents without having to manually scan each page. It's pleasantly fast and pairs with Canon's powerful CaptureOnTouch Pro software, which does a fine job of processing your scans.

TECHNOLOGY Dual CIS sheet-fed scanner • **SCANNER RESOLUTION** 600x600dpi • **DIMENSIONS** 231x291x530mm • **WEIGHT** 2.8kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** 2646C003 • **FULL REVIEW** Feb 2018

EPSON EcoTank ET-7750

★★★★☆

£539 • www.jessops.com

COMPUTER SHOPPER RECOMMENDED

Like all EcoTank MFPs, the ET-7750 offsets its high price with low running costs, and this specific model delivers sharp, solid colours that suit photo printing well.

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 5,760x1,440 • **SCANNER RESOLUTION** 1,200x2,400dpi • **DIMENSIONS** 168x526x415mm • **WEIGHT** 10.5kg • **MAXIMUM PAPER SIZE** A3 • **WARRANTY** One year RTB • **DETAILS** www.epson.co.uk • **PART CODE** C11CG16401CE • **FULL REVIEW** Sep 2018

Choosing a... **Wireless router**

01 Wireless routers each use a number of Wi-Fi standards, so you shouldn't have any trouble connecting your computer or phone wirelessly if you get an 802.11n or 802.11ac router. Nearly all routers support 802.11n, so even a cheap model should provide decent performance.

You can expect a transfer speed of around 40Mbit/s at a distance of 10m from any modern 802.11n router. The very latest routers use the 802.11ac standard, which provides tremendously fast transfer speeds. Some devices still don't support the 802.11ac standard, so check the specifications before you buy.

02 If you subscribe to an ADSL broadband service, you should buy a wireless router that has a built-in ADSL modem. This will cost more than the equivalent cable router, but it allows you to connect your router directly to your broadband connection without having to use a separate modem.

03 Most 802.11n wireless routers use the 2.4GHz frequency band. This has good range but it can be prone to interference if it's positioned close to a lot of other 2.4GHz devices, such as other routers and baby monitors. If you have trouble getting a consistent signal or you want faster speeds for video streaming, for example, it's worth buying a dual-band router that can use both the 2.4GHz and 5GHz bands.

Alternatively, a high-gain antenna can boost signals and improve ranges and throughputs to the entire house. You can also add a high-gain antenna to a PC's network adaptor. If wired network speeds are a priority, you should look for a router with a Gigabit Ethernet connection.

04 Many routers come with built-in USB ports that let you connect a USB drive and use the router as a network storage device. If you want to share a USB printer over your network, look for a wireless router that has a USB print server.

Finally, if you're interested in making voice calls over the internet, buy a router with built-in VoIP support (and phone sockets) because this can save you money.

NETWORKS

BT Complete Wi-Fi

★★★★☆

£5 per month • www.bt.com

COMPUTER SHOPPER RECOMMENDED

There are better-featured mesh systems available, but the Complete Wi-Fi is decently quick on both the 5GHz and 2.4GHz bands, and is well worth it for BT Plus customers in particular.

WI-FI STANDARD 802.11ac • **STATED SPEED** 1,733Mbit/s (5GHz), 385Mbit/s (2.4GHz) • **USB PORTS** 1 • **WALL MOUNTABLE** No • **WARRANTY** Under rental contract • **PART CODE** BT Complete Wi-Fi • **FULL REVIEW** Mar 2019

TP-LINK Archer C5400

★★★★★

£240 • www.currys.co.uk

COMPUTER SHOPPER RECOMMENDED

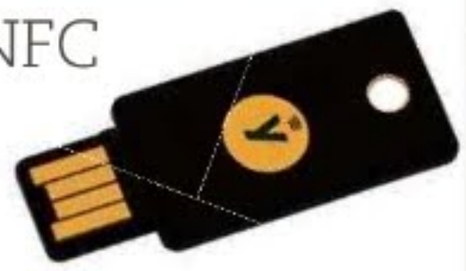
Although this isn't the fastest £200-plus router, it's still speedy, and comes with an impressive array of features, from parental controls and filters to BT YouView support and smart home integration.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 2x 2,167Mbit/s (5GHz), 2x 1,000MBit/s (2.4GHz) • **USB PORTS** 1x USB2, 1x USB3 • **WALL MOUNTABLE** Yes • **WARRANTY** One year RTB • **PART CODE** C5400 • **FULL REVIEW** May 2018

YUBICO YubiKey 5 NFC

★★★★☆

£38 • www.yubico.com



COMPUTER SHOPPER RECOMMENDED

Like the YubiKey 4 before it, this USB stick conveniently stores all the cryptographic data you need to add two-factor authentication to a PC or laptop; and this time, there's NFC, allowing you to use it with mobile devices via a single tap.

USB TYPE Type-A • **OS SUPPORT** Windows 10, macOS, iOS 11 and later, Android • **WARRANTY** One year RTB • **DETAILS** www.yubico.com • **PART** CODE YubiKey 5 NFC • **FULL REVIEW** Apr 2019

TP-LINK Deco M5

★★★★★

£166 (triple pack) • www.amzn.to/2L05qMi

COMPUTER SHOPPER BEST BUY

Provided you're willing to tinker with a few settings, the Deco M5 is the most feature-rich mesh Wi-Fi system around, even if it's not strictly the fastest. Get the triple pack for the best coverage throughout the house.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 867Mbit/s (5GHz), 400Mbit/s (2.4GHz) • **USB PORTS** 0 • **WALL MOUNTABLE** No • **WARRANTY** Three years RTB • **DETAILS** www.tp-link.com • **PART CODE** 210380 • **FULL REVIEW** Dec 2017

D-LINK DIR-1960

★★★★★

£113 • uk.insight.com

COMPUTER SHOPPER BEST BUY

The DIR-1960 is a simple yet speedy router that can optionally be turned into a mesh system (provided you buy the additional satellites, of course). Either way, you can also take advantage of built-in Alexa and Google Assistant controls.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 1,300Mbit/s (5GHz), 600Mbit/s (2.4GHz) • **USB PORTS** 1x USB2 • **WALL MOUNTABLE** Yes • **WARRANTY** Two years RTB • **DETAILS** wwww.d-link.com • **PART CODE** DIR-1960 • **FULL REVIEW** Nov 2019

NETGEAR Orbi Outdoor RBS50Y

★★★★☆

£235 • www.amzn.to/2MZg5YB

COMPUTER SHOPPER RECOMMENDED

This weatherproof Wi-Fi extender is a perfect addition to mesh systems that can't quite cover a garden. It has similar internal specfications to the brilliant Orbi RBK50, meaning high speeds and reliable connections.

WI-FI STANDARD 802.11ac • **STATED SPEED** 1x 866Mbit/s (5GHz) 1x 1,733Mbit/s (5GHz), 1x 400Mbit/s (2.4GHz) • **USB PORTS** 0 • **WALL MOUNTABLE** Yes • **WARRANTY** Two years RTB • **DETAILS** www.netgear.co.uk • **PART CODE** RBS50Y • **FULL REVIEW** Jul 2019

Choosing a... **Smart thermostat**

01 A smart thermostat can save you a lot of money by intelligently controlling your heating.

Most smart heating devices are designed to be used with hot water central heating systems, with the boiler directly controlled by the system. These typically require a relay to be wired into your boiler, with a wireless thermostat giving you direct control. Smartphone apps then tie into the system to give you remote control. While it's possible to fit controls yourself, you may want to pay an experienced plumber to do the job: expect to pay around £150 for a typical installation.

If you have electric heating, there are very few choices, and the big names (Nest, Honeywell and so on) do not directly support these systems.

02 Want smart hot water control? If you want to remotely set schedules and disable hot water while you're away, choose your smart system carefully, as many don't have this option. Hot water control usually requires a second relay to be wired into the boiler.

03 What kind of heating system do you want? There are two main choices: a central system and one with individual radiator controls. The former replaces your existing thermostat, and lets you set one temperature for your entire house. The latter requires each radiator valve to be replaced with a smart valve so that each room and radiator can have its own individual control. This option is more expensive to install but will provide you with greater savings.

04 Do you use a smart personal assistant? Make sure that your smart thermostat supports the one that you use. Amazon Alexa, powered by the Echo and Echo Dot, is the best-supported system; Apple's HomeKit, powered by Siri, isn't so well supported; Google Assistant, built into Google Home, is just gaining traction and supports Nest only.

05 If you want your smart heating system to do more, look for IFTTT support. With this handy system, you can set automatic rules, such as turning the heating off if the outside temperature rises.

SMART HOME

AMAZON Echo Dot 3rd Generation

★★★★★

£50 • www.amzn.to/2VVl5Bs

COMPUTER SHOPPER BEST BUY

A souped-up speaker means the latest Echo Dot is finally a viable music player, in addition to the best-value Echo speaker and smart home controller. Buy multiple devices and you can scatter them throughout your home, maximising Alexa coverage.

DRIVERS 1 • **RMS POWER OUTPUT** Not stated • **WEIGHT** 300g • **NETWORKING** Bluetooth, 802.11n Wi-Fi • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Echo Dor 3rd Generation • **FULL REVIEW** Aug 2019

NEST Cam IQ Outdoor

★★★★★

£289 • nest.com/uk

COMPUTER SHOPPER RECOMMENDED

While this is an expensive replacement for the old Nest Cam Outdoor, its image quality is without equal. Facial and sound recognition have also been improved, and it's now much harder for thieves to remove the camera from its mount.

VIDEO RESOLUTION 4K sensor, 1080p recording • **CLOUD STORAGE** Yes (subscription required) • **NETWORKING** 802.11ac • **WARRANTY** One year RTB • **PART CODE** Nest Cam IQ Outdoor • **FULL REVIEW** Jul 2018

TADO Smart Thermostat

★★★★★

£145 • www.amzn.to/2ZxwIfZ

COMPUTER SHOPPER BEST BUY

A flexible and stylish-looking smart heating system, the Tado Smart Thermostat distinguishes itself with a clever geolocation feature that turns on your heating when you enter a room and switches it off, saving money, when you leave.

REMOTE THERMOSTAT Yes • **HOT WATER SUPPORT** Yes • **INDIVIDUAL RADIATOR CONTROL** Yes • **VOICE ASSISTANT SUPPORT** Alexa, Google Assistant, Siri • **APPS** iOS, Android and web • **FULL REVIEW** Jan 2018

NEOS Smartcam

★★★★★

£20 • shop.neos.co.uk

COMPUTER SHOPPER RECOMMENDED

The Smartcam is a tremendous bargain of an indoor security camera. In many ways, it's not all that advanced – footage is only shot at up to 15fps, for instance – but the 1080p resolution, night-vision mode and free cloud storage make for a nifty little package.

VIDEO RESOLUTION 1080p • **CLOUD STORAGE** Yes (free) • **NETWORKING** 802.11n • **WARRANTY** One year RTB • **PART CODE** NS-CAM-02 • **FULL REVIEW** Jun 2019

GOOGLE Home Hub

★★★★★

£119 • www.currys.co.uk

COMPUTER SHOPPER BEST BUY

The first truly excellent smart screen, Google's Home Hub is both a multitalented smart home controller and a very clever device in itself, jumping seamlessly between providing mapped-out travel routes, playing YouTube videos and showcasing photo albums.

DRIVERS 1 • **RMS POWER OUTPUT** Not stated • **DOCK CONNECTOR** None • **WIRELESS** 802.11ac Wi-Fi, Bluetooth 5.0 • **DIMENSIONS** 118x179x67mm • **WEIGHT** 480g • **WARRANTY** One year RTB • **PART CODE** Home Hub • **FULL REVIEW** Feb 2019

RING Video Doorbell 2

★★★★★

£139 • www.box.co.uk

COMPUTER SHOPPER BEST BUY

This is the best of the new breed of smart, camera-equipped doorbells: it's easy to install, comes with a bundled chime, and has fairly low subscription costs for storing footage in the cloud.

VIDEO RESOLUTION 1080p • **CLOUD STORAGE** Yes • **NETWORKING** 802.11n • **WARRANTY** Two years parts and theft protection • **PART CODE** 8VR1S7-0EU0 • **FULL REVIEW** Dec 2018

Choosing a... **Smartphone**

01 A smartphone's operating system (OS) dictates its basic features and which third-party software you can install. There are three main contenders: Apple's iOS, which is found on the iPhone, Google's Android, which is used by various handset manufacturers, and Windows Phone, which has few options, especially since Microsoft has discontinued support for its OS. Apple iOS and Google Android both have thousands of apps available.

02 All smartphones have colour screens, but their resolutions vary. Basic models have 1,280x720 pixels, but text can be indistinct. Look for a display that has at least 1,920x1,080 pixels so it's easier to read text and watch Full HD videos. Don't worry too much about built-in media players or Office document editors; you can always install apps to replace these with better versions later.

The image quality of smartphone cameras has improved tremendously in recent years, and resolutions have increased to as high as 20 megapixels.

03 Very few modern smartphones have a physical keyboard for entering text; they almost exclusively use touchscreens now. Physical keyboards can aid heavy emailing, but today's touchscreen keyboards work just as well.

Android smartphones and iPhones running iOS 9 or above allow you to install a variety of custom onscreen keyboards so you can find one that suits you.

04 Be careful when choosing a contract. Look for one that includes a large data allowance if you want to use the internet regularly or you've set your phone to synchronise your contacts, calendar and email through online services.

Built-in Wi-Fi can help you avoid high data charges by connecting to the internet through wireless hotspots when you're out, or your router when you're at home. Android and iPhone handsets can operate as wireless hotspots, letting you connect your laptop to the web over your mobile data connection. There may be an extra charge for this.

SMARTPHONES

MOTOROLA Moto G7 Power

★★★★★

£160 SIM-free; £14-per-month contract • www.carphonewarehouse.com

COMPUTER SHOPPER BEST BUY

There's no shortage of Moto G7 variants to choose from, but the Moto G7 Power is easily the best value. It focuses on battery life and is thus one of the longest-lasting smartphones ever - and its performance, display and rear camera are all rather good for the price, too.

PROCESSOR Octa-core 1.8GHz Qualcomm Snapdragon 632 • **SCREEN SIZE** 6.2in • **SCREEN RESOLUTION** 1,520x720 • **REAR CAMERA** 12 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 159x76x9.3mm • **WEIGHT** 193g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.motorola.co.uk • **PART CODE** PAE90019GB • **FULL REVIEW** Jun 2019

SAMSUNG Galaxy S10+

★★★★★

£693 SIM-free; £30 up front plus £44-per-month contract • www.amzn.to/2E8ImVE (SIM-free); www.carphonewarehouse.com (contract)

COMPUTER SHOPPER BEST BUY

The dazzling 3K display dominates a sleek, luxurious-feeling design, while the Exynos 9820 processor delivers some of the fastest raw performance on any Android handset, ever.

PROCESSOR Octa-core 2.7GHz Samsung Exynos 9820 • **SCREEN SIZE** 6.4in • **SCREEN RESOLUTION** 3,040x1,440 • **REAR CAMERAS** 12 mgeapixels, 12 megapixels, 16 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 158x74x7.8mm • **WEIGHT** 175g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** wwww.samsung.com • **PART CODE** SM-G975FZKDBTU • **FULL REVIEW** Jul 2019

VODAFONE Smart V10

★★★★★

£105 SIM-free; £20-per-month contract • www.vodafone.co.uk

COMPUTER SHOPPER BEST BUY

Vodafone's budget handset will surprise you: for something that barely costs more than £100 to buy outright, it's rather speedy and has a main camera than can compete with mid-rangers. The slim-bezel look is very welcome, too.

PROCESSOR Quad-core 2GHz Qualcomm Snapdragon 429 • **SCREEN SIZE** 5.9in • **SCREEN RESOLUTION** 1,560x720 • **REAR CAMERAS** 13 megapixels, 5 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 151x70x8.2mm • **WEIGHT** 145g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** Two years RTB • **DETAILS** www.www.vodafone.co.uk • **PART CODE** Smart V10 • **FULL REVIEW** Oct 2019

GOOGLE Pixel 3a

★★★★★

£399 SIM-free; £26-per-month contract • www.carphonewarehouse.com

COMPUTER SHOPPER BEST BUY

The Pixel 3a is a welcome return to mid-range smartphones on Google's part. It's essentially a cheaper version of the flagship Pixel 3, which means a bit less horsepower but the same clean, stock Android and superb camera.

PROCESSOR Quad-core 2.8GHz Qualcomm Snapdragon 845 • **SCREEN SIZE** 5.5in • **SCREEN RESOLUTION** 2,160x1,080 • **REAR CAMERA** 12.2 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 146x68x7.9mm • **WEIGHT** 148g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** store.google.com • **PART CODE** Pixel 3 • **FULL REVIEW** Aug 2019

SAMSUNG Galaxy Note 10+

★★★★★

£999 SIM-free; £57-per-month contract • www.carphonewarehouse.com (SIM-free); www.tescomobile.com (contract)

NEW ENTRY

COMPUTER SHOPPER BEST BUY

From its cameras to its display, everything about the Note 10+ drips with ultra-premium quality. It's quite possibly the best Android phone on the market, albeit at a steep cost.

PROCESSOR Octa-core 2.4GHz Samsung Exynos 9825 • **SCREEN SIZE** 6.8in • **SCREEN RESOLUTION** 3,040x1,440 • **REAR CAMERAS** 12 megapixels, 16 megapixels, 12 megapixels • **STORAGE** 256GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 162x77x7.9mm • **WEIGHT** 196g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-N975FZSDBTU • **FULL REVIEW** Dec 2019

XIAOMI Pocophone F1

★★★★★

£270 SIM-free • www.ebuyer.com

COMPUTER SHOPPER BEST BUY

The Pocophone F1 is a phenomenal bargain: it has the same Snapdragon 845 chip as a lot of premium handsets, plus dual rear cameras, 64GB of storage and a 6.2in screen, all for a mid-range price.

PROCESSOR Octa-core 2.GHz Qualcomm Snapdragon 845 • **SCREEN SIZE** 6.2in • **SCREEN RESOLUTION** 2,246x1,080 • **REAR CAMERAS** 12 megapixels, 5 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 156x75x9mm • **WEIGHT** 180g • **OPERATING SYSTEM** Android 8.1 • **DETAILS** www.mi.com/uk • **PART CODE** MZB6715EN • **FULL REVIEW** Mar 2019

Choosing a... **Tablet**

01 All tablets rely on an operating system (OS) to run apps. You have three main choices: Apple's iOS, which runs on the iPad; Android, which Google licenses to various manufacturers; and Windows 10, which has become common in hybrid tablets and convertibles. If you own an Apple or Google smartphone, you can download your apps, music and so on to a tablet that runs the same OS, so it makes sense to stick with a compatible device.

02 It's important to pick a tablet that has a good-quality, high-resolution screen. Many budget tablets have 1,280x800-resolution displays, but better tablets have Full HD 1,920x1,080 panels, and we're starting to see tablets that have even higher screen resolutions. Some are as high as 2,560x1,600 or even 4K. Entry-level tablets typically use TN panels, which don't have particularly good viewing angles. The viewing angles of IPS panels are much better.

03 If you want to listen to music, watch films and play games, make sure your tablet has plenty of storage. Many tablets come with 8GB or 16GB of internal storage, although some budget models have less. You'll typically pay more for a higher storage capacity. Many tablets also have microSD slots that let you add extra storage, although you won't find one on an iPad. This is a cheap way of boosting storage capacity.

04 Tablets rarely include a SIM card slot. This means you'll have to rely on Wi-Fi to get online, although some tablets let you access the internet through your smartphone. If you want mobile access to the internet, look for 3G- and 4G-ready devices. These almost always cost more than Wi-Fi-only models, but they're great if you use your tablet while commuting or travelling.

05 Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on iOS but not Android, and vice versa. Windows 10, meanwhile, runs traditional desktop applications.

TABLETS

AMAZON Kindle Oasis (2019)

★★★★★

£230 • amzn.to/2mp6ldb

COMPUTER SHOPPER BEST BUY

With the addition of a blue light filter, the latest Kindle Oasis is as good an e-reader as you can get. Besides being easier on the eyes when reading at night, it has the physical page-turn buttons that cheaper Kindles lack, and the screen can auto-rotate according to how you're holding it.

PROCESSOR Not stated • **SCREEN SIZE** 7in • **SCREEN RESOLUTION** 300ppi • **REAR CAMERA** None • **STORAGE** 8GB • **WIRELESS DATA** Wi-Fi, Bluetooth • **DIMENSIONS** 159x141x8.4mm • **WEIGHT** 188g • **OPERATING SYSTEM** Kindle OS • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Kindle Oasis (2019) • **FULL REVIEW** Nov 2019

APPLE iPad (2018)

★★★★☆

£349 • www.apple.com/uk

COMPUTER SHOPPER RECOMMENDED

Apple has recalibrated its focus for the latest iPad, keeping the existing design but turning it into an education aid with Apple Pencil support and the Smart Annotation software feature. Even if you're not a teacher or in education, it's still a powerful tablet at a decent price.

PROCESSOR Quad-core Apple A10 Fusion • **SCREEN SIZE** 9.7in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 32GB • **WIRELESS DATA** None • **DIMENSIONS** 240x170x7.5mm • **WEIGHT** 469g • **OPERATING SYSTEM** iOS 11 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** iPad • **FULL REVIEW** Aug 2018

APPLE iPad Pro 10.5in

★★★★★

£529 • www.apple.com/uk

COMPUTER SHOPPER BEST BUY

While it's still stuck with a mobile OS, rather than the productivity-friendly macOS, there's no arguing with the latest iPad Pro's raw power. An A10X Fusion chip makes it much faster than the 9.7in model in both multitasking and single-threaded applications.

PROCESSOR Hexa-core 2.36GHz Apple A10X Fusion • **SCREEN SIZE** 10.5in • **SCREEN RESOLUTION** 2,224x1,668 • **REAR CAMERA** 12 megapixels • **STORAGE** 64/256/512GB • **WIRELESS DATA** 4G (cellular version) • **DIMENSIONS** 251x174x6.1mm • **WEIGHT** 469g • **OPERATING SYSTEM** iOS 11 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** 9.7in iPad Pro • **FULL REVIEW** Oct 2017

MICROSOFT Surface Go

★★★★☆

£509 • www.microsoft.com

COMPUTER SHOPPER RECOMMENDED

If you've been craving a tablet with the flexibility of a Surface Pro, without the usual expense, the Surface Go is a perfect fit. It's smaller and uses a less powerful Intel Pentium CPU, but it's still a much more work-ready 2-in-1 than any Android slate.

PROCESSOR Dual-core 1.6GHz Intel Pentium 4415Y • **SCREEN SIZE** 10in • **SCREEN RESOLUTION** 1,800x1,200 • **REAR CAMERA** 8 megapixels • **STORAGE** 128GB • **WIRELESS DATA** No • **DIMENSIONS** 245x175x8.3mm • **WEIGHT** 522g • **OPERATING SYSTEM** Windows 10 S • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** MCZ-00002 • **FULL REVIEW** Jan 2019

SAMSUNG Galaxy Tab S3

★★★★★

£359 • www.ao.com

COMPUTER SHOPPER BEST BUY

Yes, it's incredibly expensive for an Android slate, but the Galaxy Tab S3 is pure luxury: the AMOLED display looks exquisite, the stereo speakers sound great, and Samsung's S Pen stylus is included as standard.

PROCESSOR Quad-core 2.2GHz Qualcomm Snapdragon 820 • **SCREEN SIZE** 9.7n • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 13 megapixels • **STORAGE** 32GB • **WIRELESS DATA** None (4G optional) • **DIMENSIONS** 2937x169x6mm • **WEIGHT** 429g • **OPERATING SYSTEM** Android 7.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-T820 • **FULL REVIEW** Aug 2017

AMAZON Kindle (2019)

★★★★★

£70 • www.amzn.to/2x9nnhM

COMPUTER SHOPPER BEST BUY

Some key upgrades make the base Kindle a much more tempting prospect. There's a new reading light on the front, plus Bluetooth connectivity and the ability to download and listen to Audible audiobooks.

PROCESSOR Not stated • **SCREEN SIZE** 6in • **SCREEN RESOLUTION** 256ppi • **REAR CAMERA** None • **STORAGE** 4GB • **WIRELESS DATA** Wi-Fi only • **DIMENSIONS** 160x113x8.7mm • **WEIGHT** 174g • **OPERATING SYSTEM** Kindle OS • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Kindle (2019) • **FULL REVIEW** Aug 2019

Choosing a... **Soundbar**

01 If you don't have space in your home cinema setup for a set of surround-sound speakers, a soundbar is the next best thing. Whether you opt for a soundbar (which typically sits in front of your TV stand) or a soundplate (which sits underneath your TV), you'll be getting significantly better audio than the weedy speakers today's flatscreen TVs provide.

02 If you want to cut down on cable clutter, look for a soundbar with multiple HDMI inputs and outputs as well as Audio Return Channel (ARC). Not all soundbars use HDMI, with many making do with digital optical audio connections instead. This means you'll have to connect Blu-ray players, games consoles and set-top boxes to your TV and run all audio through a single cable. Also look for phono inputs for connecting older devices and 3.5mm audio jacks for tablets or smartphones.

03 As with any speaker, the number of speaker drivers inside a soundbar should give a good indication of its audio capabilities. Although this won't tell you everything about sound quality, you should still look out for separate mid-range drivers and tweeters, as these should be able to deliver a wider frequency range than full-range drivers alone.

04 Bluetooth support is a must if you want to listen to music from a smartphone or tablet without wires. Most soundbars now include Bluetooth as standard but, if your device supports it, it's worth looking for a mobile soundbar that includes aptX. This less-lossy codec is capable of higher-quality streaming than the standard A2DP profile.

AirPlay streaming is less common, but iPhone owners should keep an eye out for it.

05 For a little extra bass, be sure to look for a soundbar with a separate subwoofer. Many soundbars include a wired sub, but for extra convenience you should look for a model with a wireless subwoofer instead. These can be placed anywhere in a room near a power socket, without having to run a cable back to the soundbar itself.

HOME CINEMA

PHILIPS 55PUS6753/12

★★★★☆

£580 • www.laptopsdirect.co.uk

COMPUTER SHOPPER RECOMMENDED

This Philips set doesn't have the best implementation of HDR we've seen on a TV, but otherwise, the 55PUS6753/12 is a fantastic 4K screen for a relatively low price.

SCREEN SIZE 55in • **NATIVE RESOLUTION** 3,840x2,160 • **VIDEO INPUTS** 3x HDMI, 5x component • **TUNER** Freeview HD • **DIMENSIONS** 781x1,244x266mm • **WARRANTY** One year RTB • **DETAILS** www.philips.co.uk • **PART CODE** 55PUS6753/12 • **FULL REVIEW** Dec 2018

SAMSUNG HW-N850

★★★★★

£649 • www.box.co.uk

COMPUTER SHOPPER BEST BUY

There's no ultra-high-tech trickery here: just a soundbar, subwoofer and their combined 14 drivers blasting out pristine-quality audio, with Samsung's usual high standards for connectivity.

SPEAKERS 14 • **RMS POWER OUTPUT** 372W • **DIMENSIONS** 1,230x83x136mm (soundbar), 203x400x416mm (subwoofer) • **NETWORKING** 802.11n Wi-Fi, Bluetooth • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** HW-N850 • **FULL REVIEW** Feb 2019

SONY KD-55XF9005

★★★★☆

£949 • www.johnlewis.com

COMPUTER SHOPPER RECOMMENDED

Direct-lit backlighting, excellent upscaling and beautifully smooth motion make the KD-55XF9005 a worthy alternative to high-end OLED TVs, even though it only has a VA panel.

SCREEN SIZE 55in • **NATIVE RESOLUTION** 3,840x2,160 • **VIDEO INPUTS** 4x HDMI • **TUNER** Freeview HD • **DIMENSIONS** 771x1,228x258mm • **WARRANTY** One year RTB • **DETAILS** www.sony.co.uk • **PART CODE** KD-55XF9005 • **FULL REVIEW** Aug 2018

POLK AUDIO Command Bar

★★★★★

£249 • www.amzn.to/33TdAv4

COMPUTER SHOPPER BEST BUY

This is a genius combination of soundbar and smart speaker, and for a low price too. It's great for films, TV and music, and you can use Alexa as a voice-activated remote control.

SPEAKERS 3 • **RMS POWER OUTPUT** 260W • **DIMENSIONS** 1,091x102x51mm (soundbar), 367x188x368mm (subwoofer) • **WEIGHT** 2.3kg (soundbar), 3.9kg (subwoofer) • **DOCK CONNECTOR** None • **NETWORKING** 802.11ac Wi-Fi • **WARRANTY** Three years RTB • **DETAILS** en.polkaudio.com • **PART CODE** COMMANDUK • **FULL REVIEW** Oct 2019

PHILIPS 65OLED803

★★★★★

£1,999 • www.currys.co.uk

COMPUTER SHOPPER RECOMMENDED

If you've got the budget for an OLED TV, this is a great pick. The panel technology's built-in strengths, such as perfect blacks and wide viewing angles, are aided by Philips' exemplary image processing engine, resulting in truly wonderful picture quality.

SCREEN SIZE 65in • **NATIVE RESOLUTION** 3,840x2,160 • **VIDEO INPUTS** 4x HDMI, 1x Component • **TUNER** Freeview HD • **DIMENSIONS** 824x1,449x280mm • **WARRANTY** One year RTB • **DETAILS** www.philips.co.uk • **PART CODE** 65OLED803/12 • **FULL REVIEW** Apr 2019

SONOS Beam

★★★★☆

£399 • www.sonos.com

COMPUTER SHOPPER RECOMMENDED

The Beam could join a home cinema setup on sound quality alone, but it's loaded with smart features, too. It can adjust sound output to the size and layout of a room, for example, and form a multiroom system with other Sonos speakers.

SPEAKERS 5 • **RMS POWER OUTPUT** Not stated • **DIMENSIONS** 651x100x69mm • **WEIGHT** 2.8kg • **DOCK CONNECTOR** None • **NETWORKING** 802.11ac Wi-Fi, Ethernet • **WARRANTY** One year RTB • **DETAILS** www.sonos.com • **PART CODE** BEAM1UK1 • **FULL REVIEW** Apr 2019

Choosing a... **Bluetooth speaker**

01 Bluetooth speakers come in all shapes and sizes, so you'll need to decide what you want to do with the speaker before you buy. If you don't plan to take your music outdoors or around the house, look for a wired speaker. These are typically cheaper than speakers with built-in batteries.

If you do want a portable speaker, however, pay particular attention to how much it weighs. Ruggedised models should be able to survive accidental drops, water spills and unexpected rain showers.

02 Many of the cheapest Bluetooth speakers use the lossy A2DP Bluetooth protocol, which is prone to compressing your music and discarding detail compared with the original recording. It's hard to tell the difference when listening to pocket-sized speakers, but if you're looking for a speaker to fill a room, an aptX-compatible device is a better option. This Bluetooth protocol retains more detail than the A2DP profile, although you'll need to use it with a compatible smartphone in order to get the benefits.

03 As with any audio product, the number and size of speaker drivers can have a significant impact on the quality of sound you get from a Bluetooth speaker. Typically, the presence of multiple drivers enables the manufacturer to tune each one for specific frequencies, directing high-end sounds towards a tweeter and sending the mid-range frequencies to the main driver. Single-driver speakers with larger driver cones can be just as capable of producing fantastic audio, however.

04 Most Bluetooth speakers have at least one auxiliary input for a wired 3.5mm audio jack, in case you want to listen to music from a device that doesn't have Bluetooth.

There are other extra features to look out for, though. Speakers with built-in batteries may have a USB port for charging your smartphone, or a built-in microphone to turn it into a speakerphone when a paired smartphone receives a call. Not all speakers have physical controls; many rely on your paired device's controls for adjusting the volume or muting playback.

AUDIO

CREATIVE Outlier Air

★★★★★

£70 • uk.creative.com

COMPUTER SHOPPER BEST BUY

A marvellous set of true wireless headphones, the Outlier Air combine a lively and dynamic sound with a comfy (if large) design and long battery life. Bluetooth aptX support is worth the money in particular.

HEADPHONES SUBTYPE In-ear headset • **PLUG TYPE** None • **WEIGHT** 10g • **CABLE LENGTH** N/A • **WARRANTY** Two years RTB • **DETAILS** uk.creative.com • **PART CODE** Outlier Air • **FULL REVIEW** Jul 2019

SONY WH-1000XM3

★★★★★

£272 • www.amzn.to/2HHUG1J

COMPUTER SHOPPER BEST BUY

Bose's QuietComfort headphones have at last been toppled from the ANC throne. The WH-1000XM3 headphones don't just sound outstanding, with very effective noise cancellation, but they're smartly designed and come with a host of extras.

HEADPHONES SUBTYPE Over-ear headset • **PLUG TYPE** 3.5mm jack plug (optional) • **WEIGHT** 255g • **CABLE LENGTH** 1.2m • **WARRANTY** One year RTB • **DETAILS** www.sony.co.uk • **PART CODE** WH-1000XM3 • **FULL REVIEW** May 2019

IKEA Symfonisk

★★★★★

£99 • www.ikea.com

COMPUTER SHOPPER BEST BUY

Ikea, with a little help from Sonos, has produced two great-sounding wired speakers. The cheaper 'bookshelf' model is slim and subtle, but it's worth paying extra for the 'lamp' model, which both sounds fuller and doubles as a working lamp.

SPEAKERS 2 • **RMS POWER OUTPUT** Not stated • **WEIGHT** Not stated • **NETWORKING** Wi-Fi • **WARRANTY** One year RTB • **DETAILS** www.ikea.com • **PART CODE** Symfonisk • **FULL REVIEW** Nov 2019

ESCAPE P9

★★★★★

£999 • www.stoneaudio.co.uk

COMPUTER SHOPPER BEST BUY

A dramatically loud, rain-resistant upright speaker, the Escape P9 is something nice and different for outdoor use – provided you have plenty of cash to burn.

SPEAKERS 3 • **RMS POWER OUTPUT** 300W • **DOCK CONNECTOR** None • **NETWORKING** Bluetooth • **DIMENSIONS** 731x220x220mm • **WEIGHT** 1.2kg • **WARRANTY** One year parts and labour • **DETAILS** www.escapespeakers.com • **PART CODE** P9 • **FULL REVIEW** Sep 2019

UE Boom 3

★★★★★

£119 • www.johnlewis.com

COMPUTER SHOPPER BEST BUY

This IP67-rated Bluetooth speaker is a comprehensive upgrade on the Boom 2: it's more durable, looks better, has longer wireless range and sounds even better.

SPEAKERS 4 • **RMS POWER OUTPUT** Not stated • **DOCK CONNECTOR** None • **NETWORKING** Bluetooth (SBC) • **DIMENSIONS** 184x73x73mm • **WEIGHT** 608g • **WARRANTY** Two years RTB • **DETAILS** www.ultimateears.com • **PART CODE** 984-001360 • **FULL REVIEW** Jan 2019

BOWERS & WILKINS 607

★★★★☆

£399 • www.weybridge-audio.co.uk

COMPUTER SHOPPER RECOMMENDED

Inspired by the classic 600 series, the wired 607s deliver an exciting and enthusiastic sound profile that reveals the tiniest details in every recording.

SPEAKERS 4 • **RMS POWER OUTPUT** 125W • **WEIGHT** 4.7kg per speaker • **NETWORKING** None • **WARRANTY** One year RTB • **DETAILS** www.bowers-wilkins.eu • **PART CODE** 607 • **FULL REVIEW** Jun 2019

Choosing an... **Action camera**

01 Action cameras are typically much smaller than a regular camcorder, as they are designed to be mounted to a bike, board or car, or worn on your person. As the name suggests, they are designed primarily for shooting action footage, but because of their small size they are ideal for strapping on to your pet's collar or your children's toys for a different perspective.

02 Even basic action cameras will shoot Full HD video, and many will even shoot 4K, but frame rate is arguably more important than resolution when it comes to action video. Higher frame rates will mean smoother clips, and super-high frame rate videos can be played in slow motion to emphasise exciting shots.

Keep an eye out for 4K/30, 4K/60, 1080p/60 and 720p/120 models for the widest possible choice of resolutions and frame rates.

03 Most action cameras rely on flash memory for storing your video, letting you swap out memory cards on the fly when you fill one up with clips. More expensive devices can have integrated flash memory as well as a card slot, but it's typically cheaper to buy the basic version of a camera and pick up memory cards separately.

04 Not all action cameras have LCD displays; in fact, many don't include a sceen in order to extend battery life.

If you want to be able to see exactly what you're pointing the lens at, keep an eye out for cameras with companion smartphone apps, or wrist-mounted viewfinders that also let you start and stop shooting remotely.

05 Action cameras typically have a huge range of accessories, with specific mounts and harnesses for different activities and sports. If the camera itself isn't water resistant, a weatherproof case will protect it from the elements, while a tripod mount will let you lock it firmly in place.

Spare batteries are essential for longer shoots, and some decent video-editing software will help you to produce a more polished result.

VIDEO

AMAZON Fire TV Stick 4K

★★★★☆

£50 • www.amzn.to/2Y6q8wh

COMPUTER SHOPPER RECOMMENDED

From set-top box to dangling dongle and now an ultra-compact stick, Amazon's 4K media streamer gets sleeker with every generation. It's also been updated with a new remote, which includes a microphone for Alexa voice commands.

VIDEO OUTPUTS HDMI 2.0 • **NETWORKING** 802.11ac Wi-Fi • **DIMENSIONS** 108x30x14mm • **STREAMING FORMATS** UPnP, AirPlay, DLNA, Plex • **INTERNET STREAMING SERVICES** Amazon Video, Netflix, BBC iPlayer, ITV Hub, All 4, My5 • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Fire TV Stick 4K • **FULL REVIEW** May 2019

DJI Osmo Pocket

★★★★☆

£329 • www.amzn.to/2vl53Ba

COMPUTER SHOPPER RECOMMENDED

A cleverly made alternative to action cameras, the DJI Osmo Pocket isn't intended for extreme sports, but its mechancial stabilisation ensures smooth, great-looking footage for life-logging videos.

SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAXIMUM RECORDING RESOLUTION** 4K (60fps) • **AV CONNECTIONS** USB Type-C • **DIMENSIONS** 122x37x38mm • **WEIGHT** 116g • **WARRANTY** One year RTB • **DETAILS** www.dji.com • **PART CODE** CP.ZM.00000097.01 • **FULL REVIEW** Apr 2019

DJI Osmo Action

★★★★★

£279 • www.amzn.to/33tvpzV

COMPUTER SHOPPER BEST BUY

If you want most of the features of a GoPro action camera at a lower price, consider the Osmo Action. It's waterproof without a case, can shoot at 4K and 60fps with stablisation, and reaches the same high standard of video quality as the Osmo Pocket, as they have the same sensor.

SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAX RECORDING RESOLUTION** 4K (60fps) • **AV CONNECTIONS** None • **DIMENSIONS** 42x66x35mm • **WEIGHT** 134g • **WARRANTY** One year RTB • **DETAILS** www.dji.com/uk • **PART CODE** CP.OS.00000020.01 • **FULL REVIEW** Dec 2019

GOPRO Hero 7 Black

★★★★★

£289 • www.amzn.to/32hWxC9

COMPUTER SHOPPER BEST BUY

The Yi 4K+ is cheaper, but no other action camera comes close to the video quality of the Hero 7 Black. That's largely down to its new electronic image stabilisation, which keeps footage looking unbeatably smooth.

SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAXIMUM RECORDING RESOLUTION** 4K (60fps) • **AV CONNECTIONS** Micro HDMI • **DIMENSIONS** 45x62x32mm • **WEIGHT** 116g • **WARRANTY** One year RTB • **DETAILS** www.gopro.com • **PART CODE** CHDHX-701-RW • **FULL REVIEW** Feb 2019

APPLE TV 4K

★★★★☆

£179 • www.apple.com/uk

COMPUTER SHOPPER RECOMMENDED

This big update adds 4K content (including, for the first time, Amazon Video support). The best part is that if there's a 4K version of content you've previously purchased in HD, Apple will upgrade it free of charge.

VIDEO OUTPUTS HDMI 2.0a • **NETWORKING** 802.11ac Wi-Fi, 10/100/1,000 Ethernet • **DIMENSIONS** 35x98x98mm • **STREAMING FORMATS** AirPlay, others via apps • **INTERNET STREAMING SERVICES** iTunes, Apple Music, Netflix, Amazon Instant Video, Now TV, BBC iPlayer, ITV Hub, All 4 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** Apple TV 4K • **FULL REVIEW** Jan 2018

SAMSUNG Gear 360 (2017)

★★★★★

£153 • www.amzn.to/2wesOMX

COMPUTER SHOPPER BEST BUY

Samsung's updated 360° camera improves on the original in every way: it's more portable, supports live video stream, and is no longer limited to Samsung Galaxy phones. Best of all, it's cheaper than the previous model was at launch.

SENSOR RESOLUTION Dual 8.4 megapixels • **SENSOR SIZE** Not disclosed • **VIEWFINDER** None • **LCD SCREEN** 0.5in 72x32 PMOLED • **DIMENSIONS** 100x46x45mm • **WEIGHT** 130g • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-R210NZWABTU • **FULL REVIEW** Oct 2017

Choosing a... Compact system camera

01 If you're ready to step beyond the basic controls of a compact camera, or you want greater flexibility than an ultra-zoom can offer, a compact system camera (CSC) is the next logical upgrade. With interchangeable lenses, manual controls and stellar image quality, these cameras give proper digital SLRs a run for their money.

02 There are three competing types of CSC mount, and the one you buy determines the number of compatible lenses and accessories you have available. Samsung's NX-mount is arguably the most limited in terms of lens selection, and the company has confirmed that it's shutting down its European camera business, so it's best to avoid these altogether if possible.

Sony's E-Mount has a slightly wider range, but Micro Four Thirds offers the widest variety. Both Panasonic and Olympus cameras use this mount, and the lenses are interchangeable between manufacturers.

03 Micro Four Thirds cameras are typically more compact than other types of CSC because the image sensor is physically smaller – with a 22mm diagonal, it's roughly 30% smaller than an APS-C sensor. The APS-C sensors that Sony and Samsung use in their CSCs are the same size as those in traditional digital SLRs.

04 Like digital SLRs, CSCs come at a wide range of prices. Available from as little as £200, there's a CSC to suit every budget. Most come with at least one kit lens, but if you already have lenses for a particular CSC mount, you can buy the body on its own and save money.

05 Once you've settled on a particular mount, you should pay attention to a camera's features. Articulating screens and integrated viewfinders will help you compose shots, while extra physical controls and a hotshoe mount will give you flexibility for manual shooting.

Touchscreens are great, but they're no replacement for physical dials when it comes to changing shutter speed and aperture. An integrated flash is much more convenient than a detachable one, as you can never forget to take it with you.

PHOTOGRAPHY

CANON EOS R

★★★★☆

£3,069 • www.johnlewis.com

COMPUTER SHOPPER RECOMMENDED

This is Canon's first mirrorless full-frame camera, but you wouldn't know it. Image quality is among the very best, and the included kit lens does a fantastic job. You can also get it body-only and attach your own RF-mount lenses.

SENSOR RESOLUTION 30.3 megapixels • **SENSOR SIZE** 36x24mm • **FOCAL LENGTH MULTIPLIER** 1x • **VIEWFINDER** Electronic (3.6 million dots) • **LCD SCREEN** 3.2in (2,100,000 dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE)** 0.76x, 100% • **WEIGHT** 580g • **DIMENSIONS** 98x136x84mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **FULL REVIEW** Sep 2019

FUJIFILM X-T3

★★★★★

£1,685 • www.amzn.to/2Fccak5

COMPUTER SHOPPER RECOMMENDED

A fantastically versatile mirrorless camera, capable of taking perfect stills as much as it is recording high-quality video. There are plenty of pro-level features, too.

SENSOR RESOLUTION 26.1 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 2.7x • **VIEWFINDER** Electronic (3.69 million dots) • **LCD SCREEN** 3in (1.04 million dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE)** 0.75x, 100% • **WEIGHT** 539g • **DIMENSIONS** 93x133x59mm • **WARRANTY** One year RTB • **DETAILS** www.fujifilm.com • **FULL REVIEW** May 2019

NIKON Z6

★★★★☆

£1,699 • www.jessops.com

COMPUTER SHOPPER RECOMMENDED

If you can't quite afford the exemplary Z7, then the Z6 is the perfect alternative. It's every bit the mirrorless all-rounder, and while it has a lower-resolution sensor than the Z7, this allows it to shoot at a faster rate.

SENSOR RESOLUTION 24.5 megapixels • **SENSOR SIZE** 35.9x23.9mm CMOS • **VIEWFINDER** Electronic (3.69 million dots) • **LCD SCREEN** 3.2in (2 million dots) • **VIEWFINDER MAGNIFICATION (35MM-EQUIVALENT, COVERAGE)** 0.8x, 100% • **WEIGHT** 1,175g • **SIZE (HXWXD)** 101x134x68mm • **WARRANTY** One year RTB • **DETAILS** www.europe-nikon.com • **FULL REVIEW** July 2019

POLAROID Originals OneStep 2

★★★★☆

£99 • www.amzn.to/2DQhr05

COMPUTER SHOPPER RECOMMENDED

The OneStep 2 brings back the simple joys of instant photography. Although the stock can get quite pricey, your shots will look just as they would on a classic Polaroid – perfect for sharing or simply sticking to the fridge.

PHOTO SIZE 3.1x3.1in • **BATTERY LIFE** 15-20 packets of film • **PORTS** 1x Micro USB • **WARRANTY** One year RTB • **DETAILS** www.polaroidoriginals.com • **FULL REVIEW** Jan 2018

SONY A6400

★★★★★

£1,279 • www.amzn.to/2KO1PPj

COMPUTER SHOPPER RECOMMENDED

Sony's tiny mirrorless camera doesn't sacrifice quality in the name of portability. The 1,200-zone metering system helps produce balanced photos, and the A6400 particularly excels at speed-shooting, so it's definitely worth a look for action photography.

SENSOR RESOLUTION 24.2 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.5x • **VIEWFINDER** Electronic (2.36 million dots) • **LCD SCREEN** 3in (921,000 dots) • **LENS MOUNT** E-mount • **WEIGHT** 403g • **DIMENSIONS** 67x120x60mm • **WARRANTY** One year RTB • **DETAILS** www.sony.com • **FULL REVIEW** Oct 2019

PANASONIC Lumix DMC-G80

★★★★★

£599 • www.jessops.com

COMPUTER SHOPPER BEST BUY

The G80 is ahead of the pack when it comes to video quality, and its stills look great as well. It's more expensive than the preceding G7, but includes a superior 12-60mm kit lens, among other improvements.

SENSOR RESOLUTION 16 megapixels • **SENSOR SIZE** 17.3x13mm • **FOCAL LENGTH MULTIPLIER** 2x • **VIEWFINDER** Electronic (2.36 million dots) • **LCD SCREEN** 3in (1,040,000 dots) • **LENS MOUNT** Micro Four Thirds • **WEIGHT** 715g with kit lens • **DIMENSIONS** 79x137x130mm • **WARRANTY** One year RTB • **DETAILS** www.panasonic.com/uk • **FULL REVIEW** Jul 2017

Choosing a... **Wearable**

01 Wearable tech can include anything from chest-strap heart-rate monitors to augmented reality glasses, but the two most common types are smartwatches and fitness trackers. Both are designed to sit unassumingly on your wrist, and are almost always meant to be used in tandem with a paired smartphone.

02 Smartwatches are typically more complex and expensive, though more closely resemble a traditional wristwatch. You can use them to receive and reply to text messages and emails, quickly check maps and even play games – like a smartphone, most smartwatches allow you to install your own choice of apps.

03 Fitness trackers are much more dedicated to healthy pursuits. Step counters, heart-rate monitors and even sleep tracking are all common, and the data collected is fed back to you so you can see how your workout routine or calorie intake is going.

Many smartwatches also contain health-tracking features, but fitness-specific wearables tend to be cheaper, smaller and lighter.

04 When it comes to battery life, it's important for any wearable to last a full day, but if it's a smartwatch then you can get away with having to charge it overnight. With fitness trackers, it's better if it lasts for several days off a single charge, so you can wear it to bed and benefit from sleep tracking.

05 Look out for waterproofing as well. Wearables that don't mind a few lengths of the pool can be used for swimming or just timekeeping, and at the very least we expect a fitness tracker to be able to deal with rain or sweat.

06 Different smartwatches use different operating systems, which determine which apps you can install on your device, as well as compatibility with smartphones. Android Wear and Tizen smartwatches will work with both Android and iOS phones, but Apple's watchOS will only pair with an iOS handset.

WEARABLES

GARMIN Vivosmart 4

★★★★☆

£92 • www.amzn.to/2UYdj4M

COMPUTER SHOPPER RECOMMENDED

Comfortable, accurate and not too expensive, the Vivosmart 4 is a fine fitness tracker, albeit one without onboard GPS. It's particularly suited to those who don't already exercise but are looking to improve their overall fitness.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 0.7in • **RESOLUTION** 48x128 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** Seven days • **WARRANTY** One year RTB • **DETAILS** www.garmin.com • **PART CODE** 010-01995-04 • **FULL REVIEW** Apr 2019

APPLE Watch Series 4

★★★★★

£399 • www.apple.com/uk

COMPUTER SHOPPER BEST BUY

The latest Apple Watch is the sleekest and slickest wearable the company has ever made. An edge-to-edge screen and haptic feedback in the crown are just two of the many enhancements.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.78in • **RESOLUTION** 448x368 • **OS SUPPORT** iOS • **BATTERY LIFE** 18 hours • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** Apple Watch Series 4 • **FULL REVIEW** Jan 2019

POLAR Vantage M

★★★★★

£204 • www.amzn.to/2HEqMLJ

COMPUTER SHOPPER RECOMMENDED

A much-improved design sees the Vantage M become a sleeker and more comfortable running watch than the preceding M430, and multisport tracking goes a lot deeper, too – there's even swim tracking.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.2in • **RESOLUTION** 240x240 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** 30 hours • **WARRANTY** One year RTB • **DETAILS** www.polar.com • **PART CODE** Vantage M • **FULL REVIEW** May 2019

FITBIT Inspire HR

★★★★★

£86 • www.amzn.to/2VsxcRA

COMPUTER SHOPPER BEST BUY

There's no better sub-£100 fitness tracker for casual users than this. The Inspire HR's simplicity and stylishness give it immediate appeal, and you'll stay for the top-quality mobile app.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 0.7in • **RESOLUTION** 128x72 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** Five days • **WARRANTY** One year RTB • **DETAILS** www.fitbit.com • **PART CODE** FB505RGPK-EU • **FULL REVIEW** Jul 2019

GARMIN Fenix 5 Plus

★★★★★

£474 • www.amzn.to/2kUGgSY

COMPUTER SHOPPER BEST BUY

You'll have to pay a pretty penny for it, but the variety of features on the Fenix 5 Plus is without peer. One of the most exclusive is its support for full-colour maps, along with the ability to create routes straight from your wrist.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.2in • **RESOLUTION** 240x240 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** 18 hours • **WARRANTY** One year RTB • **DETAILS** www.garmin.com • **PART CODE** 010-01988-11 • **FULL REVIEW** Nov 2019

MOBVOI TicWatch E2

★★★★☆

£146 • www.mobvoi.com

COMPUTER SHOPPER RECOMMENDED

At this price, there's simply no better smartwatch/fitness tracker hybrid than the TicWatch E2. Built-in GPS, IP67 waterproofing and an upgraded battery are all on board, and it's more responsive than most Wear 2100 wearables.

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 1.4in • **RESOLUTION** 400x400 • **OS SUPPORT** Android, iOS • **BATTERY LIFE** Two days • **WARRANTY** One year RTB • **DETAILS** www.mobvoi.com • **PART CODE** TicWatch E2 • **FULL REVIEW** Jun 2019

SOFTWARE

ADOBE Premiere Pro CC 2019

Video-editing software

★★★★★

£20 per month • www.adobe.com

COMPUTER SHOPPER RECOMMENDED

This strong update of Premiere Pro CC adds improved Lumetri Color controls and neat integration with the Premiere Rush mobile app, among other tweaks.

OS SUPPORT Windows 10 version 1703 and later, macOS 10.12 and later (10.13 required for hardware acceleration) • **MINIMUM CPU** Intel 6th-gen and later, AMD equivalents • **MINIMUM GPU** Integrated graphics • **MINIMUM RAM** 8GB • **HARD DISK SPACE** 8GB • **DETAILS** www.adobe.com • **PRODUCT CODE** Premiere Pro CC • **FULL REVIEW** Jul 2019

KASPERSKY Security Cloud

Security software

★★★★★

£50 • www.kaspersky.co.uk

COMPUTER SHOPPER BEST BUY

It's just as effective as Kaspersky Total Security, but Security Cloud goes a step further by learning your bad security habits and warning you about them.

OS SUPPORT Windows 7/8/10, OS 10.11/macOS 10.12, Android 4.1 and later, iOS 10/11 • **MINIMUM CPU** 1GHz • **MINIMUM GPU** None • **MINIMUM RAM** 1GB (32-bit), 2GB (64-bit) • **HARD DISK SPACE** 1,020MB (Windows), 1,110MB (Mac) • **DETAILS** www.kaspersky.co.uk • **PRODUCT CODE** Security Cloud • **FULL REVIEW** Jan 2018

NORDVPN

Virtual private network

★★★★★

£9 per month • www.nordvpn.com

COMPUTER SHOPPER BEST BUY

There are cheaper VPN services available, but none has the flexibility and multi-level security features of NordVPN. It's become much faster than previous versions, too.

OS SUPPORT Windows, macOS, iOS, Android, DD-WRT router • **DETAILS** www.nordvpn.com • **PRODUCT CODE** NordVPN • **FULL REVIEW** Sep 2018

CYBERGHOST VPN

Virtual private network

★★★★★

£2.10 per month • www.cyberghostvpn.com

COMPUTER SHOPPER BEST BUY

In addition to safeguarding your privacy, CyberGhost VPN is particularly well suited to unblocking content on different streaming services. Connecting to new servers could be a bit faster, but once you're connected, everything is nice and stable.

OS SUPPORT Windows, macOS, iOS, Android • **DETAILS** www.cyberghostvpn.com • **PRODUCT CODE** CyberGhost VPN • **FULL REVIEW** Nov 2019

McAFEE Internet Security 2019

Security software

★★★★☆

£8 • www.amzn.to/2X5sQBL

COMPUTER SHOPPER RECOMMENDED

Impressively, the 2019 version takes McAfee Internet Security from an industry damp squib to one of the most reliable security suites on the market. Malware detection is vastly improved and performance is better, too.

OS SUPPORT Windows 7/8/8.1/10, macOS 10.12 and later; Android 4.1 and later, iOS 10 and later • **MINIMUM CPU** 1GHz • **MINIMUM GPU** DirectX 9 • **MINIMUM RAM** 1GB • **HARD DISK SPACE** 500MB • **DETAILS** www.mcafee.com • **FULL REVIEW** Apr 2019

APPLE macOS 10.14 Mojave

OS update

★★★★☆

Free • itunes.apple.com

COMPUTER SHOPPER RECOMMENDED

Mojave's small UI improvements and minor added features would disappoint on their own, but together they add up to a great update. It's free, too, so there's no reason not to make the switch.

OS SUPPORT OS X Mountain Lion or later • **MINIMUM CPU** Not stated • **MINIMUM GPU** Integrated graphics • **MINIMUM RAM** 2GB • **HARD DISK SPACE** 12.5GB • **DETAILS** www.apple.com • **FULL REVIEW** Jan 2019

GAMING

XBOX One S

4K games console

★★★★★

£200 • www.argos.co.uk

COMPUTER SHOPPER RECOMMENDED

HDR support is great, but it's the 4K Blu-ray player that makes this sleeker, smaller Xbox One really stand out against the competing PS4 Slim.

PROCESSOR Octa-core 1.75GHz Jaguar • **RAM** 8GB DDR3 • **FRONT USB PORTS** 1x USB2 • **REAR USB PORTS** 2x USB2 • **STORAGE** 500GB/1TB/2TB • **WARRANTY** One year RTB • **DETAILS** www.xbox.com • **PART CODE** Xbox One S • **FULL REVIEW** Dec 2016

OCULUS Go

VR headset

★★★★★

£199 • www.overclockers.co.uk

COMPUTER SHOPPER RECOMMENDED

No longer do you need a decked-out PC or premium smartphone to enjoy VR. The Oculus Go crams all the hardware you need into the headset itself, making virtual reality entertainment as immediate and accesible as it's ever been.

DISPLAY LCD • **RESOLUTION** 2,560x1,440 • **REFRESH RATE** 72Hz • **PROCESSOR** Octa-core 2.4GHz Qualcomm Snapdragon 821 • **RAM** 3GB • **WEIGHT** 467g • **DETAILS** www.oculus.com/go • **PART CODE** Go 32GB • **FULL REVIEW** Sep 2018

NINTENDO Labo VR Kit

VR headset and games

★★★★★

£70 • www.studio.co.uk

COMPUTER SHOPPER BEST BUY

This addition to the cardboard-based Labo series turns your Nintendo Switch into a platform for a myriad of inventive VR minigames. Kids in particular will enjoy constructing the goggles and controllers themselves.

AVAILABLE FORMATS Nintendo Switch • **DISK SPACE** Not stated • **DETAILS** labo.nintendo.com • **PART CODE** Nintendo Labo VR Kit • **FULL REVIEW** Aug 2019

SONY PS4 Slim

Games console

★★★★☆

£250 • www.argos.co.uk

COMPUTER SHOPPER RECOMMENDED

Sony has made the PlayStation 4 even better with a slimmer, neater chassis and superior power efficiency. It's as cheap as the PS4 has ever been as well.

PROCESSOR Octa-core 1.6GHz AMD Jaguar • **RAM** 8GB GDDR5 • **FRONT USB PORTS** 2x USB2 • **REAR USB PORTS** None • **STORAGE** 500GB/1TB/2TB • **WARRANTY** One year RTB • **DETAILS** www.playstation.com • **PART CODE** B01GVQVQH2 • **FULL REVIEW** Jan 2017

Free software guide

It's easy to access your free software. Just go to *www.shopperdownload.co.uk/383* and register with the code from the card insert. Please be aware that you need to have bought the 'Free Software Edition' and not the '£4.50 Edition' to access the downloads

GETTING STARTED
The download instructions on the card insert (opposite) show you how to connect to the download site. Make sure you type in the web address exactly as shown. You'll need your coupon code the first time you log on to the site.

ANY PROBLEMS?
If you need help with any of the software this month, please send an email to *support@creativemark.co.uk*. We check this inbox regularly. Please include the issue number of the magazine and your coupon code.

WHY DOWNLOADS?
In order to provide us with free software, publishers now require us to offer the applications as a download and require online registration. You need to use the unique code printed in the box on the card insert to register and download the software in this issue. The unique code means we stop the deals leaking online, so only *Shopper* readers get the software.

NO CODE?
If you don't have the card insert with the unique code, you must buy the £4.99 'Free Software' print version of the magazine. If you have this edition and still don't have a card, please contact *letters@computershopper.co.uk*.

REGISTER YOUR SOFTWARE BY 12th DECEMBER 2019

Steganos Safe 20

STEGANOS SAFE IS a versatile tool that aims to protect your most important files in a secure encrypted vault. You can create this vault on a system drive, but it's also possible to use an external drive or USB key, enabling you to keep your files safe as you carry them around.

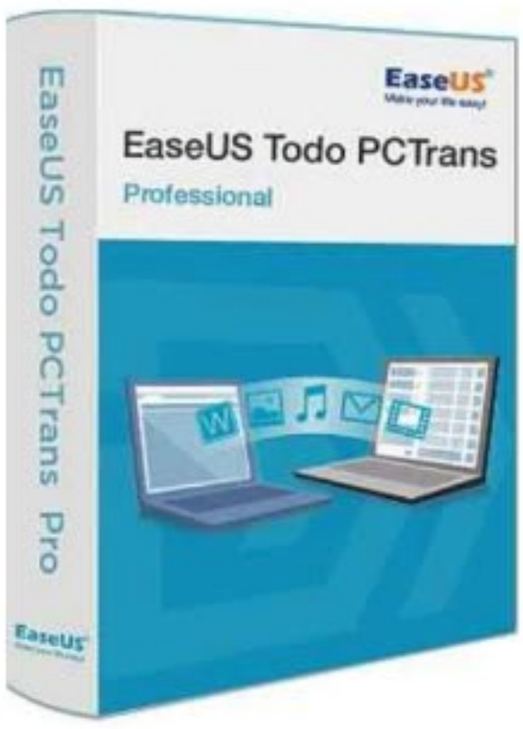
The vault is protected by a password, and Steganos Safe goes to a lot of trouble to ensure it's as secure as possible. For instance, enter a password manually and the program checks to make sure it doesn't contain any dictionary words. There's also a password generator to automatically create something really uncrackable, and you can even use pictures as your password.

Once your vault is generated, it's available in Explorer as another drive. You can create folders, copy, move or store data there and everything works like your other drives. But the difference here is Steganos Safe encrypts data as it's saved, ensuring only someone with the password can gain access.

You can even create a 'hidden safe', where a small safe (less than 3GB) is hidden inside an audio or video file. Snoopers might see a media file, and be able to play it as usual, but only you will be able to access the data it contains.

Cloud storage support also enables safes in your Dropbox, OneDrive or Google Drive accounts, and the feature set is rounded out with a comprehensive Shredder, securely deleting any remnants of confidential files to ensure they can't be recovered later.

REQUIREMENTS Windows 7, 8 or 10; 150MB hard disk space
WEBSITE www.steganos.com
NOTES Get your registration code at safe20.disc.computershopper.co.uk



EaseUS Todo PCTrans Professional 9.7

THIS PLEASANTLY SIMPLE wizard-based tool makes it easy to transfer data from an old PC to a new one.

To use the program, you must be able to connect both systems to the same network; wired or wireless both work fine, as long as both PCs are running Windows XP or later. The new system should have the same or a later version of Windows, and enough hard disk space to handle whatever you throw at it.

Once this is set up, everything else is relatively straightforward. Install Todo PCTrans on both your old and new computers; tell the program which PC is the source and which is the destination, and select the files you'd like to transfer.

You can transfer the data through a number of options. Simply connect both PCs to your local network and select the remote computer or, if this isn't possible, write the data to an image file and then simply load the file on the remote/new computer. Alternatively, if you can connect an external USB drive, use this to transfer your installed data.

There's an option to remap your drives, so, for example, a C:\Backups folder could be transferred to D:\Backups on the new PC: useful if you're storing your data on a separate internal storage drive.

REQUIREMENTS Windows XP, Vista, 7, 8, 10; 100MB hard disk space
WEBSITE www.easeus.com
NOTES Get your registration code at pctrans.disc.computershopper.co.uk

Abelssoft EasyBackup 2020

BACKING UP important data can be such a chore that it's easy to forget until it's too late.

With the rise of cloud-based storage, we rely on keeping our files stored, safe and secure. The problem with the cloud is that it relies on the same content on your PC. Cloud storage simply mirrors the files you've stored locally. If you remove files from your cloud folder, your cloud service could automatically find and re-add unwanted replaced files, or corrupted local files could be copied to the cloud in their unusable form. This isn't always the case, but we'd still advise against using cloud services such as Dropbox as a primary backup solution.

With this in mind, we'd always recommend a dedicated backup tool such as EasyBackup 2020. Designed to be simple for the novice user, you simply have to select the files you want to back up and the destination, and the tool will do the rest.

Choose the files you want to back up, from locations such as your pictures, documents and music, manually choose individual files and folders stored elsewhere on your computer, then plug in your USB stick or an external drive and your files will be backed up automatically.

Of course, if you later need to recover your data, you can simply load EasyBackup, choose a restore date and retrieve your data from the drive. It's that simple.

REQUIREMENTS Windows 7, 8, 10; 50MB hard disk space
WEBSITE www.abelssoft.net
NOTES Get your registration code within the application

IObit Driver Booster 7 Pro

IOBIT'S DRIVER BOOSTER is a simple and straightforward tool that can scan your system for outdated drivers, then download and install replacements with a click. The Pro version, available to you here, offers additional features such as backup, faster download speeds and wider hardware support.

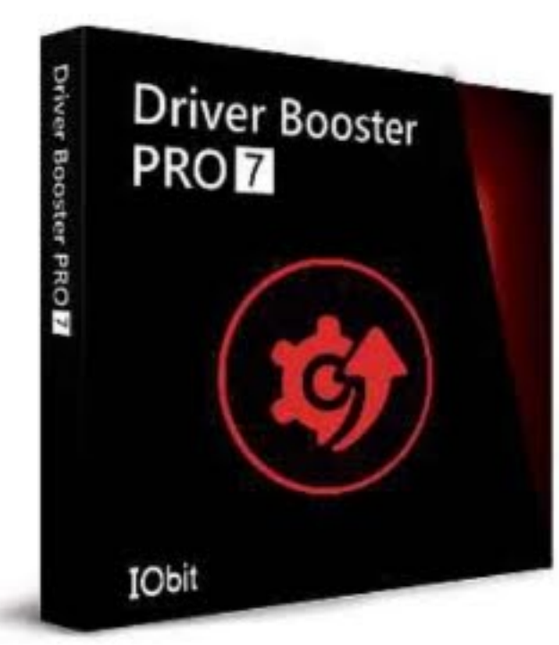
The program is unusually easy to use. There's no complex interface, no searching around trying to decide what you need to do: just launch Driver Booster, it immediately scans your PC, and a detailed report appears a few seconds later.

You can then click the Update button individually for particular drivers, which is handy if you want to keep precise control over exactly what's going on.

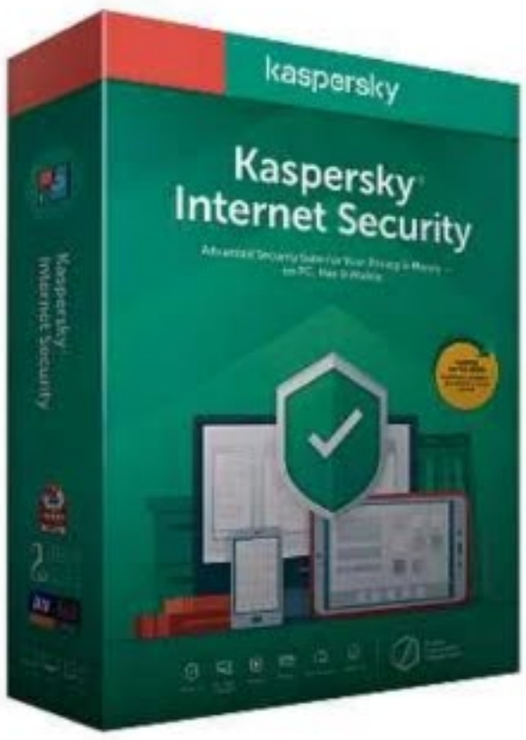
If you're in a hurry, however, just click Update Now, and Driver Booster will download and launch each update. Thanks to a silent update mechanism, you no longer have to manually wade through each and every driver update package, but do expect to reboot at the end of the process.

It's all incredibly straightforward, but more experienced users will also find plenty of tweakable options available should they need them.

Please note that Driver Booster 7 will work as the Free version after installation until you activate using your Pro serial code (see 'Notes' below).



REQUIREMENTS Windows Vista, 7, 8, 10; 70MB hard disk space
WEBSITE www.iobit.com
NOTES Get your registration code at db70.disc.computershopper.co.uk. Includes six months of updates



Kaspersky Internet Security 2020

KASPERSKY INTERNET SECURITY 2020 is a powerful suite of malware-hunting, anti-hacker web safety tools.

There's antivirus, browsing protection, a firewall, exploit protection, a vulnerability scanner, parental controls, webcam and audio protection, online transaction protection and even more tools designed to keep both your privacy and personal information safe.

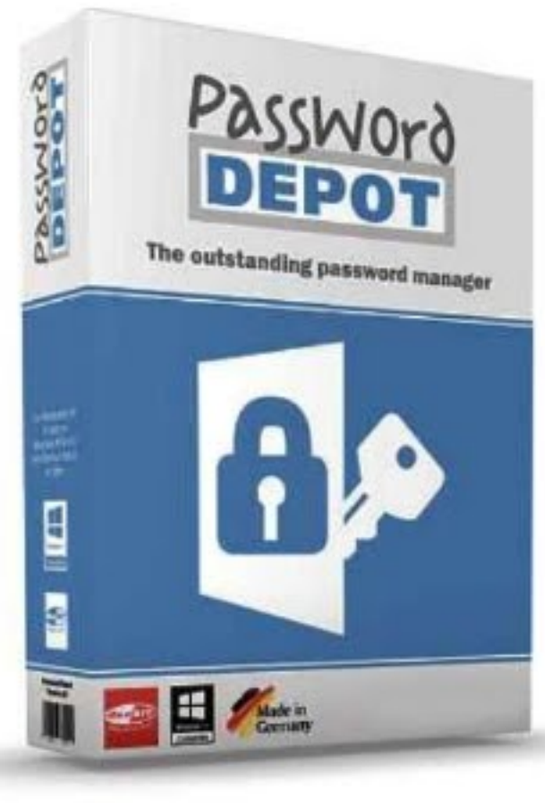
These features have real value, too. Independent testing labs such as AV-Comparatives typically rate Kaspersky as offering some of the best protection around; it's consistently been one of the highest-scoring anti-malware providers for several years now, and is quick to update its protections when new threats arise.

The Software Updater checks for updates to common applications (including Adobe Reader, Flash, Java, Chrome and Firefox, among others), and can optionally install them without you having to see or do anything at all.

The Secure Connection feature is a privacy-oriented virtual private network, automatically kicking in when you use Wi-Fi hotspots, internet banking sites and other potentially sensitive services.

The Installation Assistance tool also looks out for adware and other pests that can get silently installed with certain free software, while the Software Cleaner helps you decide what to remove.

REQUIREMENTS Windows 7, 8 or 10; 2GB hard disk space
WEBSITE www.kaspersky.co.uk
NOTES No need to activate. Includes three months of free updates



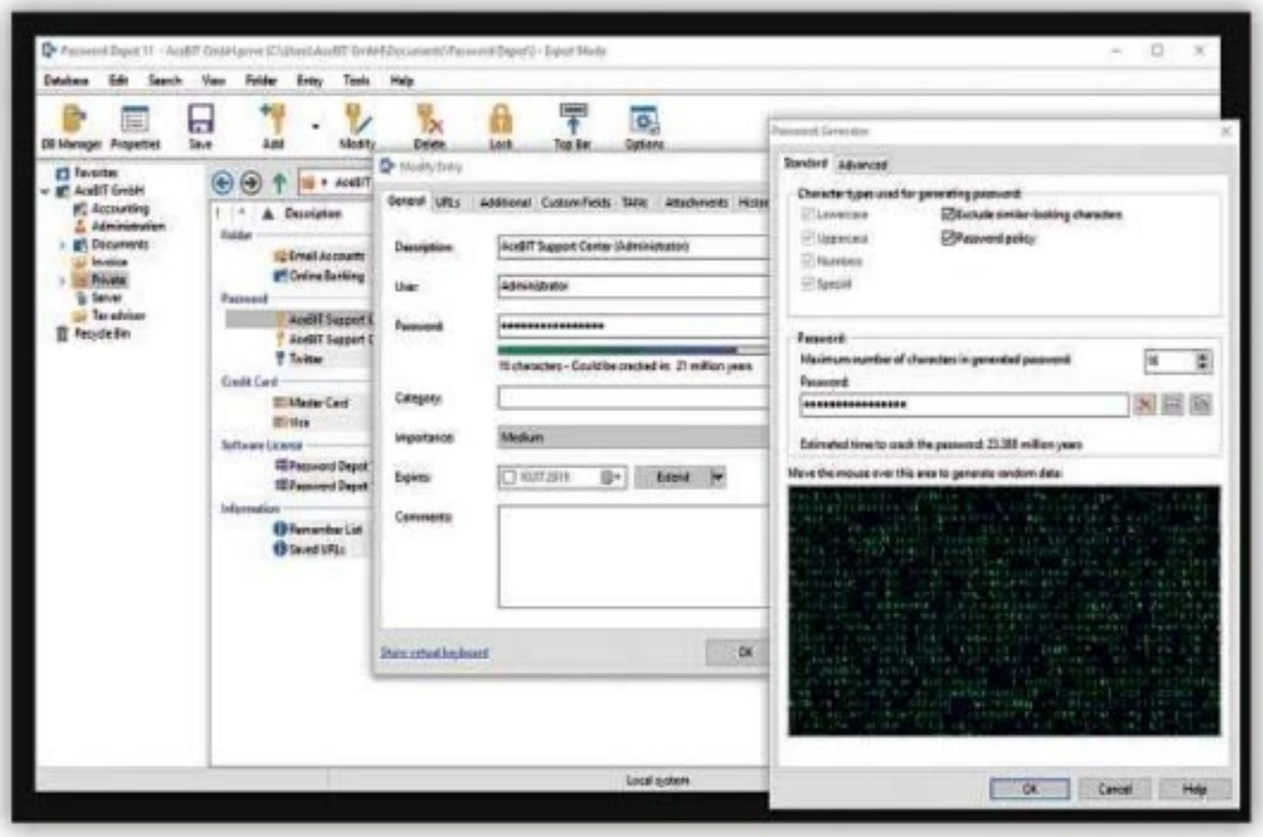
AceBit Password Depot 11

PASSWORD DEPOT IS a password manager that will safely store your login credentials, credit card numbers and other confidential information.

The program starts by creating a secure and encrypted file for your data. This can be stored locally, on a USB drive, or even on an internet server for easy access wherever you are.

Next, the built-in password generator will create lengthy, effectively uncrackable passwords for each of your logins. No need to use easy-to-guess passwords any more, or the same one for each site: let Password Depot generate something like k57&l}\##nkSd7_=de17 instead and your accounts will be far more secure.

You probably won't be able to remember these passwords, of course – but that doesn't matter. Password Depot can automatically fill in your username, password and other data on any web pages you define; this works with Firefox, Netscape, Opera and Internet Explorer. You can also copy passwords and other data to the clipboard for use elsewhere, or you can just drag and drop data to the target field.



In addition, Password Depot includes a lengthy list of password management tools to make your life easier. It's able to import passwords from other managers, for instance, and you can view passwords that haven't been used or changed in a long time. A Favourites list also allows quick access to the passwords you use most frequently.

REQUIREMENTS Windows 7, 8, 10; 100MB hard disk space
WEBSITE www.acebit.com
NOTES Get your registration code at pd11.disc.computershopper.co.uk

COMPUTER SHOPPER Resources

Chat and Communication

UPDATED **Evernote 6.21.2.8716** Store your notes, ideas and plans in the cloud, and synchronise them between computers.

UPDATED **Mailbird 2.6.12.0**
A free desktop email client for Windows.

Miranda IM 0.10.80
Chat with friends across multiple messaging platforms, including AIM, Facebook, IRC and MSN, all from one simple interface.

UPDATED **Skype for Windows 8.553.0.85** Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

UPDATED **Telegram 1.8.15** This free IM app synchronises your conversations across multiple devices, and can spruce up chats with stickers and GIFs.

UPDATED **WhatsApp Desktop 0.3.4941** A free PC and Mac version of the popular messaging app, letting you chat from your desktop.

Customisation

NEW VERSION **iolo System Mechanic Free 19.1.4.107** Speed up your system with iolo's PC optimisation suite.

UPDATED **Rainmeter 4.3.1**
Customise the desktop with your choice of tools and shortcuts.

Windows 8 Transformation Pack 9.1
Emulate the look of Windows 8 on an earlier version of the operating system.

Windows 8 UX Pack 9.1
Get a glimpse of the Windows 10 UI without committing to a full OS upgrade.

Windows 10 Transformation Pack 7.0
Bring some of Windows 10's new features to your current operating system.

Winstep Xtreme 19.2
Freshen up your system with this suite of desktop and UI replacement applications.

General

Genie Timeline Free 2017 10.0.1.100
Protect your most valuable files with this easy-to-use backup tool.

Paragon Partition Manager 16 Free
Create, format, split, merge and reorganise all your hard disk's partitions.

PeaZip 6.9.2 A tremendously powerful archive-management tool.

Screenshot Captor 4.31.2 Create and manage screenshots the easy way.

UpdateScanner 2.2.0.0 Scan all the software on your PC, find out if an update is available, then install it immediately.

ZipGenius 6.3.2.3116 A flexible file-compression tool with support for a huge number of compressed file formats.

Internet and Network

UPDATED **CarotDAV 1.15.6**
Manage all your online storage services with one simple application.

UPDATED **Cyberduck 7.1.1**
A powerful but easy-to-use FTP client for uploading and downloading your files.

UPDATED **Glasswire 2.1.166.0**
Keep tabs on your network usage with this simple monitor.

UPDATED **FileZilla 3.45.1** A fast and reliable FTP client with lots of useful features.

UPDATED **NetBalancer 9.14.1**
Make the most of your internet connection by assigning download and upload priorities to web applications.

TeamViewer 14.5.5819
Remotely control your computer from anywhere in the world.

Tweaking and Performance

UPDATED **CCleaner 5.62** Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

Defraggler 2.22 Ensure that your system is defragmented properly and improve its performance.

Finestra Virtual Desktops 2.5.4501 Set up four or more virtual desktops on your PC.

UPDATED **IObit Advanced SystemCare Free 12.6.0.369** A complete computer security, maintenance and optimisation suite.

Revo Uninstaller Free 2.1.0 Remove installed applications completely, including all their folders, system files and Registry entries.

Simple Performance Boost 1.0.5 Tweak the Windows Registry to give your PC a performance boost. CS

FRAMES & FORTUNE

Graphics cards

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NVIDIA GeForce RTX 2080 Ti

The current crop of graphics cards is the best ever, spanning everything from sprightly budget models to monstrously powerful high-end GPUs. We test the best AMD and Nvidia models, whatever your needs

THE GRAPHICS CARD market has gone through some big changes in recent months. While there are still only two big names in town, AMD and Nvidia – we'll be waiting a while longer for Intel's rumoured GPU project to materialise – both firms have made strides forward, with AMD launching its first truly excellent cards in years and Nvidia reworking almost its entire GeForce RTX range with upgraded specs.

It's an exciting time, especially as the rising fidelity of games means that dedicated graphics will always be facing greater challenges. For those looking to upgrade, or to make the big switch from integrated graphics to a dedicated card, we've made it easy to choose your next GPU by testing nine major models from multiple AMD and Nvidia series.

Since these start with affordable budget GPUs, all of them will be able to run the latest games at 1080p resolution, but we'll also be on the search for the ideal 1440p and 4K-ready graphics cards, going all the way up to the fearsome GeForce RTX 2080 Ti. Certain GPU prices sit above what their direct predecessors might have cost, but the great inflation of 2017 – brought about by an explosion in cryptocurrency mining and its requisite PC hardware – has long subsided, so you shouldn't have much trouble finding something to fit any budget.

RAM RAID

Graphics processors work by providing the computing power needed to run the complex texture, lighting and physics calculations that visual software uses to produce an onscreen image. A CPU's integrated graphics can do enough to get Windows and basic software up and running, but a dedicated GPU can process far more data at once, hence why graphics cards are so useful for games, video editing and 3D modelling applications alike.

Like a CPU, a GPU consists of multiple processor cores, except they're much smaller and number in the hundreds or thousands rather than the low double digits. More cores is likely to equal better performance, although how fast these cores run will also be a factor: again like CPUs, there's a base clock speed and a higher boost clock speed, which can kick in when there's sufficient thermal headroom to do so.

Memory, or video RAM (VRAM), can also affect performance. Graphics cards have their own memory that works independently from the PC's system RAM, and having more available will allow for more processes to be completed without a bottleneck forming.

We wouldn't say there's a minimum or ideal number of processor cores (called CUDA cores on Nvidia architectures, and stream processors on AMD architectures), but even at budget level you should try to get at least 4GB of memory. Some games will also explicitly require at least 6GB or even 8GB to enable their best graphical settings.

SPEED MERCHANTS

To test each GPU, we installed it in our usual benchmarking system, which uses an Intel Core i7-4770K processor running at stock speeds, and ran the built-in benchmarking tools of the games Dirt Showdown, Metro: Last Light Redux and Tomb Raider. We also ran the SteamVR Performance Test benchmark tool, which measures performance in VR games specifically.

You can read more about each test game on page 81, but ultimately the idea is to see how each graphics card handles games that are very different in the amount of horsepower they need and how they're optimised for different hardware. We always used the highest possible quality settings, as well as anti-aliasing (except when stated), so the results should tell you how well a GPU can run each game at its respective best. Generally, 60fps is the number to aim for, with 30fps being the absolute minimum; anything over 60fps is good, but you'll need a monitor with a high refresh rate to see the difference.

It's also worth remembering that as frame rates get especially high, you start to get diminishing returns in terms of visible smoothness. For example, a game running at 40fps will appear clearly smoother than it does at 30fps, but the difference between 130fps and 140fps will be much harder to perceive, even though the gap is 10fps in both cases. Don't, therefore, feel obliged to spend more if the graphics card you initially want is already performing highly.

HEATING CONTEST

We've also tested each card on thermal performance, using the free GPU-Z utility to measure core temperatures at idle and under heavy load. GPU overheating is a rare problem even on cards that come pre-overclocked by the manufacturer, but cooler is better regardless: heat building up inside your PC can make it run slower and noisier, and as one of the largest PC components, graphics cards can contribute to unnecessary toastiness.

We typically find that open-air coolers – which use fans to expel heat away from the GPU – are both more effective and quieter than blower-style coolers, which suck cold air into an enclosed chamber, pull it across the hot GPU and then blow the heated air out the back. Since most GPUs come in a variety of 'partner' models, made by companies such as MSI, Zotac, Asus, Gigabyte, EVGA and so on, you'll typically have a selection of different cooler designs to choose from, although the underlying GPU will perform similarly, if not identically, across them. Open-air-cooled cards also tend to be more expensive, so it can be worth putting up with a blower cooler if the saving is big enough.

ELECTRIC BOOGALOO

There are higher priorities than power efficiency when choosing a graphics card, but it's still worth noting how much juice a GPU needs to run. The most powerful models can chug up to 300W when under load, and so will need to be paired with a sufficiently powerful PSU – at least 650W – to ensure that both it and the rest of the PC are receiving enough juice. You'll also need to make sure you have enough 8-pin and 6-pin PSU cables to deliver that power to the GPU, as higher-end cards will require multiple connectors.

At the other end of the scale, some budget cards might not need any cables at all, and can get all the power they need from their PCI-E motherboard slot. This might be an attractive quality if you're building, say, a compact system where extra cables might get in the way, or you're concerned about the environmental impact of your PC's power usage.

THE BEST GRAPHICS CARDS FOR...

Full reviews start over the page, but these are our top picks for gaming at different resolutions

1080p

AMD Radeon RX 570

Once upon a time this GPU merely bridged the gap between the entry-level RX 560 and the mid-range RX 580, but while there have always been preferable alternatives to those cards, the RX 570's drastic price drops have seen it settle as a powerful budget option. It's cheaper and faster than Nvidia's much newer GTX 1650, and can even make a fair go of 1440p in certain games. It excels as a 1080p card, however, performing as well as it needs to make lower-end GPUs look underpowered and conventional mid-range cards look like overkill.

1440p

AMD Radeon RX 5700

An obscenely good-value graphics card at £290, this cruises through games with very nearly the same ease as the RTX 2060 Super: a newer and better-cooled GPU that was made, in large part, to take down the RX 5700. Since Nvidia's card is much more expensive, we recommend the Radeon instead. There's simply nothing this affordable that runs as well at 1440p, its 111fps result in Tomb Raider being a particular highlight. It can't quite reach 60fps in Metro: Last Light Redux, but that's easily fixed by turning off SSAA, which isn't as useful at higher resolutions anyway.

4K

NVIDIA GeForce RTX 2070 Super

This is something of a dead heat with the AMD Radeon RX 5700 XT: the latter is slower, but much cheaper, so it shares the same value-for-money quality as the RX 5700. If there's a reason to stretch the purse strings, however, it's 4K, and the RTX 2070 Super handles this punishing resolution without asking for the exorbitant sums of the RTX 2080 Super and RTX 2080 Ti. Even with slightly lower clock speeds than the RX 5700 XT, it does what AMD's card can't in hitting 30fps in Metro, and manages a slick 75fps in Tomb Raider as well. The RTX 2080 Ti is about 50% faster in both, but we're not sure it's worth paying out more than twice as much for.

AMD Radeon RX 570

COMPUTER SHOPPER BEST BUY ★★★★★

£130 • From www.awd-it.co.uk

VERDICT

Don't be fooled by its age: the heavily discounted RX 570 will outpace any 'true' budget GPU

THE RX 570 is easily the odd one out of all these GPUs. Although it hasn't been directly replaced, making it current-gen in a certain sense, it's not based on the same Navi architecture as AMD's Radeon RX 5700 and RX 5700 XT, and it's not even from last year. In fact, it launched all the way back in April 2017, and it's based on the old Polaris architecture that originated with the long-gone RX 480 (*Shopper* 345).

You can still buy it, however, and price drops over time means that this erstwhile mid-range GPU has been enjoying a new lease of life as a powerful budget card. As such, it's worth considering alongside – and even above – much more recent entry-level GPUs such as the GeForce GTX 1650.

SEASONED VETERAN

This isn't too surprising when you remember that the RX 570 was closer in specs to the mid-range RX 580 than it ever was to AMD's more overtly 'budget' GPUs. It combines 4GB of GDDR5 VRAM with 2,048 stream processors (AMD's term for cores), and on the Asus ROG Strix RX 570 OC partner card we have here, there have been some relatively bold overclocks to boot.

The reference design (which you can't actually buy, due to the lack of an AMD-built, stock RX 570 card) runs its cores at a base speed of 1,168MHz, boosting to 1,244MHz when temperatures allow. This particular card will instead aim to run at a permanent 1,300MHz in its Silent and Gaming modes, pushing even further to 1,310MHz in OC mode.

It seems to default to Gaming mode, though you can easily switch to Silent mode (which reduces fan speeds) or OC mode by installing Asus' GPU Tweak II software. Since OC mode produces the best performance while also keeping fan noise under control, we used it to conduct our testing.

Besides it totally smashing the RX 470 it replaced, we've always appreciated how the RX 570 could match or even beat the 4GB version of the RX 580 in tests. Most crucially, in 2019, it can reliably outperform the more expensive GTX 1650 as well. Its focus on slick 1080p gaming was evident in Dirt Showdown running at 1080p, where it produced 118fps, and going up to 2,560x1,440 only caused it to drop to 98fps. Compared to the GTX 1650's respective 101fps and 76fps, it's no contest.

The RX 570 is hard to fault in Tomb Raider as well. It averaged 92fps at 1080p and 63fps at 1440p, again beating the GTX 1650 on both counts. Maintaining high frame rates in Metro: Last Light Redux proved to be a much bigger ask, but the RX 570's 45fps at 1080p is still perfectly fine to play without the need to make any cuts to graphical quality. The GTX 1650 averaged 31fps here, which is also technically playable, although 45fps looks a lot smoother in motion.

However, 1440p is too much for both cards: the RX 570 still comes out ahead but its 25fps result needs improvement. Luckily, that can be easily attained by disabling SSAA: this doubles the frame rate to 50fps, which also happens to be significantly higher than the GTX 1650's 34fps under the same conditions.

TWEAK WILLED

This isn't the best card for virtual-reality hardware (not least because it only has one HDMI port in addition to its single DisplayPort and two DVI-D outputs), but it's quite capable of playing most VR games at medium quality or higher. That's according to the SteamVR Performance Test, in which the RX 570 scored 6.6 out of 11. While that doesn't sound great, it's still rated as 'High' by the Valve-designed benchmark, whereas the GTX 1650's score of 5.4 is classed as 'Medium'.

For the sake of thoroughness, we also ran our gaming benchmarks in the default Gaming mode, and the results were at most a meagre one or two frames lower than in OC mode, so GPU Tweak II is just an option rather than must-have software. That said, it has other uses, too – it can enable a 0Db fan mode, for instance, which will disable both fans when the GPU's load is light enough that it can get by with passive cooling. This obviously allows for silent running, although even in OC mode, this is a pleasingly quiet graphics card.

Nonetheless, temperatures are kept under control. When idling, it hovers around 36°C, rising to 72°C under heavy load and only ever peaking at 74°C. This and power consumption are the two areas where Nvidia's budget GPU wins out: it's both much cooler under load, and uses a tiny amount of electricity, never exceeding its 75W TDP. The RX 570's performance advantage is worth it, but it runs hotter and can slurp up to 155W, more than twice as much juice.

Looks-wise, the angular plastic of the ROG Strix RX 570 OC keeps it in line with all other ROG Strix cards, including more recent ones, so don't worry about getting old-fashioned design with this older GPU. There's even a touch of addressable RGB lighting on the side, and this can be synced with Asus's AURA system to match the LED colours and effects of other Asus hardware in your PC.

WILD CARD

Ultimately, the worst thing you could say about the RX 570 is that it doesn't stand up to current mid-range performance. The GTX 1660 Ti, for instance, performs much better, as does the Radeon RX 5700. Regardless, its pricing puts it in budget territory, where it's comfortably the fastest around. Pick one up if you're trying to stay below £150; it's a convincing reminder that newer doesn't always mean better.

AMD Radeon RX 5700

COMPUTER SHOPPER BEST BUY ★★★★★

£290 • shop.amd.com

VERDICT

AMD finally claims the mid-range GPU crown with this brilliantly powerful, and surprisingly cheap, Navi card

IN MANY WAYS, the RX 5700 is everything you'd expect from the lesser model in a two-strong GPU launch. Where the RX 5700 XT is grooved and interesting-looking, this is a plain grey box without so much as a backplate to cover the circuit board. Where the RX 5700 XT is running at its full capacity, the RX 5700 is intentionally hobbled with a lower core count and clock speeds than its GPU can allow for.

And yet, of these two graphics cards – the long-awaited Navi line-up that introduces AMD's revamped RDNA architecture – the RX 5700 ends up as an arguably even better deal than its more capable sibling.

LITTLE BROTHER

Before we explain why, a reminder of the RX 5700's specs: it has the same underlying processor as the RX 5700 XT, including 8GB of GDDR6 memory, but with only 2,304 stream processors enabled, a lower base clock speed of 1,465MHz and a lower maximum boost clock speed of 1,725MHz. AMD says you can more likely expect around 1,625MHz when gaming, due to heat constraints.

This is, if the price didn't already give it away, a mid-range graphics card, intended both to outperform the GeForce RTX 2060 and undercut the RTX 2060 Super that Nvidia released shortly after AMD's own launch. By the looks of our testing, the RTX 2060 Super does have the edge on performance – chalk that up to its newly upgraded 8GB of memory and tuned clock speeds – but considering how much cheaper the RX 5700 is, we'd say it does an awfully good job of making sure it never falls too far behind.

Dirt Showdown saw our test PC's CPU being the limiting factor once more, as the RX 5700 scored 111fps at both 1080p and 1440p, both identical results to those of the RX 5700 XT, and almost identical to those of the RTX 2060 Super, which scored 110fps at 1440p. 4K proves more useful as a point of comparison, although both GPUs were once again neck and neck on 97fps. That's also 11fps higher than the standard RTX 2060.

In Metro: Last Light Redux, the RX 5700 yielded 86fps at 1080p, 51fps at 1440p and 23fps at 4K, all representing small leads over the RTX 2060, although the RTX 2060 Super is slightly faster at all three resolutions. Not by much, mind – 57fps at 1440p is closer to the 60fps ideal but only 6fps ahead of the more affordable RX 5700, and Nvidia's GPU still can't reach 30fps at 4K, producing 26fps instead.

At this highest of our tested resolutions, there's a similarly small gap after turning off SSAA: the RX 5700 managed 46fps to the RTX 2060 Super's 51fps. It's heartening to see a sub-£300 graphics card manage at least reasonable 4K performance in Metro, even if its focus is arguably more on 1440p and 1080p, although dropping from Very High to High would be preferable for regular play.

Tomb Raider required no such sacrifices, as the RX 5700 produced 168fps at 1080p, 113fps at 1440p and 58fps at 4K, all with the Ultimate quality preset and FXAA in effect. This presented the only occasion when the RTX 2060 Super broke double digits on its performance lead; if you have a 144Hz monitor, you might appreciate how it scored 129fps at 1440p. The difference at 4K was, however, marginal at best: 62fps on the RTX 2060 Super isn't that different to 58fps on the Radeon.

SCRAPPY RETURNS

Rounding out our performance benchmarks with a perfect score of 11 in the SteamVR Performance Test, the RX 5700 has shown itself to be fantastically spry for a sub-£300 card. In fact, it's fair to say this is the most powerful GPU you can buy for £290: the absolute cheapest RTX 2060 Super partner model we could find is £375, and the GTX 1660 Ti can't compete in a straight frame-rate fight.

Perhaps even more significantly, the RX 5700 is only slightly slower than the RX 5700 XT. At 1080p, both cards produce such high frame rates that the differences are visually negligible, and the cheaper card still does very well at 1440p; it's only 7fps behind the RX 5700 XT in Metro, for example. It's only at 4K where you'd consistently notice the RX 5700 XT's performance advantage.

Furthermore, the RX 5700 keeps up as well as it does while also staying cooler, quieter and more efficient. Other than a very slightly higher idle temperature of 62°C, its load temperature of 76°C and peak of 77°C are both lower than those of the RX 5700 XT, and we noticed the blower cooler being a bit less noisy as well. That's likely a positive side effect of having fewer cores.

It also uses less power, rising to 150W during games and staying there – remember, the RX 5700 XT jumped as high as 212W. This still requires both 8-pin and 6-pin PSU connectors, which is unusual for a mid-range card, but that's the sum of the downsides.

CONSTELLATION PRIZE

If you're not keen on the reference design, custom open-air fan models start from about £340. That's a big bump, though still cheaper than any RTX 2060 Super variant.

Even with its blower-style cooler, the RX 5700 is the Navi card we'd buy for top-quality 1080p and 1440p gaming. The RX 5700 XT is superb for 4K on a budget, and the RTX 2060 Super might appeal if you're determined to use ray-tracing in the few games that support it, but this performs almost as well, and for much less money. It's the mid-range GPU to beat.

AMD Radeon RX 5700 XT

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£329 • From shop.amd.com

VERDICT

A much more affordable RTX 2070 Super alternative for 1440p and 4K

THE SECOND AND more expensive of AMD's 2019 GPUs is the full, unshackled Navi experience: it's the same underlying processor as the RX 5700 with none of the hardware switched off. That means a higher stream core count of 2,560, as well as higher base and boost clock frequencies of 1,605MHz and 1,905MHz respectively.

The RX 5700 XT also has 40 compute units, essentially clusters of stream processors, while the RX 5700 only has 36. Both have the same 8GB of GDDR6 memory, however, running at a maximum memory bandwidth of 448GB/s in both cases.

FRESH STARTS

When it launched a few months ago, these specs were enough to make the RX 5700 XT a clear victor over its then-rival the GTX 2070. The arrival of the RTX 2070 Super complicates matters, if you're looking specifically in the lower-high-end region of graphics cards, but AMD's card weathers this more powerful challenger well.

For one thing, it's a lot cheaper. We're testing the reference design, which you can buy directly for £329 from AMD – £211 less than the Zotac-made RTX 2070 Super model on page 78. Partner versions of the RX 5700 XT are also generally more affordable, even if they commonly land closer to £400.

Second, the performance difference isn't particularly wide, and even when it is clearly in the RTX 2070 Super's favour, it's not quite to the extent that you'd expect that extra money to buy you. The RX 5700 XT is still a very good performer, at 1080p and 1440p especially: in Metro: Last Light Redux, it managed 96fps and 58fps at these respective resolutions. 4K was too much on max settings, with performance dropping to 26fps, but this was quickly raised to 52fps by turning off SSAA.

To give due credit to the RTX 2070 Super, it came out ahead by between 4fps (at 4K) and 11fps (at 1440p), which could be slightly noticeable, although in Dirt Showdown, the two GPUs ran about the same. The RX 5700 XT produced 111fps at 1080p, 111fps at 1440p and 103fps at 4K, which was at worst just 3fps behind the RTX 2070 Super. Again, the biggest difference came at 4K, although the RX 5700 XT shows it can happily run older or less intensive games at this resolution without the need to lower any settings.

It could manage Tomb Raider at 4K as well, averaging 67fps – more than enough for smooth visuals, and only 8fps behind the RTX 2070 Super. Purely numerically, the Nvidia GPU achieved much higher frame rates at 1080p – the RX 5700 XT produced 199fps to the RTX 2070 Super's 230fps – but not only would you need an immensely expensive 240Hz monitor to show these in action, you'd need superhuman vision to perceive a meaningful difference. What's more, the RX 5700 XT managed to become the faster of the two at 1440p, with an excellent 166fps.

Lastly, the RX 5700 XT attained a perfect score of 11 in the SteamVR Performance Test. This card will therefore run any VR game on the market, at high quality, for 90fps or higher. This, however, brings us on to a certain oddity: AMD is a member of the VirtualLink Consortium, an organisation promoting the VirtualLink connectivity standard for VR headsets, yet there's no VirtualLink port on the RX 5700 XT's reference design.

RADEON GAGA

In any event, the RX 5700 XT finally delivers something we haven't really seen since the GTX 1070: a 4K-ready graphics card for less than £350. The RTX 2060 – which, interestingly, also launched at £329 – was another 1440p contender that could handle 4K, but the RX 5700 XT is significantly more capable of such a high resolution without having to drop quality settings, except in the most demanding games.

The big catch, it would seem, is the lack of special features, or at least those on the same impact level as ray-tracing and DLSS. Radeon Image Sharpening is generally worth turning on if you can: it's a filter that adds a modest sharpening effect to parts of in-game scenery that might otherwise look soft or blurred. While the performance cost is negligible, however, it doesn't outright improve performance as DLSS does, and currently there's no support for DirectX 11, making uncountable games incompatible.

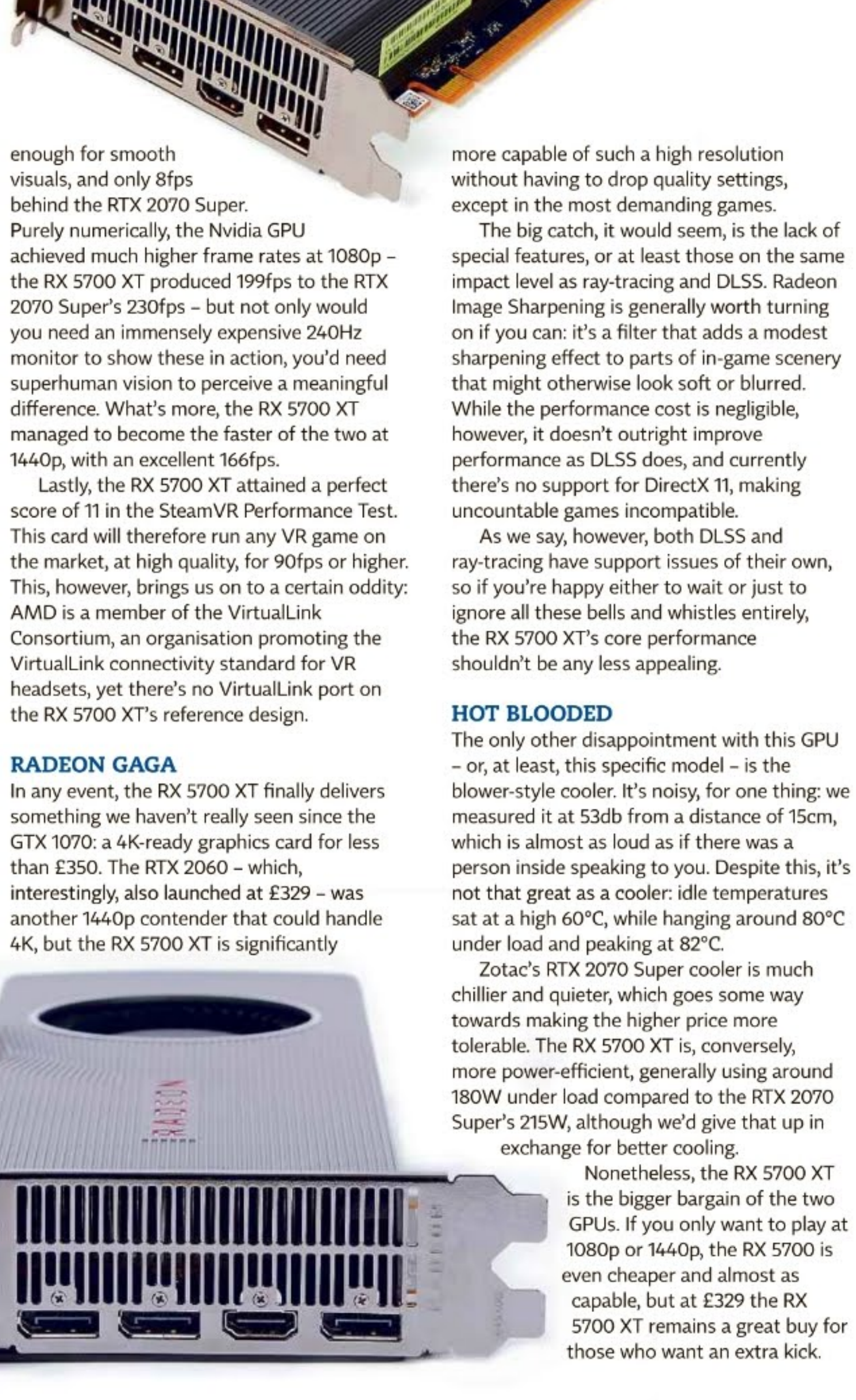
As we say, however, both DLSS and ray-tracing have support issues of their own, so if you're happy either to wait or just to ignore all these bells and whistles entirely, the RX 5700 XT's core performance shouldn't be any less appealing.

HOT BLOODED

The only other disappointment with this GPU – or, at least, this specific model – is the blower-style cooler. It's noisy, for one thing: we measured it at 53db from a distance of 15cm, which is almost as loud as if there was a person inside speaking to you. Despite this, it's not that great as a cooler: idle temperatures sat at a high 60°C, while hanging around 80°C under load and peaking at 82°C.

Zotac's RTX 2070 Super cooler is much chillier and quieter, which goes some way towards making the higher price more tolerable. The RX 5700 XT is, conversely, more power-efficient, generally using around 180W under load compared to the RTX 2070 Super's 215W, although we'd give that up in exchange for better cooling.

Nonetheless, the RX 5700 XT is the bigger bargain of the two GPUs. If you only want to play at 1080p or 1440p, the RX 5700 is even cheaper and almost as capable, but at £329 the RX 5700 XT remains a great buy for those who want an extra kick.



NVIDIA GeForce GTX 1650

★★★★☆

£143 • From www.ebuyer.com

VERDICT

The GTX 1650 is Nvidia's most powerful budget GPU yet, but it faces a strong challenge from the RX 570

IT'S BEEN ALMOST a year since Nvidia first announced its GeForce RTX 20-series cards, but we finally have a replacement for the entry-level GTX 1050 as well. The GTX 1650 is a world away from the monster frame rates and real-time ray-tracing of its RTX cousins, joining the GTX 1660 Ti (overleaf) and GTX 1660 in the more affordable 16-series, but it's still an interesting position, especially when it's in the tiny form factor of this Zotac GeForce GTX 1650 OC model.

The GPU within is the cheapest of Nvidia's current crop, and without a GTX 1650 Ti to compete with, is the only truly 'budget' GPU of the entire generation as well. To help shoulder this responsibility, it has 4GB of GDDR5 memory – twice that of the GTX 1050 – as well as an increased CUDA core count of 896.

SHORT AND SWEET

GTX 1650 processors have a stock boost clock of 1,665MHz, but Zotac has overclocked this ever so slightly to 1,695MHz. Its design comprises a simple, single-fan cooler, with the bare minimum of video outputs on the rear: one HDMI port, one DisplayPort and one DVI-D connector. There's no VirtualLink USB Type-C port for VR headsets, as you'd get on certain RTX 20-series cards.

This simplicity has its benefits, however. At only 151mm long it's about as miniscule as GTX cards come, and there are no 6-pin or 8-pin PSU power connectors because it doesn't need any. The GeForce GTX 1650 OC can be powered entirely through its PCI-E x16 slot on the motherboard, which when combined with its small stature, makes it potentially perfect for compact PC builds where the case might not allow for longer cards or have adequate cable routing.

It's no surprise that the GTX 1650 outpaces the GTX 1050 on core performance, but in most tests it's markedly faster than the GTX 1050 Ti as well. This is most dramatically visible in Dirt Showdown, where at 1,920x1,080 with Ultra settings enabled, the newest GPU averaged 101fps – far more than the GTX 1050, which managed 74fps, and the GTX 1060 Ti at 81fps. It's also a highly favourable matchup against AMD's Radeon RX 560, another budget GPU, which scored 75fps.

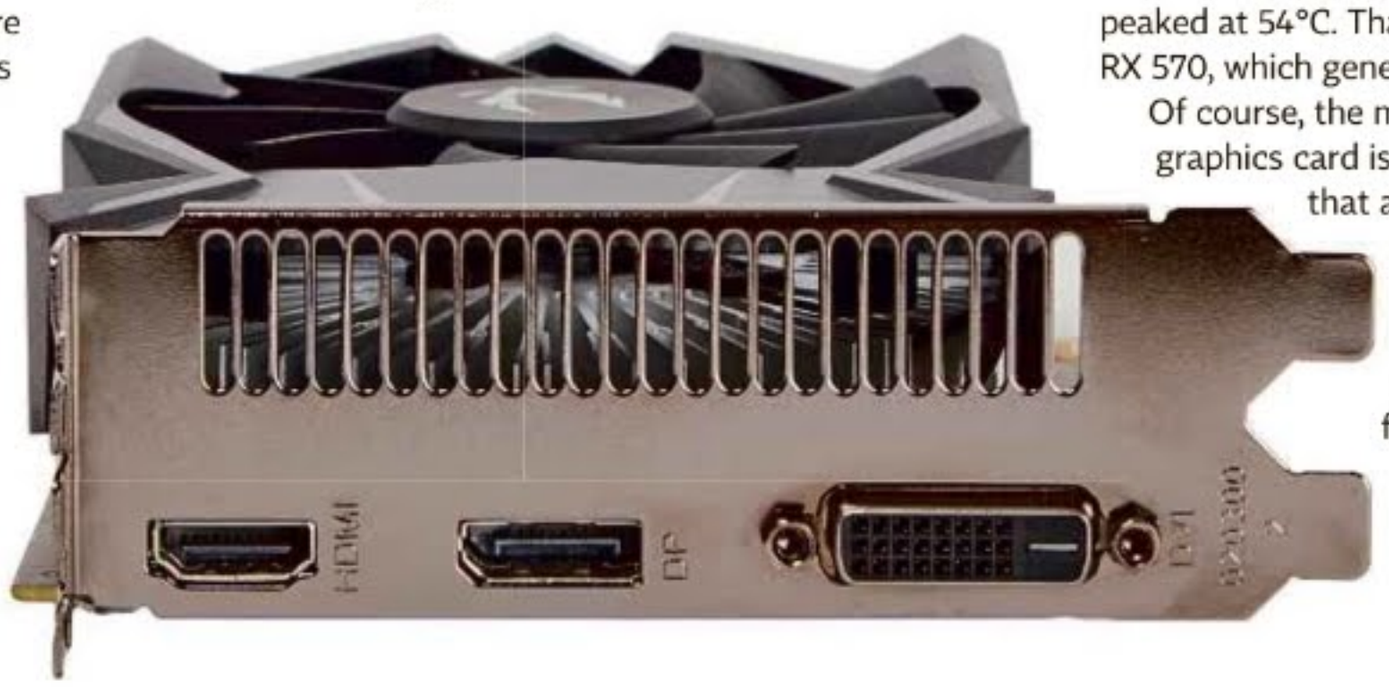
The GTX 1650 has improved ability at 2,560x1,440, too: at this resolution it stayed smooth in Dirt, producing 76fps with Ultra settings still in place.

DEMAND AND CONQUER

More graphically demanding games will push the GTX 1650 to its limits. Metro: Last Light Redux averaged a barely acceptable 31fps at 1,920x1,080 with the Very High preset, and going up to 2,560x1,440 dropped this to a spluttering 17fps. Nonetheless, at least it actually reaches the 30fps mark at 1080p, where the GTX 1050, GTX 1050 Ti and RX 560 all fall short. 1440p isn't entirely out of the question, either. Turn off SSAA and 17fps jumps to 34fps, which is enough to get by on.

Tomb Raider runs well, too, with its integrated benchmark ending at 77fps at 1,920x1,080 and 48fps at 2,560x1,440, both with the Ultimate quality setting and FXAA smoothing out edges. Once again, that's a total victory for the GTX 1650 over its budget rivals, as at 1080p, the GTX 1050 produced 55fps, the GTX 1050 Ti 62fps and the RX 560 a mere 49fps.

Finally, although we wouldn't call this an ideal graphics card for VR, it can handle most current games at medium settings. That's according to the SteamVR Performance Test, which gave it a medium-tier score of 5.4.



Performance-wise, the GTX 1650 leads the way on what you can expect from an overtly low-end GPU. Of the other three, the only one that's still worth buying is the GTX 1050, and that's only if you absolutely can't spend more than £100.

However, it's not just budget cards that the GTX 1650 has to contend with. As we've already seen, the AMD Radeon RX 570 has plummeted in price from the mid-£200 range to just £130, putting this mid-ranger right next to the GTX 1650. The Asus ROG Strix RX 570 model confirms it's a far better deal: at 1080p it scored 118fps in Dirt, 45fps in Metro and 92fps in Tomb Raider.

That's a heavy blow to the GTX 1650 as an actual purchase proposition, but it's not necessarily a fatal one. Its petite dimensions allow it to fit into Mini-ITX cases that even smaller partner variants of the RX 570 cannot, and it's a lot more efficient, too. We recorded Asus's RX 570 using up to 155W under load, but according to GPU-Z, the GTX 1650 only ever peaked at 90% of its 75W TDP, about 68W.

NIP IN THE AIR

Despite the single fan, it also runs quietly and very cool. An ideal temperature of 30°C is fine but the GTX 1650's load temperature of 53°C is downright excellent, and it only peaked at 54°C. That's much chillier than the RX 570, which generally ran around 72°C.

Of course, the main reason to buy a graphics card is performance, and on that alone the RX 570 is unquestionably the better buy. For the niche appeal of its size and efficiency, the GTX 1650 scrapes a fourth star, although a recommendation only applies if you specifically need a smaller, more discrete GPU.

NVIDIA GeForce GTX 1660 Ti

★★★☆☆

£305 • From www.box.co.uk

VERDICT

Once a great mid-ranger, better-value alternatives end up leaving the GTX 1660 Ti behind

IT WAS ALWAYS likely that Nvidia's Geforce RTX graphics cards wouldn't entirely kill off the older GTX series: RTX cards are defined by their baked-in support for ray-tracing and DLSS anti-aliasing, but these still require at least fairly beefy GPUs to pull off, so cheaper cards without these features would still be a viable option unless Nvidia wanted to abandon the budget market completely.

What we didn't expect, however, was that there would be a GTX successor to the mid-range GTX 1060, something that's already been replaced by the RTX 2060 and now the RTX 2060 Super as well. There are two, in fact: the GTX 1660 and the slightly faster GTX 1660 Ti.

KEEP IT SIMPLE

Surprise aside, this does make a certain sense. As good as the RTX 2060 and RTX 2060 Super both are, they're pretty pricey by mid-range standards, and the lack of games with either ray-tracing or DLSS integration means that these features alone aren't yet worth splashing out more for. Notably, Nvidia has recently enabled very basic ray-tracing functionality on most GTX cards via a driver update, although they won't be able to run, say, Metro: Exodus's global ray-traced illumination while maintaining playable performance.

Either way, there's still room for a more affordable mid-range Nvidia card for PC builders who can live without those two key RTX features, and we've tested the MSI GeForce GTX 1660 Ti Gaming X 6G to see whether this is it.

At £300, it's one of the more expensive partner card models available (others start at as little as £260), but it's very nicely made, with a sturdy aluminium backplate and some tastefully positioned RGB lighting strips. Crucially, it's also cheaper than the RTX 2060 Super, although it's also £15 more than the AMD Radeon RX 5700's starting price.

The arrival of this all-new AMD GPU makes life an awful lot harder for the GTX 1660 Ti; while it, too, was designed without fancy tricks like ray-tracing in mind, its core performance impresses hugely for the price.

Our Dirt Showdown benchmarks didn't give the GTX 1660 Ti the best start, either. At 1080p, it only managed 99fps – an underwhelming showing that doesn't even match the 101fps of the entry-level GTX 1650, let alone the RX 5700 and its 111fps. Its 93fps at 1440p is also 18fps behind that of the RX 5700, and its 4K result of 76fps is 21fps slower.

STARK ATTACK

In our other games tests, the GTX 1660 Ti didn't do outright badly, but the RX 5700 invariably performed better. Metro: Last Light Redux demonstrated this rather starkly: with 64fps at 1080p, 36fps at 1440p and just 15fps at 4K, Nvidia's GPU makes the RX 5700 look in a completely different league. The latter also failed to reach 30fps at 4K, but that's not an essential milestone for a mid-range card, and its 51fps at 1440p looks particularly smoother than the GTX 1660 Ti's equivalent result.

Tomb Raider at least allows the GTX 1660 Ti to breathe a little more, and despite its 150fps at 1080p and 95fps at 1440p still placing it behind the RX 5700, the differences aren't as immediately visible as in Metro. 47fps at 4K is decent as well, but the 58fps-scoring RX 5700 remains the more appealing option for higher resolutions.

Virtual-reality performance is much closer: the GTX 1660 Ti scored 10.9 in the SteamVR Performance Test, a mere 0.1 off the perfect 11 that the RX 5700 (and the entirety of the GeForce RTX 20-series) produced. You'll be able to run most VR games on their highest settings without having to worry about big performance drops.

The GTX 1660 Ti is unlucky in a sense, as for a few months between it launching and AMD's new Radeon GPUs appearing, it could actually have been considered rather potent; its closest AMD rival at the time, the RX 590, was slower, noisier and much worse value. The RX 5700 simply set a new standard, one the 1660 Ti has more trouble trying to reach.

It's not all bad news. MSI has added a nicely quiet dual-fan cooler to this model, adorned with some subtle RGB lighting, and this keeps core temperatures down better than the RX 5700's blower cooler. That includes idle temperature, which we measured at 42°C, as well as load and peak temperatures of 63°C and 64°C respectively.

FORCED OUT

The GTX 1660 Ti also uses less power, despite sometimes creeping up to 102% of its 130W TDP under heavy load. You only need to plug in one 8-pin PSU cable, whereas the RX 5700 needs both 8-pin and 6-pin connectors.

Still, since most quality PSUs will be able to handle two power ports, this shouldn't be a concern. The RX 5700 simply performs too well to pass over it in favour of the GTX 1660 Ti; the latter is cooler and more efficient, but at all resolutions (and 1440p in particular) you can often quite literally see the difference. At the very least, it's not worth buying a GTX 1660 Ti partner card that costs more than the RX 5700 – and certainly not one that's only a few pounds less than the RX 5700 XT as well.

NVIDIA GeForce RTX 2060 Super

★★★★☆

£390 • From www.ebuyer.com

VERDICT

The RX 5700 is cheaper and the RX 5700 XT is faster, but this is still a powerful and well-designed graphics card

NOT TO COMPLAIN about an already-good graphics card being relaunched with even better specs, but the RTX 2060 Super risks taking things a bit too far – with the price, anyway. The original RTX 2060 was already pushing the definition of 'mid-range' with its £329 tag, and this £390 model – Zotac's GeForce RTX 2060 Super Mini – is one of the cheapest options available. That's a risky move when both the RX 5700 and RX 5700 XT can be had for less.

That said, sometimes you're paying for qualities besides performance. This Super Mini design is a beauty: it's short enough to fit in most microATX and Mini-ITX cases, but still crams in two good-sized open air fans for optimum cooling. Most of the casing is plastic, but it has a convincing matt metal effect, and there's a strong aluminium backplate covering the circuit board. Besides contributing to a cleaner, more grown-up look, this backplate protects the PCB and makes it easier to wipe away dust.

LESS FOR MORE

All of this puts it in good stead next to the RX 5700, which in return for the lowest possible price, must be bought with AMD's reference design, which is a lot longer than the RTX 2060 Super Mini, and has a less attractive blower cooler as well. However, if you can make room for it, the Radeon GPU has a huge price advantage: you can buy it directly from AMD for just £290, while Zotac's customised card is a full £100 more expensive.

At least hardware-wise, the RTX 2060 Super is significantly souped up over the standard RTX 2060. It has 8GB of GDDR6 memory instead of 6GB, bringing it in line with the RX 5700, and has 256 additional CUDA processor cores, bringing the total up to 2,176. Base clock speeds have also been raised from 1,365MHz to 1,470MHz, and the RTX 2060 Super also has more RT cores – 34 instead of 30 – for improved performance when enabling ray-traced graphical effects.

The end result is that the RTX 2060 Super Mini has a performance advantage over the RX 5700, but the extent will depend on the game. Dirt Showdown, for instance, runs so quickly on both cards that our test rig's CPU became the bottleneck before either of the GPUs did; as such, the RTX 2060 Super Mini produced completely identical scores of 111fps at 1,920x1,080, 111fps (again) at 2,560x1,440 and 97fps at 3,840x2,160.

Metro: Last Light, which is much more GPU-dependent, allows Nvidia's GPU to open up a lead, producing 95fps at 1080p, 57fps at 1440p and 26fps at 4K. This last result might make it look like 4K is beyond the RTX 2060 Super Mini's capabilities, but disabling SSAA boosts it to 51fps, which is enough to enjoy. The RX 5700 sits between 3fps and 7fps behind, which isn't a huge amount but can make for a visible difference below 60fps.

MIND THE GAP

In Tomb Raider, there's also only a small gap at 4K: the RTX 2060 Super Mini averaged 62fps, the RX 5700 58fps. At lower resolutions, however, the RTX 2060 Super Mini is the clear winner, with 187fps at 1080p and 129fps at 1440p. The RX 5700 was quick too, with 168fps and 113fps respectively – we're not convinced you could even tell the difference at 1080p – but for smooth 1440p, the Nvidia card has it beat.

Both GPUs are tied in the SteamVR Performance Test, scoring 11, but the RTX 2060 Super Mini is inarguably the more powerful of the two. Now that a few more games have begun supporting ray-tracing and DLSS, its Nvidia-exclusive feature set is also more appealing than it once was, although don't expect ray-traced performance to be anywhere near as high as that of the RTX 2070 Super, RTX 2080 Super or RTX 2080 Ti.

These advantages make the £100 premium a lot easier to stomach, unless you're likely to be playing older or less demanding games that won't take full advantage of the GPU's strength. That said, it's still a lot of cash for what can sometimes be a single-digit advantage, as there's also the matter of the RX 5700's big brother, the RX 5700 XT.

At £329 for the reference model, this is still cheaper than Zotac's GeForce GPU, and while it lacks ray-tracing or DLSS support, it overtakes it in core performance. Tomb Raider provides the best example for this: the RX 5700 XT produced 199fps at 1080p, 166fps at 1440p and 67fps at 4K, beating the RTX 2060 Super Mini on all three counts.

COOL INTENTIONS

Consequently, the RTX 2060 Super Mini is stuck between the superior value of the RX 5700 and the superior performance of the RX 5700 XT. In terms of a strictly logical purchasing decision, then, either AMD GPU could be the better option.

And yet, it would be unfair to leave the RTX 2060 Super Mini out of the running entirely. It's expensive, yes, but it's also a very capable 1440p card, and it's easier to live with in terms of quietness and coolness: with core temperatures ranging from 28°C at idle to 69°C at load, this is a much better-ventilated graphics card than either of AMD's reference models. Keep it in mind, especially if you're planning a more compact PC, or want to try ray-tracing and DLSS.

NVIDIA GeForce RTX 2070 Super

COMPUTER SHOPPER RECOMMENDED ★★★★☆

£540 • From www.amazon.co.uk

VERDICT

Despite costing more than the RX 5700 XT, higher performance and a far better cooler make this card worth the cash

EVEN AS NVIDIA'S GeForce range has become bigger, more complicated and potentially more confusing – what with all the Ti suffixes and Super variants – its '70 cards have always been reliably good buys.

We therefore have high hopes for the RTX 2070 Super, even if it doesn't go as far as the RTX 2060 Super in upgrading the memory. Here, you get the same 8GB of GDDR6 as the standard RTX 2070, but clock speeds have risen across the board – base speeds are up from 1,410MHz to 1,605MHz, boost speeds up from 1,620MHz to 1,770MHz – and the CUDA core total has jumped from 2,304 to 2,560.

LOST AT C

Our testing model, a Zotac GeForce RTX 2070 Super Amp Extreme, is £540 – pricier than the majority of RTX 2070 cards seem to be. Of course, this is an extensive custom job even by partner card standards. The default dual-fan cooler is gone, replaced by a long triple-fan cooler, and it comes with a factory overclock of 1,830MHz. It's perfectly possible to find cheaper versions without such comprehensive tweaks, however: Zotac itself makes the £490 GeForce RTX 2070 Twin Fan, which has just two fans and runs at stock speeds. This is much more in line with RTZ 2070 pricing.

Even on the more expensive Amp Extreme model, admittedly, the design doesn't scream luxury. The plastic around the fans feels cheap, and while there is a backplate, it's a plain black metal affair; there certainly hasn't been the same attention to design as on MSI's Gaming X Trio design for the RTX 2080 Super and RTX 2080 Ti. There are fewer output ports as well, which is entirely down to the lack of a USB Type-C VirtualLink connector.

This mainly benefits VR headsets, so if you don't own or want one, it won't be a huge concern, although it's always nice how they function as standard Type-C ports as well. In this case, you get three DisplayPort sockets and an HDMI output, so at least basic monitor connectivity is well covered.

When it comes to performance, the RTX 2070 Super has a tough task: it needs to follow its predecessor in providing a genuine high-end alternative to Nvidia's costlier cards, while taking on the Radeon RX 5700 XT, a GPU that has the major advantage of costing up to £211 less.

The RTX 2070 Super has the edge in Dirt Showdown, if only a very small one.

Its 113fps at 1080p, 111fps at 1440p and 108fps at 4K are all equal to or better than those of the RX 5700 XT, but by 3fps at most. More positively, that 4K result – which is the least affected by bottlenecking – is only 2fps behind the RTX 2080 Super, and 5fps behind the RTX 2080 Ti.

AMP IT UP

A more GPU-reliant game, Metro: Last Light Redux, provides more encouraging results. Scoring 106fps at 1080p, the RTX 2070 Super opens up a wider 10fps lead on the RX 5700 XT, and this creeps up to 11fps at 1440p, where Nvidia's GPU managed a very impressive 69fps. In other words, this is the cheapest GPU that can break 60fps at Quad HD resolution. Similarly, it manages 30fps – the absolute minimum you should be aiming for – at 4K, whereas the RX 5700 XT produced 26fps. This seems like another tiny difference, but it can be noticeable when frame rates are this low, unlike when they're sky high in Dirt Showdown. Furthermore, turning off SSAA results in a 62fps average, which is a clearly visible 10fps faster than what the RX 5700 XT did in the same test.

In Tomb Raider, the RX 5700 XT managed a surprising victory at 1440p by outperforming the RTX 2070 Super's 152fps. The latter was faster at 1080p, with 230fps to the AMD card's 199fps, and its 75fps at 4K is a great result. Both GPUs are tied in the SteamVR Performance Test, scoring 11 out of 11.

In all these tests (except SteamVR), the RTX 2080 Super has a modest performance lead, but whether it's worth the £750 you'd spend on it is another matter. At 1080p, you only get an extra 1fps in Dirt, 12fps in Metro and 17fps in Tomb Raider. This last result comes at a point where the game is running so fast that you don't need any more frames anyway. The RTX 2070 Super is therefore better value than the RTX 2080 Super, just as the standard RTX 2070 was to the RTX 2080.

In fairness, the RTX 2070 Super's performance leads over the RX 5700 XT are comparably minor, but this specific Zotac model has some other advantages, too. It's much quieter than the blower-style cooler used in AMD's reference design, and runs much cooler too: we measured an idle core temperate of 36°C, a load temperature of 63°C and a peak temperature of 64°C. That's much less warm on all three counts, especially idle temperature, where the RX 5700 XT was nearly twice as hot. The RX 5700 XT tends to use less power than the RTX 2070 Super, which tended to stay at around its official 215W rating in our benchmarks, but with PC health in mind we'd take that and better cooling over temperatures exceeding 80°C.

HEALTHY COMPETITION

Unlike when we first reviewed the RX 5700 XT, there are now a range of partner versions with (theoretically) improved coolers, but these can cost up to £400 – a serious dent in the RX 5700 XT's price advantage. However, that still leaves a £140 saving, so we won't say the RTX 2070 Super is the entirely better pick for 1440p and 4K gaming. It is, however, a worthy adversary.

NVIDIA GeForce RTX 2080 Super

★★★☆☆

£750 • From www.ebuyer.com

VERDICT

A better overall GPU than the RTX 2080, but still not the best premium card to buy

THE ORIGINAL RTX 2080 was stuck in a difficult position. While undeniably a very powerful GPU, in practice it wasn't sufficiently faster than the RTX 2070 to justify its far higher price, and at the same time, it couldn't match the outright ground-breaking performance of the RTX 2080 Ti. Flanked on both sides by better value and better power respectively, there was little convincing reason to choose the RTX 2080.

The new RTX 2080 Super at least seems to have the right idea on how to avoid a similar fate. The core specs have been upgraded to hopefully bring it closer in line with the RTX 2080 Ti. The CUDA core count has risen from 2,944 to 3,072, and the new GPU also has 48 ray-tracing cores to the RTX 2080's 46. Clock speeds have received a minor tune-up too, with the reference RTX 2080 Super hitting a base speed of 1,650MHz and a boost speed of 1,815MHz; previously, these were 1,515MHz and 1,710MHz.

CHOICE CUT

The partner model on test here, MSI's GeForce RTX 2080 Super Gaming X Trio, pushes things slightly further with a modest overclock to 1,845MHz. The best news of all is the price: this particular card costs £750, which is £49 less than the RTX 2080 Gaming X Trio we reviewed in *Shopper* 372. That's a refreshing change from most of the RTX 2060 Super and RTX 2070 Super models we've seen, which appear to use the updated specs as a reason to raise prices, not lower them or keep them in parity with the preceding GPUs.

£750 is still a lot of money, but MSI's design is befitting of it. A classily sleek, strong backplate protects the rear, RGB lighting adds customisation options, and the reference design's dual-fan cooler is turned into a triple-fan setup with a larger radiator. Like the rest of the Gaming X Trio range, which spans all three of the high-end RTX GPUs, one of these fans is slightly smaller than the others, which some may find a little goofy-looking, but unless you're vertical-mounting, you won't ever see it while it's in your PC.

Be warned, however, that this is one seriously bulky graphics card. Measuring 327mm long, 140mm wide and 56mm deep, it's significantly larger than the reference design, and although it takes up the standard two PCI slots in a case, the cooler takes up more space beyond that. Take care if your PC has another PCI-E device below the main graphics card slot, or something like a PSU shroud that could get in the way. A lot of mini-tower and small form factor cases, more pressingly, simply won't have room at all, so check your clearances before buying.

The bigger problem, however, is that the RTX 2080 Super doesn't exactly deliver the performance improvements that were hoped for. In Dirt Showdown, it bumps up against a 144fps barrier at both 1080p and 1440p, and while its 4K result of 110fps is pretty good, that's only 2fps faster than the RTX 2070 Super.

LITTLE BY LITTLE

Metro: Last Light shows a slight step up from the standard RTX 2080, with 118fps at 1080p, 76fps at 1440p and 34fps at 4K. Unfortunately, these are all just single-digit improvements, as the RTX 2080 produced 114fps, 69fps and 30fps respectively. Turning off SSAA at 4K results in a smooth 68fps, which is good, but then that's also only slightly above the RTX 2070 Super. All of this also means the RTX 2080 Super struggles to close the gap with the year-old RTX 2080 Ti, which runs Metro visibly smoother at all three resolutions.

It doesn't matter as much that the RTX 2080 Super is behind in Tomb Raider, as it runs fast enough – 247fps at 1080p and 171fps at 1440p – that the RTX 2080 Ti's even faster results don't translate into a perceptible advantage. 87fps at 4K isn't bad, either: it's a decent 12fps ahead of the RTX 2070 Super, albeit 23fps behind the RTX 2080 Ti.

All three of these GPUs scored 11 in the SteamVR Performance Test, but the RTX 2080 Super still ends up back where the RTX 2080 started: uncomfortably sandwiched between a better-value RTX 2070 (or in this case, the RTX 2070 Super) and the significantly more muscular RTX 2080 Ti. If the added cores and raised clock speeds had produced greater improvements, it could have been a genuinely attractive alternative for those who want the best possible 1440p and 4K performance without breaking £1,000, but when the RTX 2070 Super so often comes within a few frames per second, it's more sensible just to opt for the cheaper one.

SOFT POWER

In some ways that's unfortunate, as MSI has done fine work on the engineering side. The Gaming X Trio cooler is quiet and effective: we recorded core temperatures of 43°C at idle and 66°C under load, with a rare peak of 68°C. This model is also somehow more efficient than the RTX 2080 Gaming X Trio: that had a TDP of 260W, but this card is rated at 250W, and we only measured it drawing between 214W and 235W during our benchmarks.

Sadly, it will take more than that to beat the RTX 2070 Super on value. The 2080 Super is technically the most powerful GPU you can get without splashing out on the RTX 2080 Ti, and the lower price is a step in the right direction, but it still feels like Nvidia's middle child needs to be either much cheaper or even faster in order to make it a worthwhile investment.

NVIDIA GeForce RTX 2080 Ti

★★★★☆

£1,170 • From www.ebuyer.com

VERDICT

Nothing beats the RTX 2080 Ti for sheer performance, although its pricing and power consumption are just as high

UNLIKE THE REST of the RTX line-up, there's been no Super-branded do-over for the RTX 2080 Ti. Perhaps that's because it simply doesn't need one: for all the improvements introduced by its more recent GeForce brethren, including the RTX 2080 Super, the RTX 2080 Ti remains in a league of its own for price and performance.

That said, there have been some developments since we first looked at Nvidia's own Founders Edition of the RTX 2080 Ti back in *Shopper* 371: mainly, the launch of partner card models. For the purpose of this group test, then, we've done a fresh round of testing with the MSI GeForce RTX 2080 Ti Gaming X Trio, which has the same 11GB of GDDR6 but comes with a factory overclock of 1,755MHz.

An even more alluring upgrade is the triple fan cooler, which you'll notice is the same as that of the GeForce RTX 2080 Super Gaming X Trio. The dual-fan cooler of the Founders Edition was fine, but having a third fan is especially welcome when the GPU and circuit board are as gigantic as this one.

GREAT LENGTHS

On that note, your first concern when shopping for an RTX 2080 Ti should be whether you can actually fit it inside your PC case. The GeForce RTX 2080 Ti Gaming X Trio is almost outwardly identical to MSI's RTX 2080 Super model, which means it's a gargantuan 327mm long, a full 60mm more than the Founders Edition. Most mid-tower chassis designs should be able to squeeze it in, but a lot of smaller cases simply won't have room.

Another thing to check before buying is how many PSU cables you have. This is the first graphics card we've tested to require not one, not two, but three power connectors: two 8-pin and one 6-pin. While it's not uncommon for modular and semi-modular PSUs to include the requisite cables, cheaper and non-modular units might only have one or two 6+2-pin cables, so as with case size we strongly suggest double-checking whether your PC can accommodate a graphics card of this stature.

Once these barriers are cleared, however – and you've paid the small fortune of £1,170 – the RTX 2080 Ti rewards your investments with performance that can go well beyond its peers. Metro: Last Light Redux provides the best demonstration of this, with the RTX 2080 Ti averaging 126fps at 1080p, 97fps at 1440p and 45fps at 4K. At all three resolutions, the game runs visibly smoother than the RTX 2080 Super (assuming you have a monitor with a sufficiently high refresh rate), and this is also the only graphics card of the bunch with which disabling SSAA isn't essential for good 4K performance. Then again, turning it off produces 88fps, so it's worth doing regardless.

Tomb Raider also sees the RTX 2080 Ti breaking records, with a spectacular 303fps at 1080p and 212fps at 1440p. Admittedly, at these resolutions it would be nearly impossible to perceive the difference between this card and the RTX 2080 Super, but at 4K it still holds a meaningful advantage, with 110fps to the slower GPU's 87fps.

TEAM GAME

In Dirt Showdown, unfortunately, the RTX 2080 Ti is held back by the CPU – it couldn't get past 112fps at both 1080p and 1440p. At 4K, on the other hand, it managed to creep to the top of the leaderboard, although its 113fps result is only marginally better than that of the RTX 2080 Super. If you're willing and eager to build a PC around this GPU, you'd better add a recent and high-powered CPU to your shopping list, as holding it back in bottleneck-prone games is even more of a shame than usual.

VR performance is no concern, as the RTX 2080 Ti breezed to a perfect 11, and MSI hasn't followed AMD and Zotac in their abandoning of the VirtualLink connection standard. Compatible VR headsets owners will therefore be able to get power, video output and data all through a single USB Type-C port on the RTX 2080 Ti's rear, and there are still plenty of ports for regular monitors, including three DisplayPort outputs and one HDMI socket.

Noise-wise, we experienced a bit more coil whine than with the RTX 2080 Super, although it was still a very infrequent occurrence, and the three fans successfully avoided excessive volume under load.

Likewise, although this was the toastiest of Nvidia's high-end GPUs, it's nowhere near as prone to overheating. An idle temperature of 52°C might initially be cause for alarm, but this only rises to 71°C under load, and the absolute highest peak we witnessed was 73°C. Even with one shrunken fan, MSI's cooler design is more than a match for this hulking GPU.

Those three power connectors aren't just there to be a cable-tidying nuisance, however. The RTX 2080 Ti is a very thirsty GPU indeed, and the official TDP of 300W is accurate: we recorded it jumping around the 298-305W range when running benchmarks. It shouldn't be surprising that an incredibly powerful card needs an incredible amount of power, but a capable PSU is vital. Nvidia suggests a 650W unit at minimum, and we're inclined to agree.

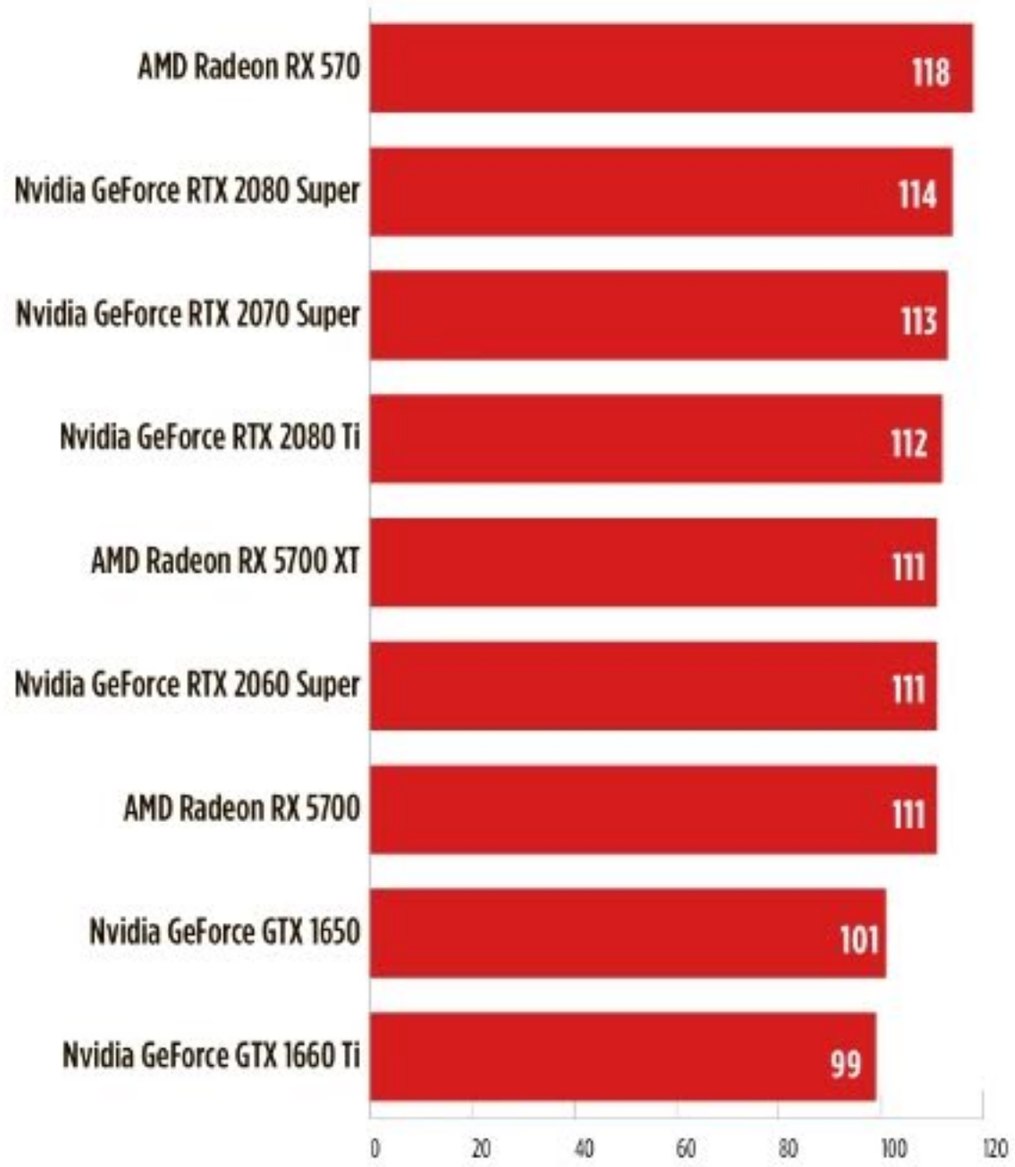
LONELY AT THE TOP

There will always be room in the market for ambitious GPUs like this, even if the price is set well outside sensible territory for most prospective buyers, but at least the RTX 2080 Ti has the performance to back it up.

It's still a luxury purchase, however, and the RTX 2070 Super, RTX 2080 Super and even the Radeon RX 5700 XT can all make respectable runs at 4K for considerably less cash, and mostly with lower hardware requirements. The logical choice is to get one of these instead, unless you're lucky enough to have £1,170 to spare.

BENCHMARKS

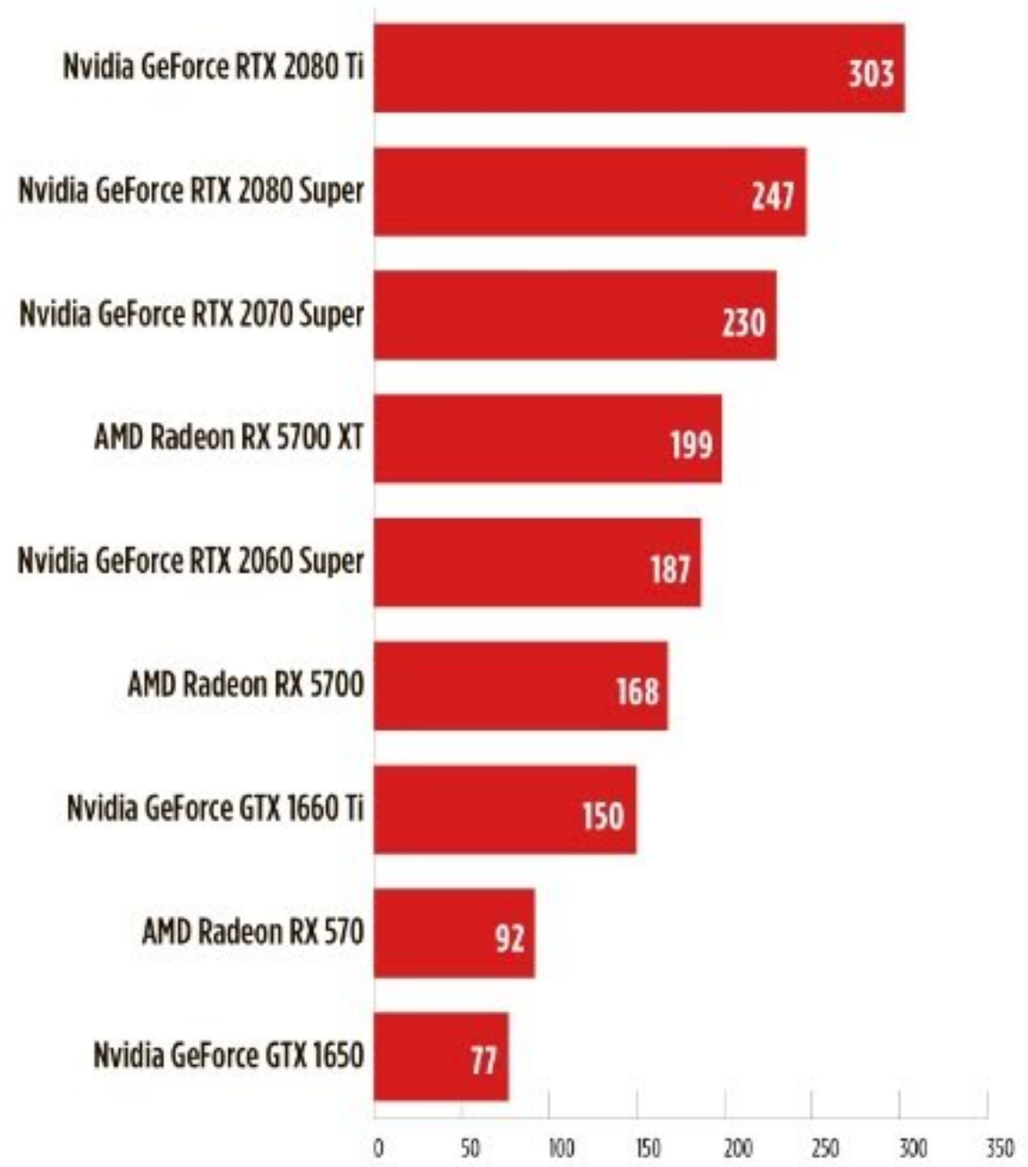
Dirt Showdown 1080p



This racing game is very easygoing on GPUs, making it a good test of lower-end performance, although it's prone to CPU bottlenecking at higher frame rates. Luckily, anything above 60fps will be a smooth ride.

SETTINGS USED Ultra quality, 4x MSAA, 1,920x1,080

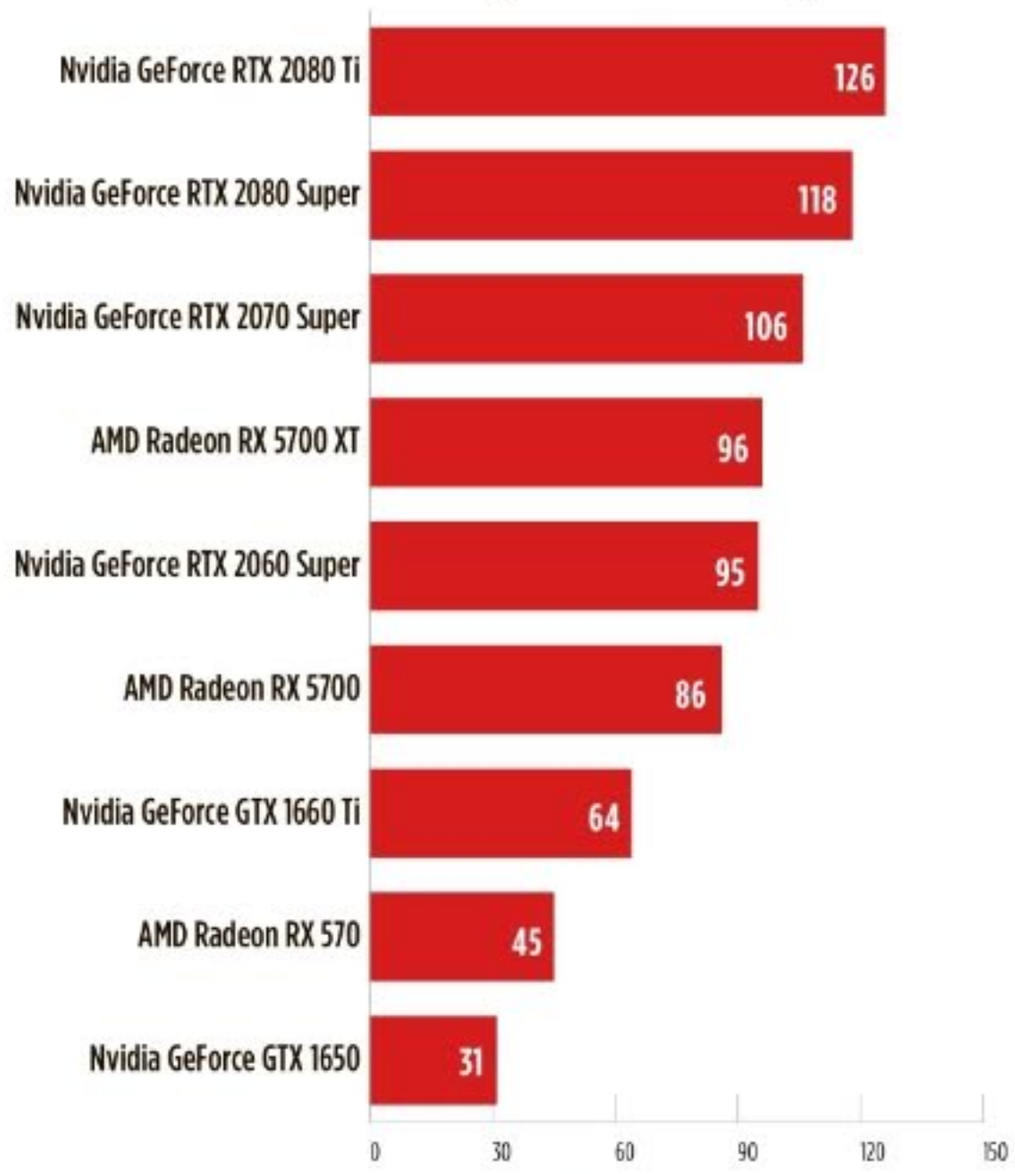
Tomb Raider 1080p



Tomb Raider is sufficiently well optimised to run smoothly on budget GPUs, and the lack of a CPU bottleneck means it can extract the full potential of high-end cards too. 60fps is easy, so aim higher if your monitor supports it.

SETTINGS USED Ultimate quality, FXAA, 1,920x1,080

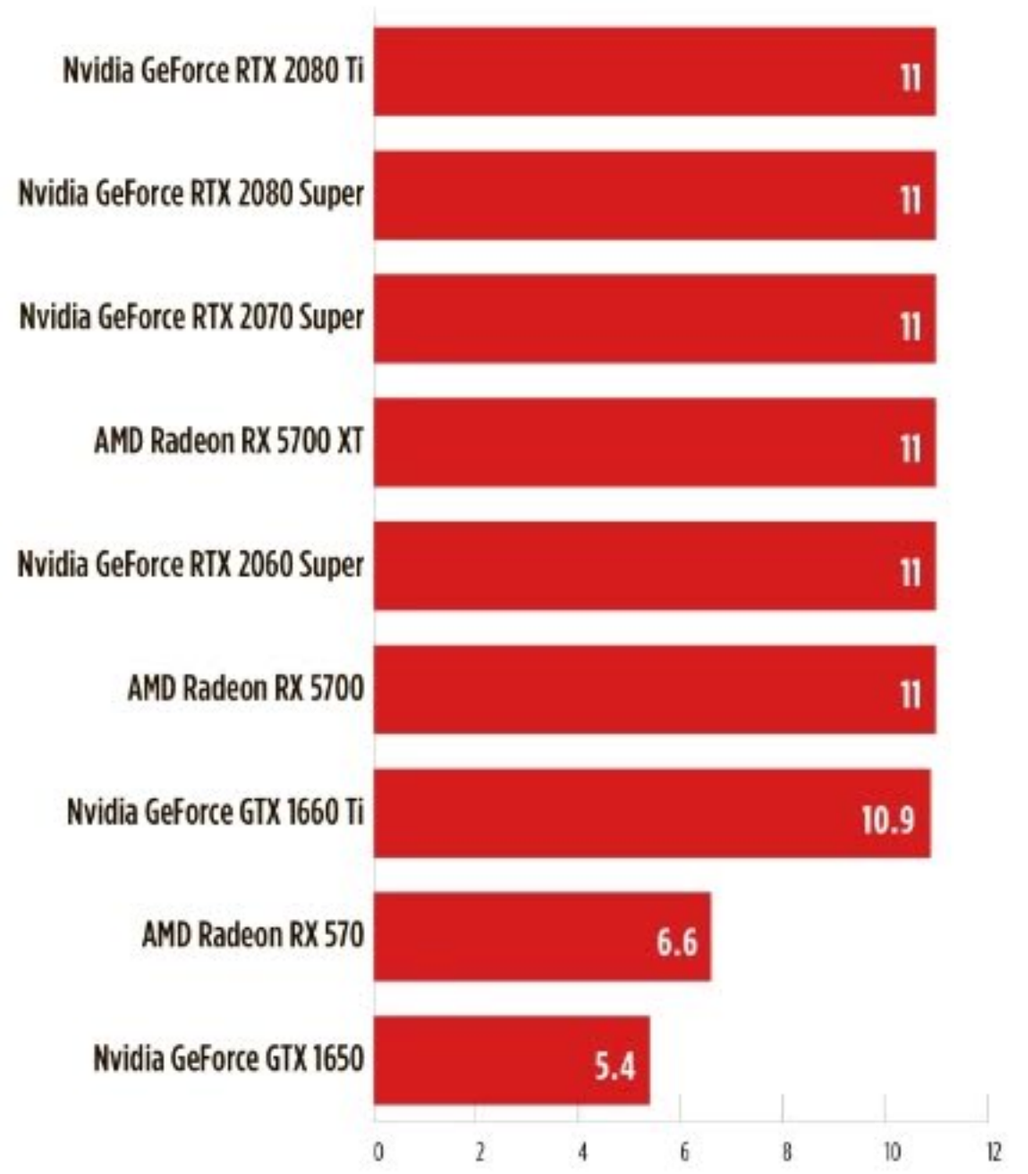
Metro: Last Light Redux 1080p



The wealth of high-detail textures, lighting and particle effects in this stealthy FPS put a serious strain on even the most powerful graphics cards. Anything over 30fps will be playable, but you can still breach 60fps on most GPUs.

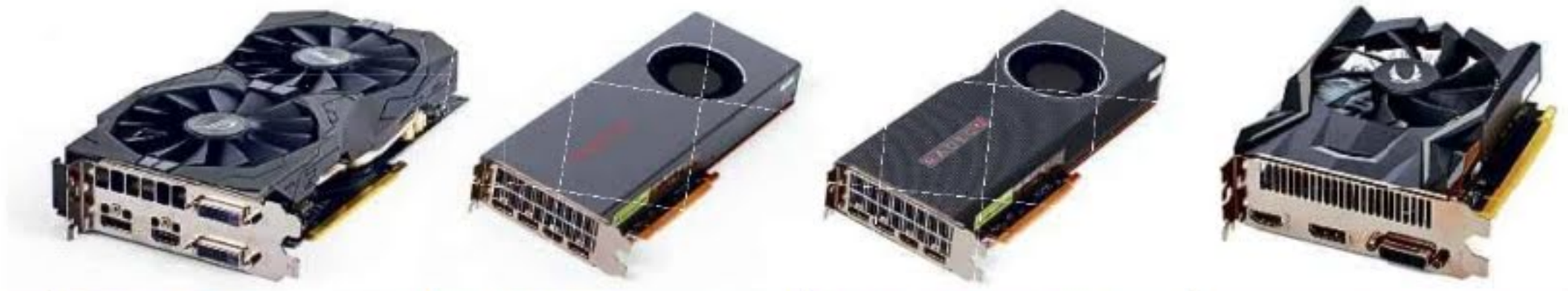
SETTINGS USED Very High quality, SSAA on, 1,920x1,080

SteamVR Performance Test



This dedicated VR benchmark plays a section of Valve's Aperture Robot Repair demo. Higher scores (up to 11) denote how high you can keep the graphics quality while maintaining 90fps. The lower the score, the more you'll have to reduce quality to hit this frame rate.

SETTINGS USED N/A



Award	BEST BUY	BEST BUY	RECOMMENDED	
Manufacturer	**AMD**	**AMD**	**AMD**	**NVIDIA**
GPU	Radeon RX 570	Radeon RX 5700	Radeon RX 5700 XT	GeForce GTX 1650
Model name	Asus ROG Strix RX 570 OC	AMD Radeon RX 5700	AMD Radeon RX 5700 XT	Zotac GeForce GTX 1650 OC
Rating	★★★★★	★★★★★	★★★★☆	★★★★☆
HARDWARE				
Rear slots taken up	2	2	2	2
GPU cores	2,048	2,304	2,560	896
GPU clock speed	1,168MHz	1,465MHz	1,605MHz	1,485MHz
GPU clock boost speed	1,310MHz	1,725MHz	1,905MHz	1,695MHz
Memory	4GB GDDR5	8GB GDDR6	8GB GDDR6	4GB GDDR5
Memory interface	256-bit	256-bit	256-bit	128-bit
Max memory bandwidth	224GB/s	448GB/s	448GB/s	128GB/s
Graphics card length	240mm	268mm	272mm	151mm
Video outputs	1x HDMI, 1x DisplayPort, 2x DVI-D	1x HDMI, 3x DisplayPort	1x HDMI, 3x DisplayPort	1x HDMI, 1x DisplayPort, 1x DVI-D
Power leads required	1x 8-pin	1x 8-pin, 1x 6-pin	1x 8-pin, 1x 6-pin	None
Maximum power draw (TDP)	120W	180W	225W	75W
Cooling	2x open air fans	Blower	Blower	1x open air fan
Monitor syncing support	AMD FreeSync	AMD FreeSync	AMD FreeSync	Nvidia G-Sync
Multiple GPU support	CrossFire	CrossFire (DX12 only)	CrossFire (DX12 only)	None
BUYING INFORMATION				
Price	£130	£290	£329	£143
Warranty	Two years repair and replace	One year RTB	One year RTB	Five years RTB
Supplier	www.awd-it.co.uk	shop.amd.com	shop.amd.com	www.ebuyer.com
Details	www.amd.com	www.amd.com	www.amd.com	www.zotac.com
Part code	ROG-STRIX-RX570-O4G-GAMING	RX 5700	RX 5700 XT	ZT-T16500F-10L

Prices correct at time of going to press





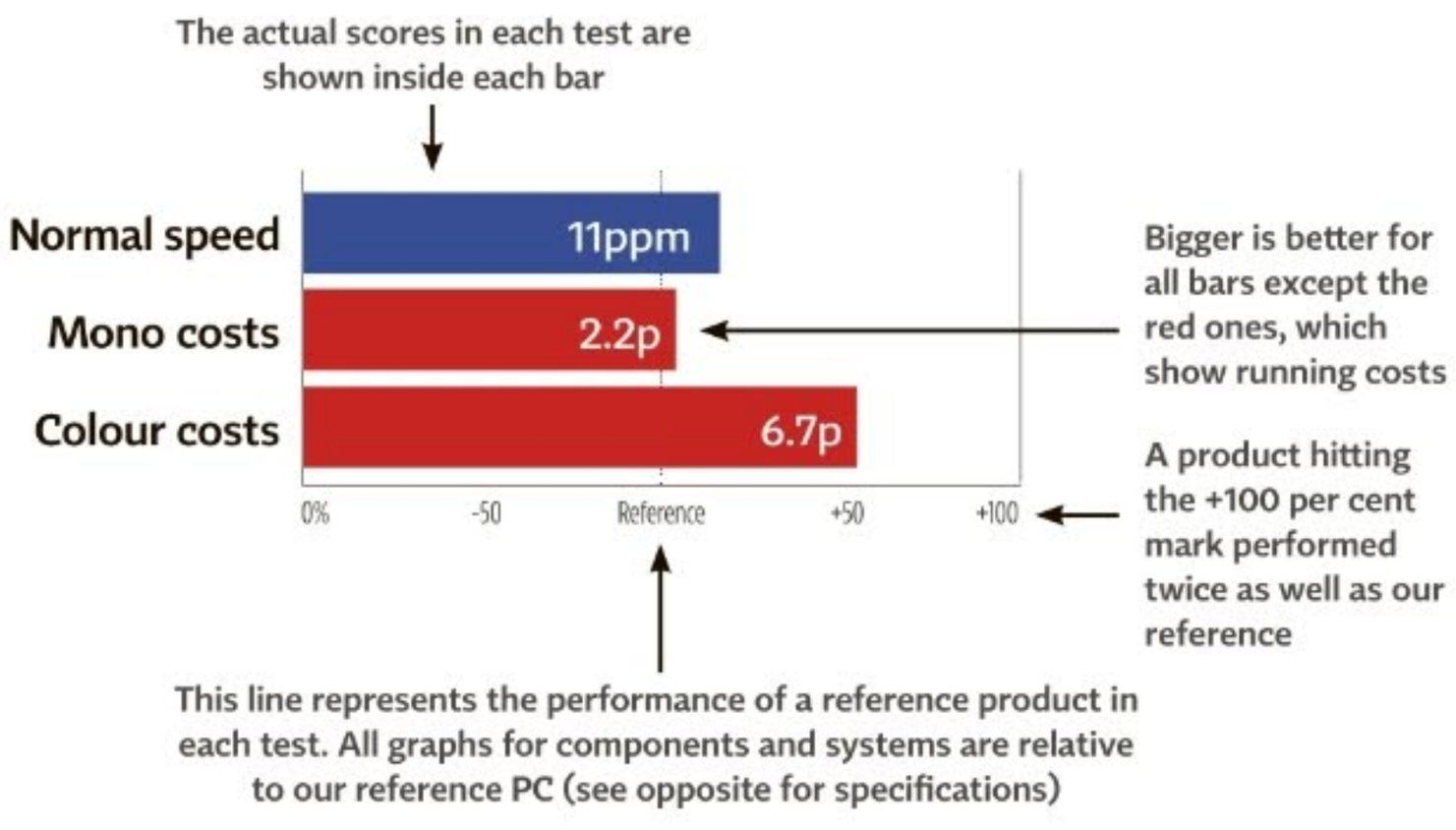
			RECOMMENDED		
	NVIDIA	**NVIDIA**	**NVIDIA**	**NVIDIA**	**NVIDIA**
	GeForce GTX 1660 Ti	GeForce RTX 2060 Super	GeForce RTX 2070 Super	GeForce RTX 2080 Super	GeForce RTX 2080 Ti
	MSI GeForce GTX 1660 Ti Gaming X 6G	Zotac GeForce RTX 2060 Super Mini	Zotac GeForce RTX 2070 Super Amp Extreme	MSI GeForce RTX 2080 Super Gaming X Trio	MSI GeForce RTX 2080 Ti Gaming X Trio
	★★★☆☆	★★★★☆	★★★★☆	★★★☆☆	★★★★☆
	2	2	2	2	2
	1,536	2,176	2,560	3,072	4,352
	1,500MHz	1,470MHz	1,605MHz	1,650MHz	1,350MHz
	1,875MHz	1,650MHz	1,830MHz	1,845MHz	1,755MHz
	6GB GDDR6	8GB GDDR6	8GB GDDR6	8GB GDDR6	11GB GDDR6
	192-bit	256-bit	256-bit	256-bit	352-bit
	288GB/s	448GB/s	448GB/s	496GB/s	616GB/s
	247mm	210mm	308mm	327mm	326mm
	1x HDMI, 3x DisplayPort	1x HDMI, 3x DisplayPort	1x HDMI, 3x DisplayPort	1x HDMI, 3x DisplayPort, 1x VirtualLink (USB Type-C)	1x HDMI, 3x DisplayPort, 1x VirtualLink (USB Type-C)
	1x 8-pin	1x 8-pin, 1x 6-pin	1x 8-pin, 1x 6-pin	2x 8-pin	2x 8-pin, 1x 6-pin
	130W	175W	215W	250W	300W
	2x open air fans	2x open air fans	3x open air fans	3x open air fans	3x open air fans
	Nvidia G-Sync	Nvidia G-Sync	Nvidia G-Sync	Nvidia G-Sync	Nvidia G-Sync
	None	None	SLI	SLI	SLI
	£305	£390	£540	£750	£1,170
	Three years repair and replace	Five years RTB	Five years RTB	Three years repair and replace	Three years repair and replace
	www.box.co.uk	www.ebuyer.com	www.amazon.co.uk	www.ebuyer.com	www.ebuyer.com
	www.msi.com	www.zotac.com	www.zotac.com	www.msi.com	www.msi.com
	GTX 1660 Ti GAMING X 6G	ZT-T20610E-10M	ZT-T20710B-10P	RTX 2080 SUPER GAMING X TRIO	RTX 2080 TI GAMING X TRIO

How we test

Find out how well products perform with the help of *Computer Shopper*'s comprehensive tests

COMPUTER SHOPPER'S REVIEWS use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the *Reviews* section, as shown on the right. Look in the 'Summary of tests' table (below) for details of each test we run.

For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See opposite for a description of our benchmarking software and game tests.



SUMMARY OF TESTS

PC SYSTEMS & GAMING LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Metro: Last Light Redux (1080p)	Frames per second at 1,920x1,080, SSAA, Very High detail
LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Processor-intensive multitasking test
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
Battery life	Run time in minutes for continuous video playback
SMARTPHONES/TABLETS	
Battery life	Run time in minutes for continuous video playback
PRINTERS AND MFPs	
Mono text speed	Pages per minute for correspondence-quality text
Mixed colour speed	Pages per minute for presentable text and graphics
Mono page cost	Running costs expressed as pence per page
Colour page cost	Running costs expressed as pence per page
DIGITAL CAMERAS	
Battery life	Number of shots from full charge
CAMCORDERS	
Battery life	Run time in minutes for recording
ROUTERS	
Laptop 2.4GHz 5m	Mbit/s at 5m with 802.11ac laptop on 2.4GHz band
Laptop 2.4GHz 1 floor	Mbit/s 1 floor up with 802.11ac laptop on 2.4GHz band
Laptop 2.4GHz 2 floors	Mbit/s 2 floors up with 802.11ac laptop on 2.4GHz band
Laptop 5GHz 5m	Mbit/s at 5m with 802.11ac laptop on 5GHz band
Laptop 5GHz 1 floor	Mbit/s 1 floor up with 802.11ac laptop on 5GHz band
Laptop 5GHz 2 floors	Mbit/s 2 floors up with 802.11ac laptop on 5GHz band
NETWORK-ATTACHED STORAGE	
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
HARD DISKS	
Huge files	Average MB/s for read/write of a single 2.5GB file
Large files	Average MB/s for read/write of 2.5GB of large files
Small files	Average MB/s for read/write of 2.5GB of small files
PROCESSORS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
MOTHERBOARDS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
GRAPHICS CARDS	
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4x MSAA, Ultra detail
Tomb Raider	Frames per second at 1,920x1,080, SSAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail

BENCHMARKS

SHOPPER BENCHMARKS

Our benchmark suite uses open-source software that runs on Windows, macOS and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It's designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a hybrid, laptop or desktop, from both sections of the magazine.

3D BENCHMARKS

DIRT SHOWDOWN

Dirt Showdown is a cracking racing game that makes good use of DirectX 11's fancy graphical effects. You'll want at least 30fps for smooth racing.

TOMB RAIDER

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013's Tomb Raider reboot is a great indicator of mid-range performance.

METRO: LAST LIGHT REDUX

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.

RATINGS & AWARDS

Computer Shopper rates products out of five:

★★★★★
Excellent

★★★★☆
Very good

★★★☆☆
Good

★★☆☆☆
Below average

★☆☆☆☆
Avoid!

The best products can win the following awards:

BEST BUY

Products with outstanding quality and performance for the money win our Best Buy award.

COMPUTER SHOPPER
BEST BUY

RECOMMENDED

Products that don't quite qualify for a Best Buy award but are still highly rated by our reviewers.

COMPUTER SHOPPER
RECOMMENDED

BUSINESS BUY

The very best products for work win our Business Buy award.

COMPUTER SHOPPER
BUSINESS BUY

Product Reviews

Our guide to all the products reviewed in this month's *Computer Shopper*

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How much will I save? £%

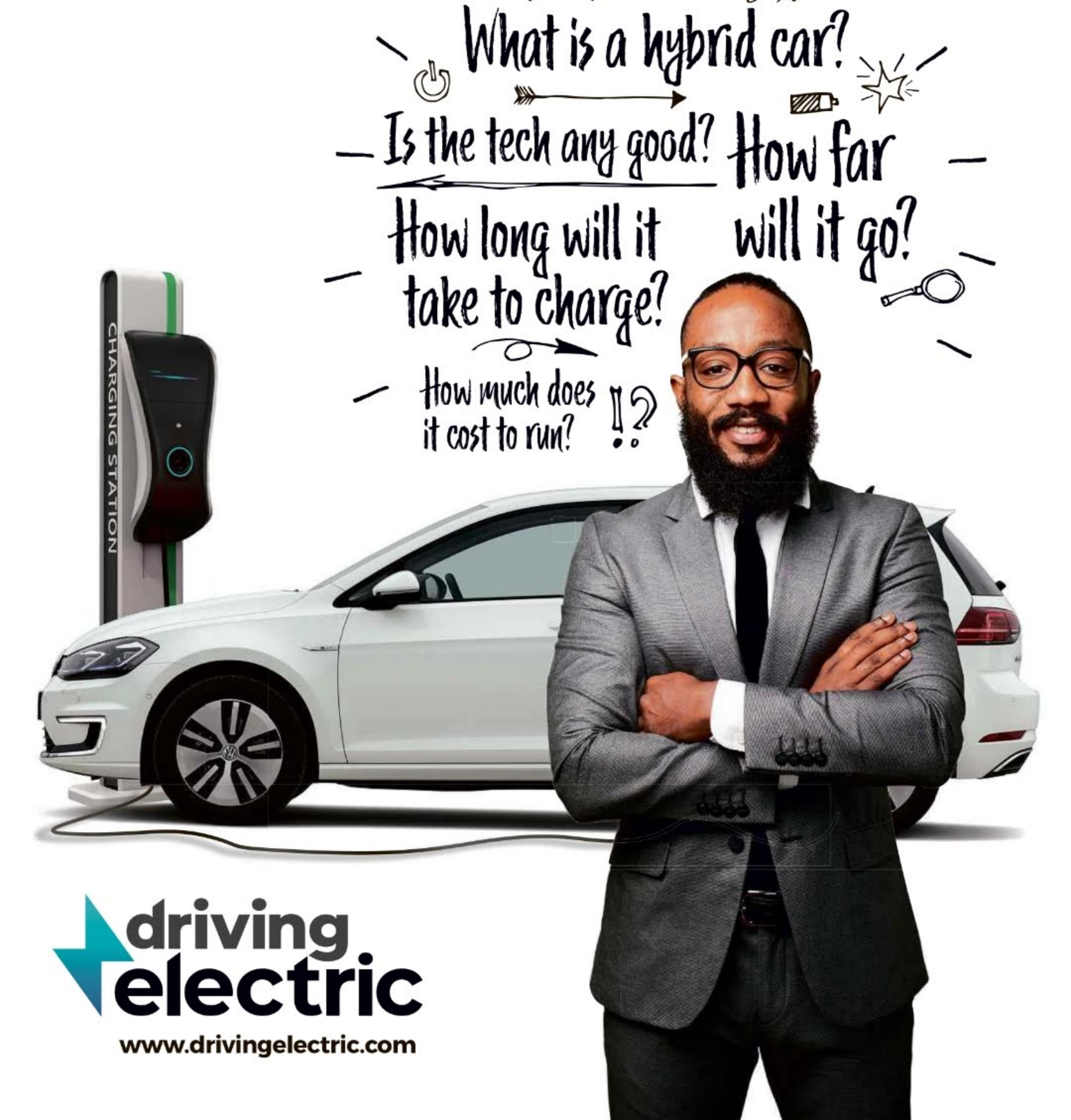
What is a hybrid car?

Is the tech any good?

How far will it go?

How long will it take to charge?

How much does it cost to run? !?



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RIP
14TH JANUARY
2020

THE END OF WINDOWS 7?

IF YOU STILL HAVE A WINDOWS 7 PC, THE IMPENDING END OF LIFE OF THE OPERATING SYSTEM MAY HAVE YOU WORRIED. DAVID LUDLOW SHOWS YOU HOW TO STAY SAFE AND EXPLAINS WHY WINDOWS 10 ISN'T YOUR ONLY OPTION

Windows 7 was released in 2009, and has since proved to be a stupendously successful operating system, delivering the features, quality and stability that PC owners had been calling out for. Given its success, it's no surprise that around 30% of computers still run the operating system.

Yet despite its ongoing popularity, Microsoft is finally pulling the plug on Windows 7. This means that from 14th January 2020, PCs will no longer receive any security updates for the 10-year-old operating system.

For many, this signals that it's game over for the operating system and that it's time to make a change. But is that really true? In this guide, we look at the options if you want to keep running Windows 7 or how you can reuse your old hardware. And for those who want to make the move to Windows 10, we explore what that operating system offers and reveal how to enjoy a seamless upgrade.

HOW TO MAKE WINDOWS 7 SAFE

If you want to keep using Windows 7, we should start with a warning: without security patches, running the operating system represents a security risk. Although Windows 7 may no longer be of interest to Microsoft, hackers will continue to probe the operating system and may well find new weaknesses in it that they will exploit. Given that there are still millions of computers running Windows 7, the effort to find new vulnerabilities is well worth the effort.

Alexey Pankratov, enterprise solutions manager at Kaspersky, warns, "An old unpatched OS is a cybersecurity risk – the cost of an incident may be substantially higher than the cost of upgrading. This is why we recommend that customers migrate to supported versions and ensure that additional security tools are in place during the transition period."

That's a fairly stark warning, but what really happens now that support has ended? Here, we'll tell you what will happen and how you can legislate, as far as possible, against the issues that you may face.

NO MORE SECURITY PATCHES

The issue Windows 7 users face after 14th January 2020 isn't so much that they won't see new features but, as we pointed out above, that Microsoft will no longer provide security updates for its operating system, potentially leaving flaws open to hackers. This sounds bad, and it is, but it's important to view all of this in context.

While flaws in your operating system are one way in which hackers will try to attack you, it's not the only one. Flaws in other software that you're running can prove to be just as dangerous, if not more so. Just because Microsoft is no longer supporting Windows 7 with updates, it doesn't mean that other software vendors will do the same thing. As long as you can run software on Windows 7 that can be updated, you can minimise the risk.

Next, cyber criminals will use a variety of social engineering tricks, from phone calls to dodgy popups on websites, that can trick you into installing bad software. While antivirus software will catch some of this, it won't stop it all.

Finally, with so many people using the cloud, cyber criminals often try to attack these services, completely bypassing the need for your computer.

As you can see, Windows 7 only makes up part of the security puzzle, and the lack of updates for the operating system isn't the only threat to you and your computer. This is good news, as it means that you at least have the option to protect against as many of the other threats as possible.

WINDOWS 7 EXISTING UPDATES

Although this is the end of official Windows 7 updates, you can still install all the security updates and patches that have been released previously. This even goes for after 14th January 2020, as you'll still be able to run and use Windows Update.

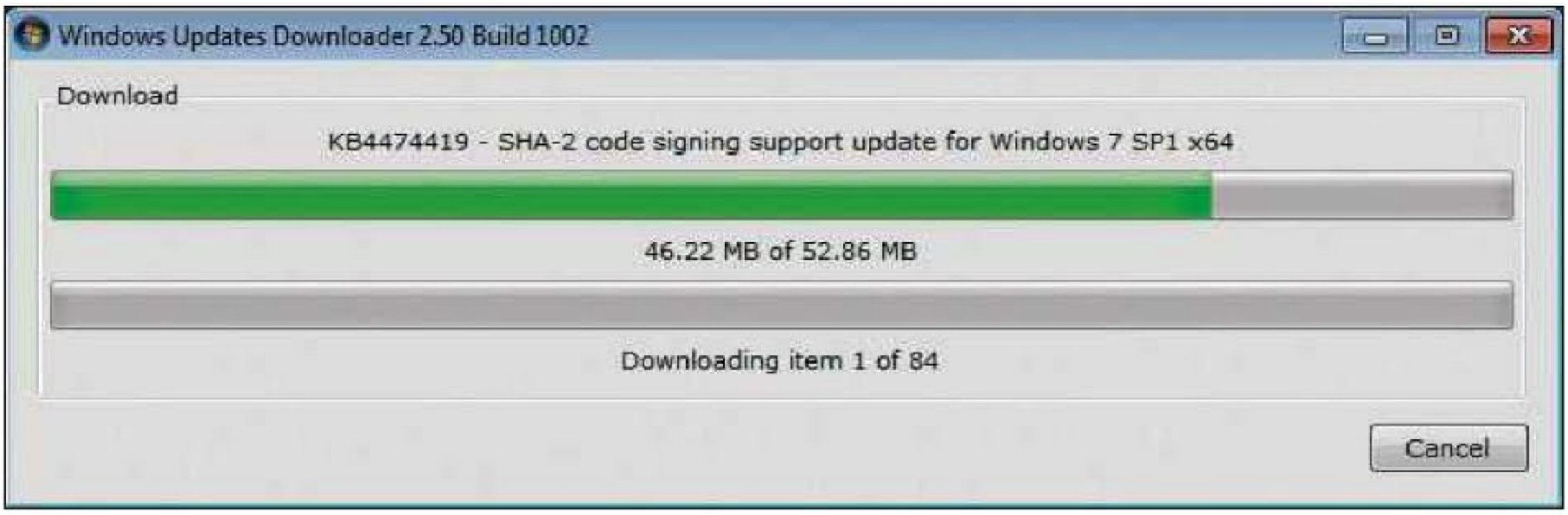
This is important, as if you perform a clean install of Windows 7 at any point, you'll know that you can still update it to the most secure level that it can be. That at least ensures that the current known threats are fixed in the software.

MAKE YOUR OWN WINDOWS 7 DISC

There's a chance Microsoft may decide to turn off the update server in the future, which may scupper your plans. However, there is a way around the issue: create your own Windows 7 installation disc complete with all of the latest updates.

To do this, you'll need a Windows 7 installation disc with SP1. Use the physical disc if you have it, otherwise you'll need to download the Windows 7 ISO disc image, which isn't as easy as it should be. Microsoft has a download site (*tinyurl.com/w7isodownload*). All you have to do is enter your Windows 7 licence code into the box and you're good to go. However, if you got your computer from a third party, you may get an error message telling you that the ISO disc file is not available for you.

BELOW: You can still update old versions of Windows 7 to the most recent security patch



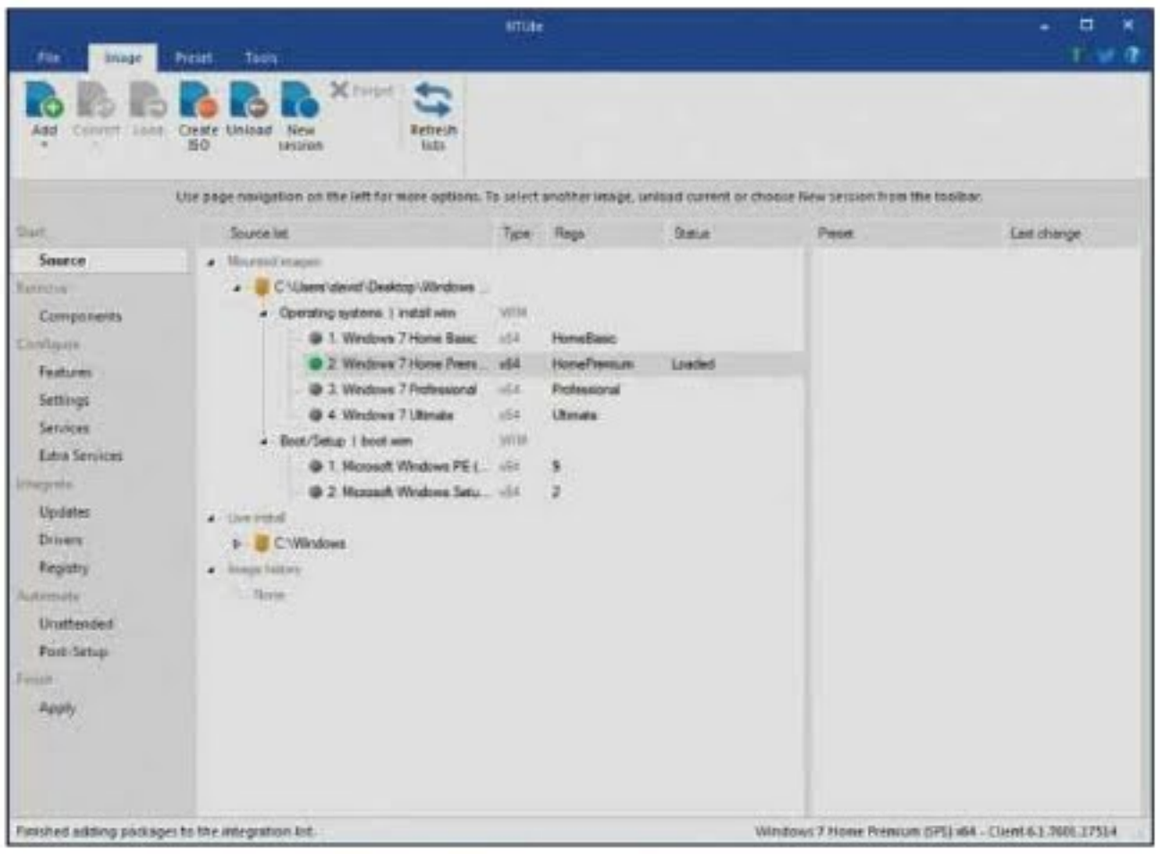
ABOVE: You can download all the Windows updates that you need for offline use

The alternative is to go to *tinyurl.com/softlaywindows* and use the download links there to get the version of Windows 7 that you have. Next, you need to download all of the Windows 7 updates and save them in a file.

You can do this by using the Windows Updates Downloader (*www.windowsupdatesdownloader.com*). Download the latest version of this and install it on your computer. Next, you need to download the latest list of Windows 7 updates (64-bit Windows: *tinyurl.com/383windows1* or 32-bit Windows: *tinyurl.com/383windows2*). Double-click the file that you downloaded and you'll see a popup message that says, "Compressed UL file installed". Click the OK button to continue.

From the Start menu, run Windows Updates Downloader and you'll see a list of updates. Click Check All and then click Download to save the updates to the Download folder listed (you can click the Change button to pick a different location).

Next, you need to combine the files that you've downloaded with the Windows 7 installation media, creating a new installation disc that has everything you need. To do this, download NTLite (*www.ntlite.com*) and install it.

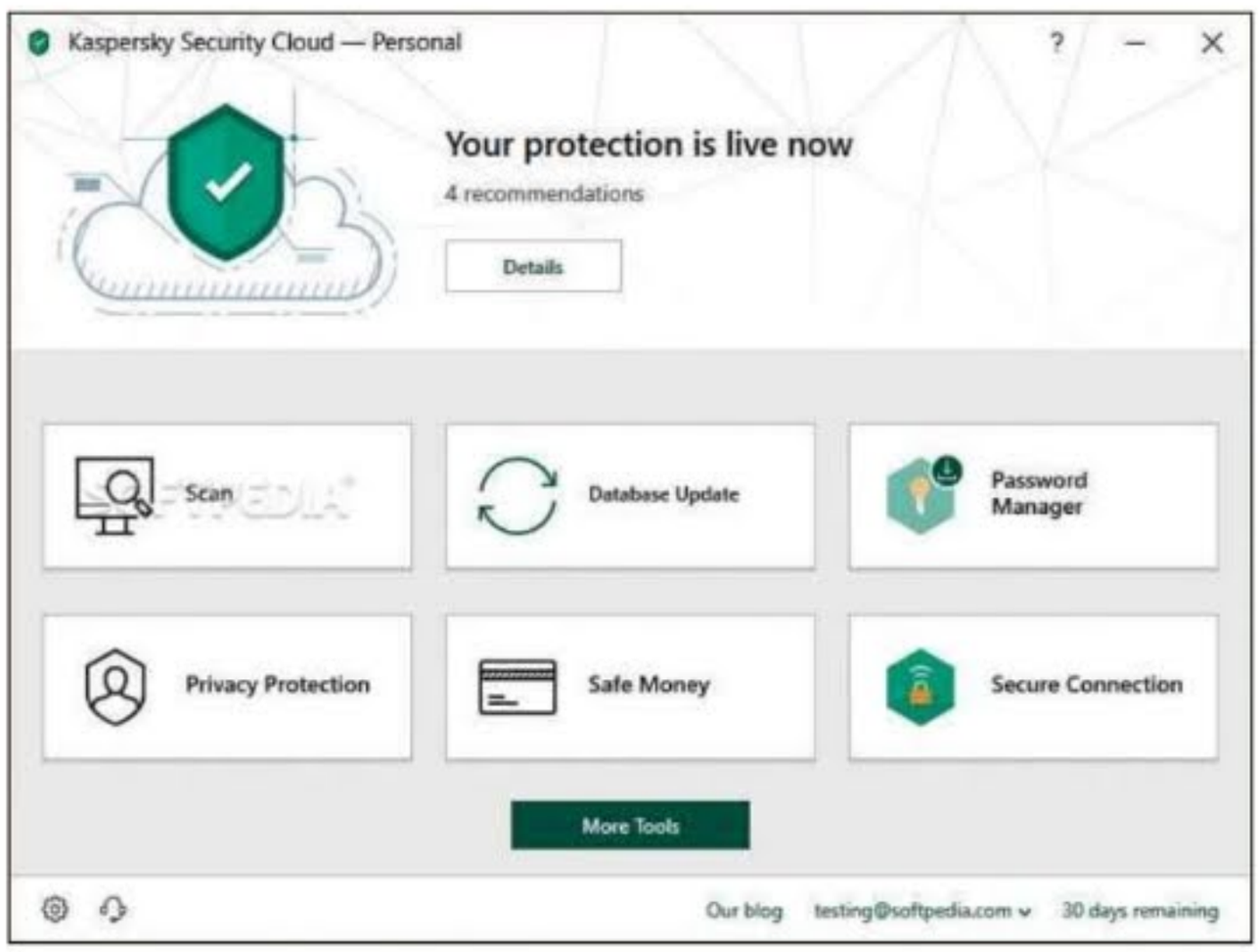


ABOVE: Make your own installation disc using NTLite

Now, you need to extract the files from your Windows 7 ISO. If you have a physical disc, you can just insert this and drag the files into a folder. If you downloaded an ISO file, you can extract the files using the free 7-Zip utility (*www.7-zip.org*).

Run NTLite from the Start menu, click the big Add button and select Image directory. Browse to the files that you extracted from your ISO file and click Open. In the list that appears, select the version of Windows 7 that you have, and then click the Load button. Once it says Loaded next to your OS, click Updates listed under Integrate in the left-hand panel. Click Add and select Directory containing packages. Navigate to the folder where you downloaded your updates and choose Select Folder. The updates will then be scanned. Ignore any errors for unsupported packages and click OK.

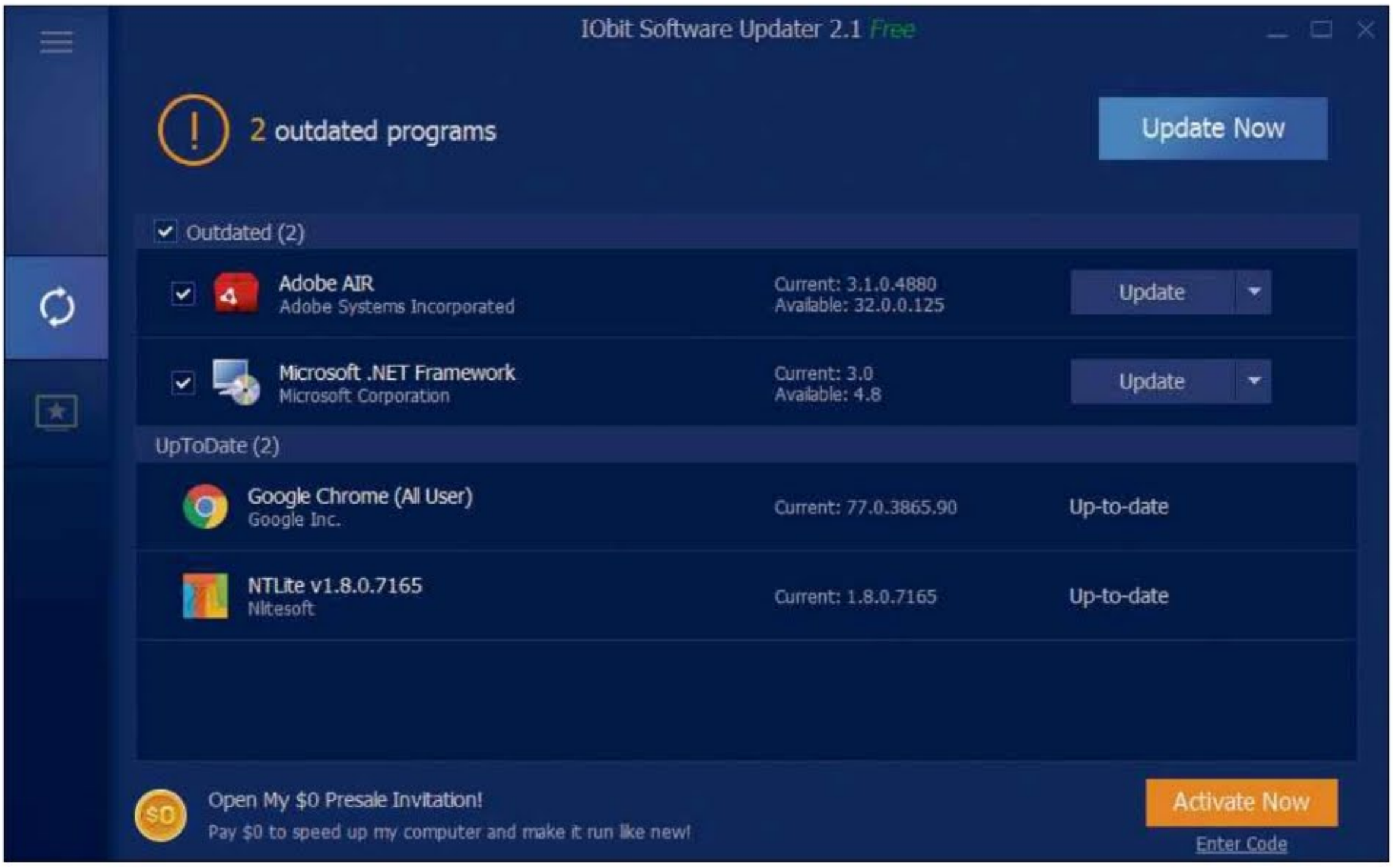
Click the Apply link at the bottom of the list and then check the Create ISO box. Navigate to where you want to save the disc image and give it a sensible name, such as Windows7.iso. Click the Process button at the top and your image file will be created. NTLite will now integrate the updates and build you a new installation disc. Once done, you can right-click the file and select Burn disc image: you'll need a blank DVD to hand, and this will become your new installation disc.



LEFT: You'll want proper security if you're going to run Windows 7

FUTURE WINDOWS 7 UPDATES

Although Microsoft is cutting off Windows 7 support for home users, businesses can sign up for a support plan that will bring security updates for the next three years. The catch? Updates have to be paid for, and they're quite



expensive. As a home user, you can sign up for an Enterprise account, but the hassle and expense mean that it's not particularly worth it.

INSTALL SECURITY SOFTWARE

Your best line of defence for Windows 7 is to install quality security software. The latest version of Kaspersky Security Cloud supports Windows 7 computers, and the software typically does well in our tests.

Having security software such as this should catch the majority of malware before it can get through to Windows 7, although these things aren't guaranteed. There will be a point where Windows 7 drops off the support list, but given how popular the operating system is, we can't see this being the case for a few years yet. With security software in place, you have the best chance of keeping your computer as secure as it can be.

UPDATE SOFTWARE

As we mentioned, other software that you're running can be a security issue, so it's important to keep this up-to-date. You can manually update the software that you have, and many applications come with their own software updaters. However, you can also use a tool such as the free IOBit Software Updater (*tinyurl.com/383windows3*) to scan your computer and let you know about anything that's out of date.

ABOVE: Make sure your software is kept up to date

The paid-for version can schedule scans and updates, but you can use the free one for one-click updates manually.

Where IOBit (or other updater software) can't help is if there are no updates for your software, because it is out of date or because Windows 7 is no longer supported. For example, Microsoft has announced that Office 365 will no longer be supported on Windows 7 after 14th January 2020. The only options are to continue to run out-of-date software or to switch to alternatives that are supported, such as LibreOffice in the case of Office.

UPDATE DRIVERS

Old drivers can cause problems and even be a security risk, so you need to update them. We recommend going straight to the source and downloading drivers directly from the manufacturer. If you have a big-brand PC or laptop, such as Dell, you'll need to go to that company's support site to download the latest drivers for your computer.

BELOW: Updated drivers can help save you from a security headache

For a specialist company or a home-build PC, you will need to go to a few different places. First, you should make a list of the hardware inside your computer, including manufacturers and model numbers of your devices. Include the motherboard, printer and any internal expansion cards that you have.

To get this information, you may need to open up the side of your PC's case and look inside to see this information. Typically, expansion cards and motherboards will have the model number written on them, although you may have to look hard.

Armed with this information, you can visit each manufacturer's website in turn, finding the support page for your hardware and then downloading the latest drivers and utilities.

SWITCH BROWSERS

Don't use Internet Explorer on Windows 7. Instead, update to a browser that's more secure and will have more updates. Chrome and Firefox are good choices, and should continue to see updates for a considerable amount of time.

SWITCH TO A STANDARD ACCOUNT

Standard accounts are a good way to use Windows 7 more securely. These accounts have less access to system settings and restrictions to prevent them from installing or removing applications or even making system-wide settings changes. The good thing about a Standard account is that any software you run has the same limitations, which can prevent malware from taking hold of your computer.

To create one of these limited accounts, you first need to log in as an Administrator and make sure the account has a password. Go to Control Panel, User Accounts and Family Safety, User Accounts, and select your user account. Click Create a password and enter a new password twice. Enter a hint if you want, then click OK. Next click Manage another account and click Create a new account. Give the account a name, then select Standard and click Create Account. You now have a Standard user account. You can set a password for it by following the steps at the start of this paragraph. You can now restart your computer and log in as the limited Standard account.

While you can do pretty much everything you want from a Standard account, there are times where you run into restrictions. For example, you may not be able to install a new application, or you may not be able to change a Control Panel setting because you don't have the right level of access. To get around this, right-click the installer or application and select Run as administrator.

ABOVE: A Standard account is a good way of locking down your computer

You'll see a popup box asking you to select an Admin account, and to enter its password. Likewise, if you stroll into part of the Control Panel that requires administrator privileges, you'll need to enter the password for your admin user.

BELOW: You can force Windows 7 to run applications as an administrator when you need to

HOW LONG WILL WINDOWS 7 BE SECURE FOR?

There's no definitive answer to this question. If a massive vulnerability is discovered the day after the last update goes out, then the answer would be not very long. However, it seems more likely that this won't happen.

Provided software, drivers and other applications maintain Windows 7 support and get updates, you may find that you can keep running the operating system for quite some time. However, you have to do this accepting the risks that you're taking. Unsupported operating systems aren't something we recommend easily. Taking our steps here will make Windows 7 as secure as it can be, but it's still not as secure as Windows 10.

Ultimately, Windows 7 is on borrowed time, and you'll have to move to a different operating system at some point, even if it's just to get a particular bit of hardware or software working.

REPURPOSE AN OLD WINDOWS 7 PC

Just because Windows 7 is no longer supported, it doesn't mean that your hardware is completely useless. When the time comes for you to move away from the operating system, you have several choices on what to do with your old computer. Here, we look at the options and what you can do.

TURN WINDOWS 7 INTO A FILE OR PRINT SERVER

PROS

- ✔ You still have your old computer if you need it

CONS

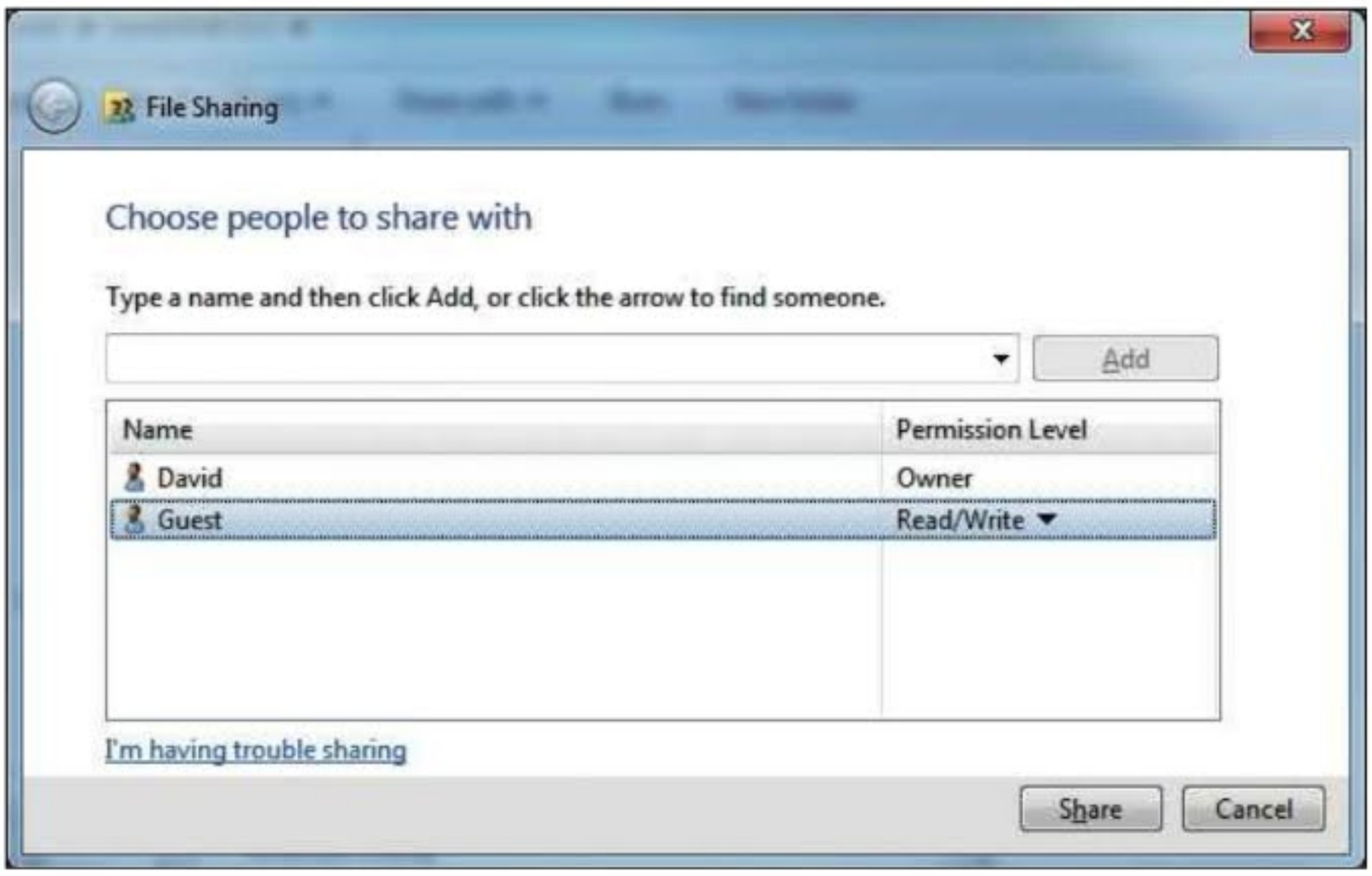
- ✘ You use a comparatively large amount of power
- ✘ Printers may still not work

One of the biggest issues about moving away from Windows 7 is that some of your old hardware may not have drivers available in a new operating system. For example, many older printers will not work with Windows 10.

Rather than having to upgrade your printer to use with a new operating system and computer, you could instead turn your Windows 7 PC into a file server. To do this, boot up your Windows 7 computer and log in to get to the desktop.

Sharing a folder in Windows is very easy. All you have to do is find the folder you want to share in Windows Explorer, right-click it and select Properties, then click the Sharing tab. You can now click the Share button to make the folder available on the network. However, note that some system folders, such as the Windows directory, cannot be shared and will have the necessary button greyed out.

To share a folder in Windows 7, you need to select which users will have access to the folder over the network. For Windows 7, the default share username you're using will be listed in the main window with a Permission Level of Owner. You should leave this setting alone, and choose additional users that will have access to this folder.



ABOVE: You can choose the level of access for each user

If you turned off password-protected sharing, you should select the Guest account from the drop-down menu and click Add. If you're using password-protected sharing, select the user accounts that you want to give access and click Add (repeat for as many user accounts as you need). To give all user accounts access, simply select Everyone from the drop-down menu.

Next, for each account you've selected, you can choose the Permission Level. Read lets those users look at, but not modify, files stored in this folder, and Read/Write lets users view and modify files stored in the folder. For home use, it's best to set Read/Write as the permission level for all users, unless you specifically don't want network users being able to modify files.

Sharing a printer is just as easy. On the computer that has the printer installed, go to the Printers section of the Control Panel. Right-click the printer you want to share and select Printer Properties. Click the Sharing tab and select Share this printer. You can change the name of the printer if you like. Click OK to share the printer.

Once you've done this, you can find the printer on the network in Explorer by selecting your Windows 7 computer. However, installing a network printer requires you to have the drivers for the printer, which may not be possible on your new computer. Our guide to

RIGHT: Sharing a printer over the network is simple, but you'll still need printer drivers

Windows 10 on pages 97–98 has more information on how to deal with this issue.

For safety, if your router supports it, you can block internet access to your Windows 7 computer. You'll still be able to access the computer over your home network, but Windows 7 will not be online. How you do this differs from router to router. For example, with many Netgear routers, you go to the web management page and the Access Control section. You can then turn off internet access for a computer. Remember, if you need to download anything to your Windows 7 computer, you'll need to turn on internet access again.

INSTALL WINDOWS 10

PROS

- ✔ You get the latest operating system and security updates

CONS

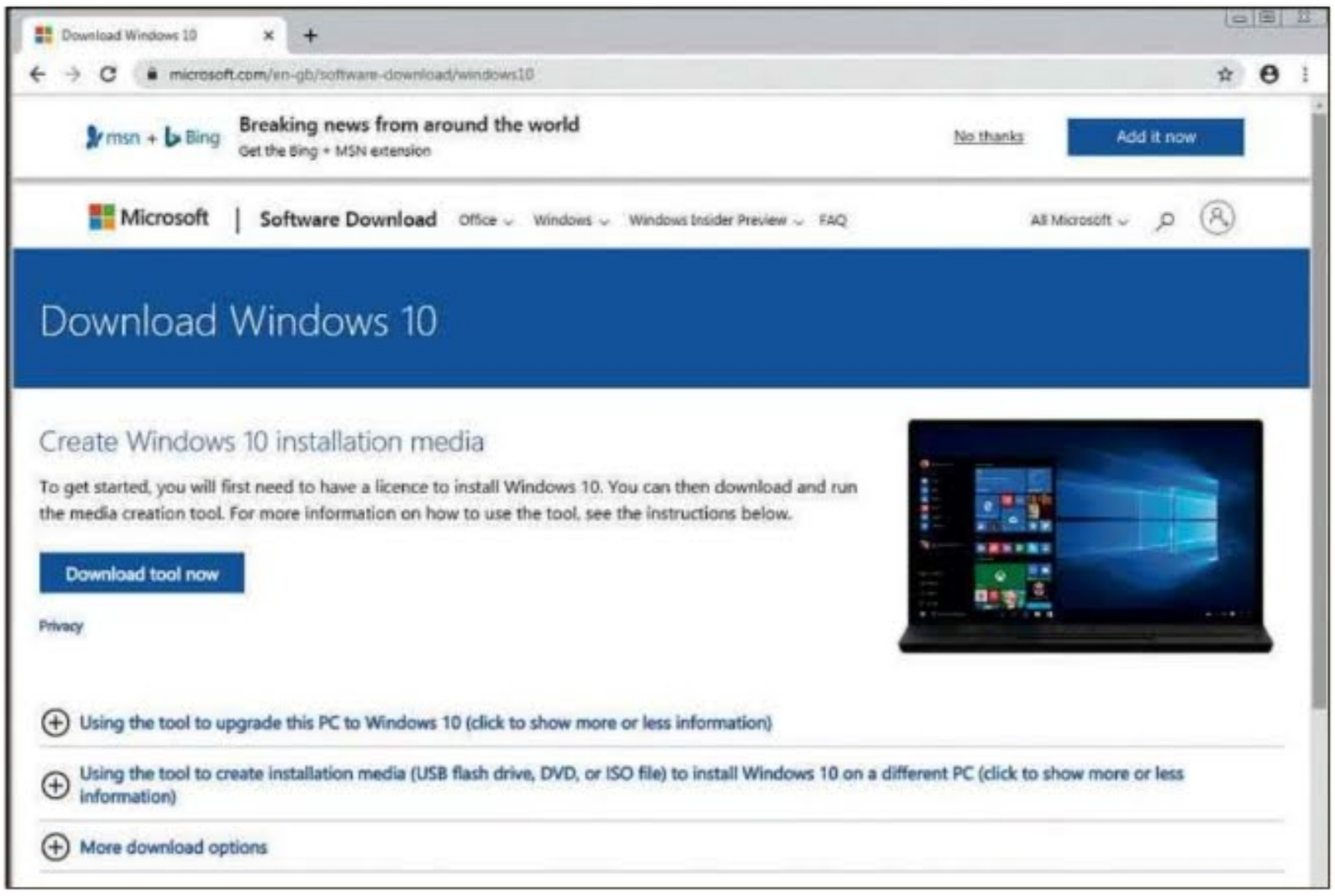
- ✘ Old hardware and software may not work
- ✘ You may have to pay for a new licence

Windows 10 is a very good operating system that has been through several revisions, each one adding new features. The good news is that the software is largely compatible with Windows 7 hardware, so you should be able to upgrade. Microsoft lists the official requirements as a 1GHz or faster processor, 1GB of RAM for 32-bit Windows (2GB for 64-bit), 16GB of hard disk space for 32-bit Windows (20GB for 64-bit), and a DirectX 9 or later graphics card.

First, you should check compatibility with your computer. The best way to do this is to download the Windows 10 Download Tool from Microsoft's website (*tinyurl.com/383windows4*). Once you've downloaded the tool, run it and choose the option to upgrade your computer. Your PC will be checked for any compatibility issues, such as not having enough hard disk space or some hardware being incompatible. This gives you a chance to fix or repair issues if you can.

If your computer has the go-ahead for upgrading, you'll need a Windows 10 licence key, which you can buy from Microsoft's online store. Windows 10 Home costs £120 for a licence, and you'll need this key for your computer.

However, you may be able to upgrade for free if you're prepared to do a clean installation. Make sure that you've taken a backup of your Windows 7 PC and its files, then you can run the Download Tool, but select the option to create installation media. Follow the wizard through and insert a 4GB USB drive to create a boot drive that you can use to install Windows 10. Reboot your computer with the USB drive inserted and boot from this to start the Windows 10 installation. When you're asked, enter your Windows 7 licence key rather than a Windows 10 one, and the software should accept it. We tried it with our Windows 7 Home Premium Key and it all worked perfectly.



ABOVE: Download the Windows 10 tool to check your computer's compatibility for an upgrade

To check if it has worked, after you've installed Windows 10 go to Settings in the Start menu, select Update & Security and then click the Activation link in the left-hand panel. Under the Activation header in the main pane, you should see a message that says, "Windows is activated with a digital licence linked to your Microsoft account".

If you don't, or Windows 10 didn't take your Windows 7 key, you'll need to buy a Windows 10 licence to use your computer.

The main downside of this approach is that you may find that some software and hardware is incompatible with Windows 10. For example, old printers may not work with your new operating system. And, as you've upgraded your Windows 7 PC, you don't have that to hand to run your older printer. There are some workarounds (see page 98), but you may need to upgrade to newer hardware and software.

BELOW: You can check if you have a genuine copy of Windows 10 or not

INSTALL UBUNTU

PROS

- ✔ Free
- ✔ Runs fast

CONS

- ✘ Won't work with existing software

If you'd rather switch to Linux, Ubuntu is a good choice. The latest version has slightly higher hardware requirements than Windows 10, but you'll find that a lot of Windows 7 hardware is up to the job. The main requirements are a 2GHz dual-core processor, 4GB of system memory and 25GB of free hard disk space. You can download Ubuntu from *ubuntu.com*.

This will get you an ISO file, which you can burn to a blank DVD for installation on your computer. Alternatively, if you want to install via USB, you'll need to download and install a program called Rufus (*rufus.ie*). Once you've got the application, run it, then insert the USB drive that you want to use and select this from the Device menu. Select the Boot selection as FreeDOS, then click Select, navigate to the Ubuntu ISO file and choose Open. Click Start and your bootable USB drive will be created, which you can use to install Linux on your computer.

However, a quick word of warning. If you have a laptop, make sure you have

RIGHT: Running Ubuntu can be a good way to breathe new life into an old computer

Wi-Fi enabled: many laptops have a keyboard combination that toggles Wi-Fi on and off, but these typically only work in Windows 7. So boot into Windows 7 and turn on Wi-Fi before you install Ubuntu.

Ubuntu runs fast on most computers and can breathe new life into an old one, particularly a laptop. There are some things to watch out for. First, not all Wi-Fi adaptors are supported directly from Ubuntu. There's no easy workaround, but the help forums at *help.ubuntu.com* have lots of friendly people that can point you in the right direction to upgrade drivers.

The second problem is that Ubuntu doesn't support the same software as Windows. If you've got old applications that you rely on, you'll have to find Linux alternatives for them, although you can run VirtualBox and run your old computer as a virtual one (see below).

TURN YOUR WINDOWS 7 PC INTO A VIRTUAL ONE

PROS

- You get to keep your old computer
- You can still run old applications

CONS

- Your Windows 7 PC will run slower
- Old peripherals are hard to get working

If you've bought a shiny new PC but still want to access your old computer, you can convert your Windows 7 PC into a virtual one for free. The easiest way to do this is to use your Windows 7 installation disc and create a new virtual machine in the free VirtualBox application. However, you can also convert your entire Windows 7 PC into a virtual one, which we'll show you how to do here.

First, you'll need as much free disk space as the amount of storage that you're currently using: if you can delete old files and applications, do this now. We recommend using an external hard disk to save the image to, if you have one to hand, so that you're not taking up valuable storage space.

To convert your computer to a virtual one, you'll need Microsoft's free Disk2vhd program from Microsoft (*tinyurl.com/msdisk2vhd*). Download this to your computer, then extract the files and run the application. First, remove the option

ABOVE: Create a virtual image of your computer with the free Disk2vhd

to Use VHDX (a slightly older virtual disk image has to be used for compatibility). You can select which hard disks you want to save, then choose where you want to save your virtual image, and click Create. Your computer will be virtualised.

Next, you need to download and install VirtualBox to your computer (*www.virtualbox.org*). This is a free virtualisation application, which supports .vhd files.

Open VirtualBox and select New to create a new virtual machine, then enter a name for your computer, such as Windows 7. This should set the operating system as the right type, but if not, use the drop-down menus to select the type of operating system you want and click Continue. You need at least 2GB of RAM dedicated to the virtual machine, so you can leave the default or increase this if you have more system RAM: 4GB makes Windows 7 run smoothly. Click Continue, then select Use an existing virtual hard disk file. Select the folder icon and then click the Add button and browse to the .vhd file from your old computer and select Open. Choose this virtual hard disk from the list and select Choose.

Once you're done, you can click Start to boot your old computer as a virtual one, and you'll see that you have your old files and applications, which will still run. Windows 7 may need reactivating, which may mean calling Microsoft. Tell them that you've changed motherboard as the reason for this, and you should get your operating system activated. You should now clear out your old computer, as you can only have one Windows 7 version running on one PC per licence key.

In VirtualBox, it's worth installing the VirtualBox Guest Additions on your virtual computer by clicking Devices, Insert Guest Additions CD Image, which will let you run your old computer at a higher resolution.

From the View menu, you can even run your computer in Seamless mode, which dumps the Windows 7 desktop image and makes it look as though applications you're running are actually on Windows 10. Just take note of the popup box, which tells you which key combination you need to switch back to regular virtualisation mode.

This method is handy if you have old applications that you rely on, as you can run them as though they were native Windows 7 applications. However, a virtual computer can take up a lot of disk space. And, while VirtualBox lets you share your actual computer's USB ports through the Devices, USB menu, it can be tricky getting old peripherals such as printers to work correctly.

BELOW: You can run your old computer as a virtual machine

GETTING THE MOST OUT OF WINDOWS 10

If you've just made the jump to Windows 10, or you're still debating whether to make the move from Windows 7, you'll find there's a lot to like about the new operating system, particularly with the most recent May 2019 update. This latest version of Microsoft's operating system fixes a lot of issues with older software and introduces some smart new features. Here's our rundown of Windows 10's best features.

TROUBLESHOOTING

Got a problem with your computer? No trouble. With the latest version of Windows 10, there are now a lot more troubleshooting tools. Click on the Start menu and go to Settings, Update & Security, Troubleshoot. Here, you'll find a long list of tools that are designed to find and fix problems automatically, from Windows Update to recording audio and network issues. If you're having a problem, check out one of these tools first.

PAUSE UPDATES

If you go to the Updates section of the Settings menu, you'll see that you now have the option to pause updates for up to 35 days, and you can defer the big updates (which are generally released twice a year) for up to 18 months. This takes away one of the biggest issues with Windows 10 – that it would upgrade you to the latest version regardless of whether you wanted to or not.

ABOVE: Windows 10 makes it easier to find and fix issues with your computer

VIRTUAL DESKTOPS

Virtual Desktops are a great way to boost productivity on your Windows 10 computer. Rather than having a single desktop, you can have multiple ones, for example one with your email client and web browser, and then one with your photo-editing software. You can then switch between the desktops, letting you keep everything neater and avoiding having too many open applications on a single desktop.

To use Virtual Desktops, press Windows-Tab and you'll see the desktops listed at the top. You can use the New desktop button to add a new one, and you can hover over an existing one and press the 'x' to get rid of one. Click any desktop to switch to it.

You can also use keyboard shortcuts to switch between desktops. Press Ctrl-Windows-Left/Right Arrow to move between them.

HIDDEN START MENU

Right-click the Start menu and you get a secret menu that pops up. This has shortcuts to lots of features that you may find useful, such as Settings, Disk Management, Powershell (the terminal for typing in commands) and Task Manager. It's a far quicker way of getting through the operating system.

SHOW DESKTOP

Is your desktop too cluttered with windows? You can get rid of them all and show the plain desktop quickly with this little trick. Just move your mouse cursor to the bottom-right of the screen next to the clock and click. All of your windows are hidden immediately, so you can see the desktop and do what you need to there, such as copying a file or emptying the Recycle Bin.

To bring everything back again, just repeat the procedure and all your open applications will pop up just where they were before.

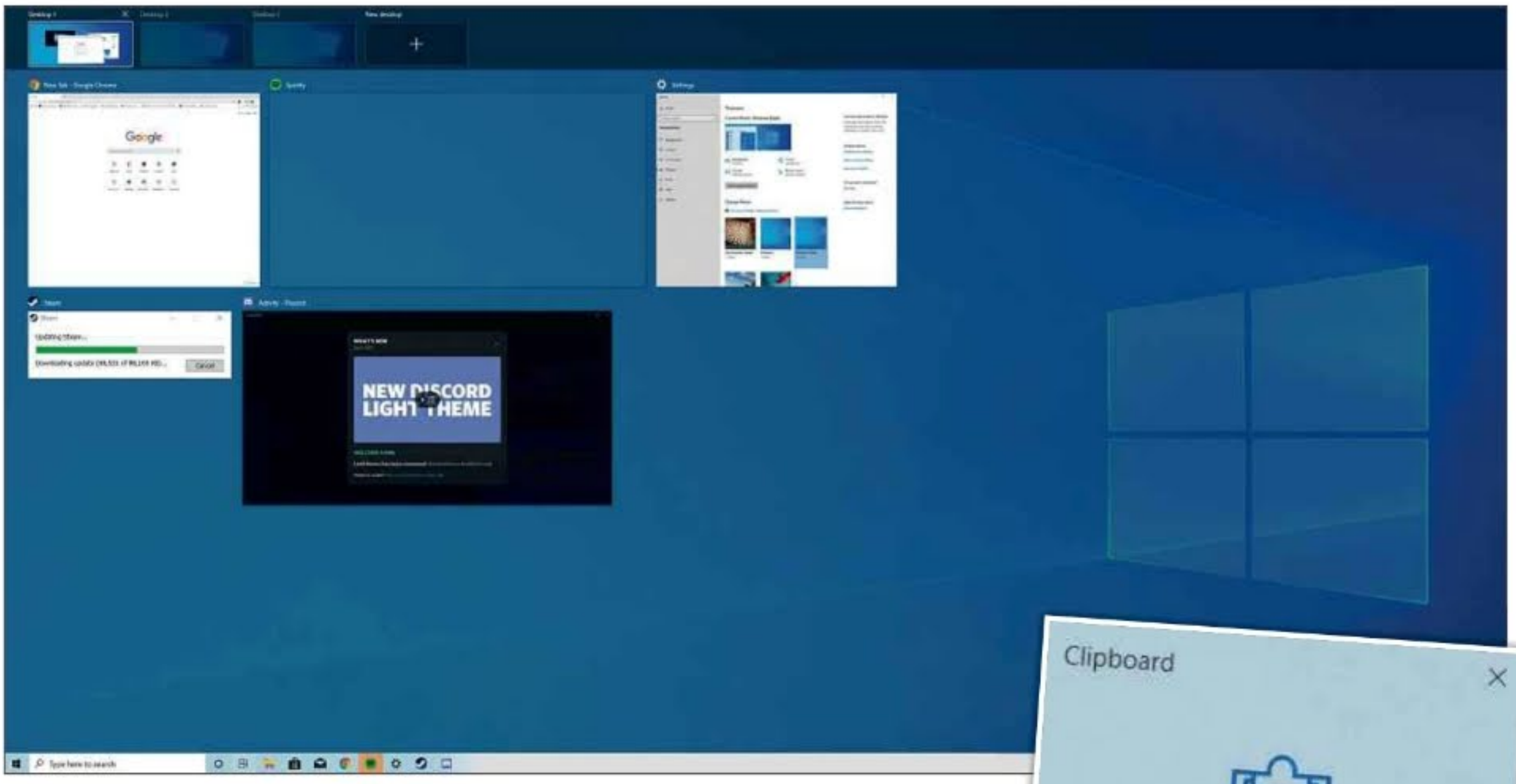
SHAKE A WINDOW

If you just want to focus on a single application, you can do that easily, too. Just left-click and hold a window with the cursor, then give your mouse a good wobble, shaking the window around. This will cause all other windows to go away, and you're left with focus on just the one that you want.

WHAT ABOUT WINDOWS XP?

The even older Windows XP is still popular, with nearly 3% of users using this 18-year-old operating system, according to the latest stats. Some of the options that we recommend for Windows 7 apply to Windows XP, although the latter operating system hasn't been supported for a much longer time, so there's now less choice when it comes to security software: AVG Free and Avast Free are two decent options, but there's no Kaspersky or Norton software available.

As such, it's hard to recommend still using Windows XP seriously if you're going to go online, as it is not a safe operating system. Any computer running Windows XP has far more limited upgrade options, too: you could install Windows 7, although moving from one unsupported OS to another isn't a particularly good idea. Currently, Windows XP computers are interesting from an historical point of view, like an old games console, but offer little for those who want modern computing.



SEARCH EVERYWHERE

Thanks to the latest Windows 10 update, the Index now scans your entire computer, so you can search for files anywhere. Just open up the Start menu and start typing to find what you're looking for. It can take a little while to build the full index, so expect results to improve over time as Windows scans your entire hard disk.

CLIPBOARD HISTORY

If you use copy and paste a lot, Clipboard History is for you. With your cursor positioned anywhere on the Windows desktop, press Windows-V and you'll see a popup message telling you, "Can't show history". Click Turn on and you'll enable Clipboard history. In future, press Windows-V to paste and you'll see a popup box showing you your recent clipboard selections: just select the one you want to paste. Pressing Ctrl-V will still paste the most recent item. CS

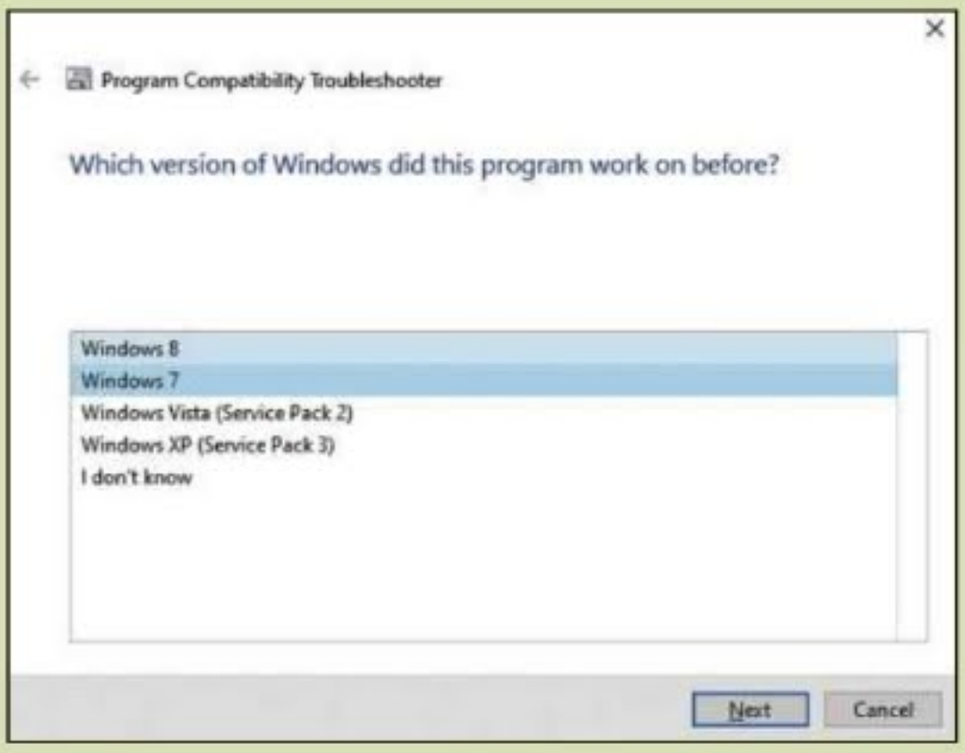
ABOVE: Virtual Desktops give you a lot more working space for your Windows 10 PC

RIGHT: Clipboard History is great if you're always copying and pasting

GETTING OLD HARDWARE AND SOFTWARE TO RUN

One of the biggest issues that people moving from Windows 7 to Windows 10 will encounter is getting old hardware and software to work. One option is to virtualise your old Windows 7 computer, and still run it under Windows 10. With Seamless mode, Windows 7 applications feel like part of Windows 10, but it's not a perfect solution, and you end up dedicating a lot of physical resources to do this.

There are alternatives. Old software, including drivers for printers and scanners, may run under Windows 10 if you use the compatibility mode. Just right-click the program that you want to run and select Troubleshoot compatibility. In the dialog box that comes up, select Troubleshoot program, then select 'The program worked in earlier versions of Windows but won't install or run now', and click Next. Now select Windows 7 from the list that appears, and click Next again.



LEFT: It may be possible to get your old software to run on a new computer

Click Test this program and, if there are no problems click Next, then choose, 'Yes, save these settings for this program'. You can now try to run this application or driver again. If you run into problems or the application still won't run, you're out of luck with this method.

Scanner owners may find themselves better off buying and installing Vuescan (*www.hamrick.com*), which comes with drivers for many old scanners. You can download a free trial, after which the software costs $50 (around £40).

Unfortunately, there's no guaranteed method of getting all hardware and software to work, so if you've upgraded to Windows 10, you may need to bite the bullet and upgrade to more recent peripherals and software.

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★★★★★
SIMON

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The DIGITAL CRYSTAL BALL

COMPUTER SIMULATION UNDERPINS MUCH OF MODERN LIFE, FROM WEATHER FORECASTING TO THE DESIGN OF OUR PCs. **MIKE BEDFORD** LOOKS AT THE ROLE PLAYED BY THE TECHNOLOGY, WHILE ACKNOWLEDGING THAT IT DOESN'T ALWAYS GET THINGS RIGHT

It's a science that was known to the ancients. What's more, the earliest computing device ever discovered, dating back over 2,000 years, was built for this purpose. But unlike much of the so-called wisdom of times gone by – and here we could mention alchemy, sorcery and numerology – this know-how is alive and well, and a driving force behind much of today's science and technology. The discipline in question is simulation, something that became ever more achievable with the advent of electronic computers.

Here we investigate the technology of computer simulation, illustrating it with examples where a near-perfect representation of reality is achieved, allowing engineers to make decisions with confidence. It has to be admitted, however, that there are some aspects of the world around us that defy all attempts to be simulated, however good our computers and software, and we also delve into this somewhat surprising assertion. →

MODELLING AND SIMULATION

Before we can differentiate the good from the bad, we need to take a high-level view of the technology. And to do that, we need to make sure that we're all singing from the same hymn sheet when we use two terms that are sometimes used interchangeably: modelling and simulation.

Most people would agree that a model is something that represents reality. So, for example, a model of a car represents a real car visually. In the realm of simulation, a model still represents something in the real world, but the representation it captures is its behaviour, often by using mathematical equations. This takes us back to school physics lessons and you'll probably recall, for example, Ohm's Law, which is written as $V = IR$. Putting it into words, this says that the potential across a resistor in volts is the value of that resistor in ohms, multiplied by the current flowing through it in amps. This, therefore, is a model of the behaviour of a simple DC circuit.

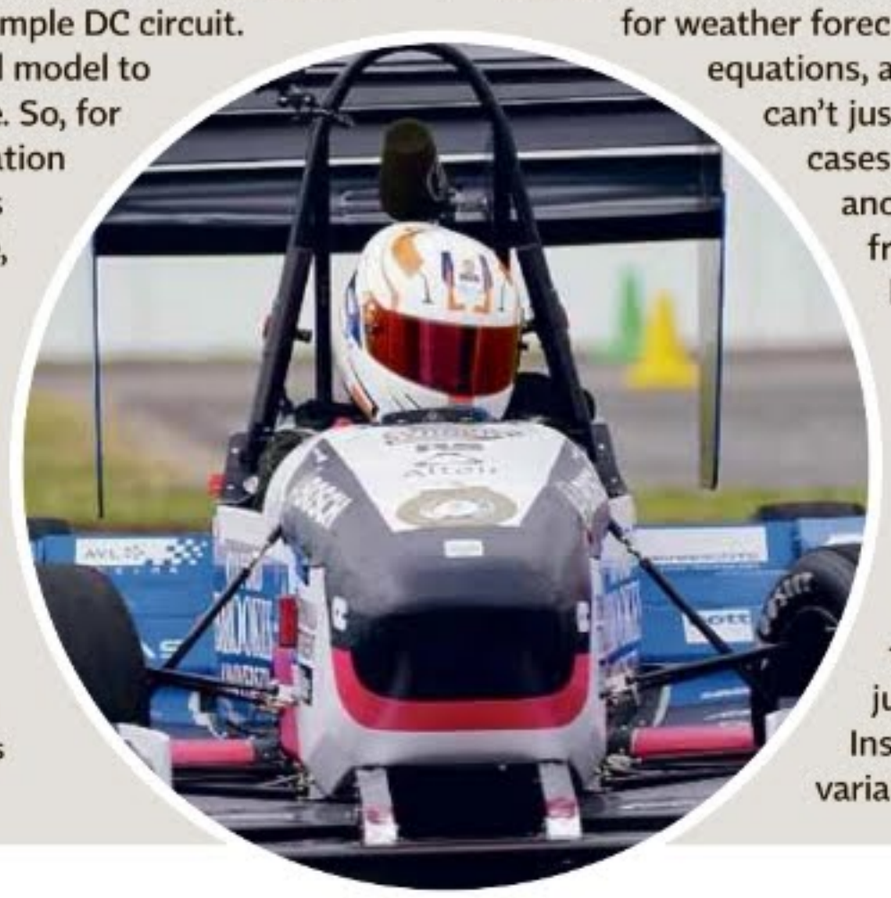
Simulation involves using a mathematical model to find out how a real-world system will behave. So, for example, if we plug into the Ohm's Law equation a figure of 2 amps for I and 3 ohms for R, it's clear that V will be 6 volts. What we've done, therefore, is to simulate that electrical circuit, although this is a simple example, which doesn't need more than a bit of mental arithmetic. In reality, simulation exercises are much more demanding in terms of computing power.

Most models of the real world use differential equations, which define the rate at which some variable changes with time. Now, unlike the case with Ohm's Law, however, we can't just plug in some numbers to get an answer. Instead, to calculate the future state of a system defined by a differential equation, it's necessary to progress through time, calculating the result in a step-by-step fashion. What's more, if you want accurate results, you have to step through in very small increments.

The method of solving a differential equation is clearly more taxing than solving Ohm's Law, but we're still talking about just a single equation. In reality, most things we might want to simulate are defined by lots of differential equations, which are interlinked. So, for example, today's models of the atmosphere, which are used for weather forecasting, contain at least 10 differential equations, and often many more. What's more, they can't just be solved individually because, in many cases, the output of one equation is an input to another. This represents yet another step up from the complexity of solving Ohm's Law – but we're not done yet.

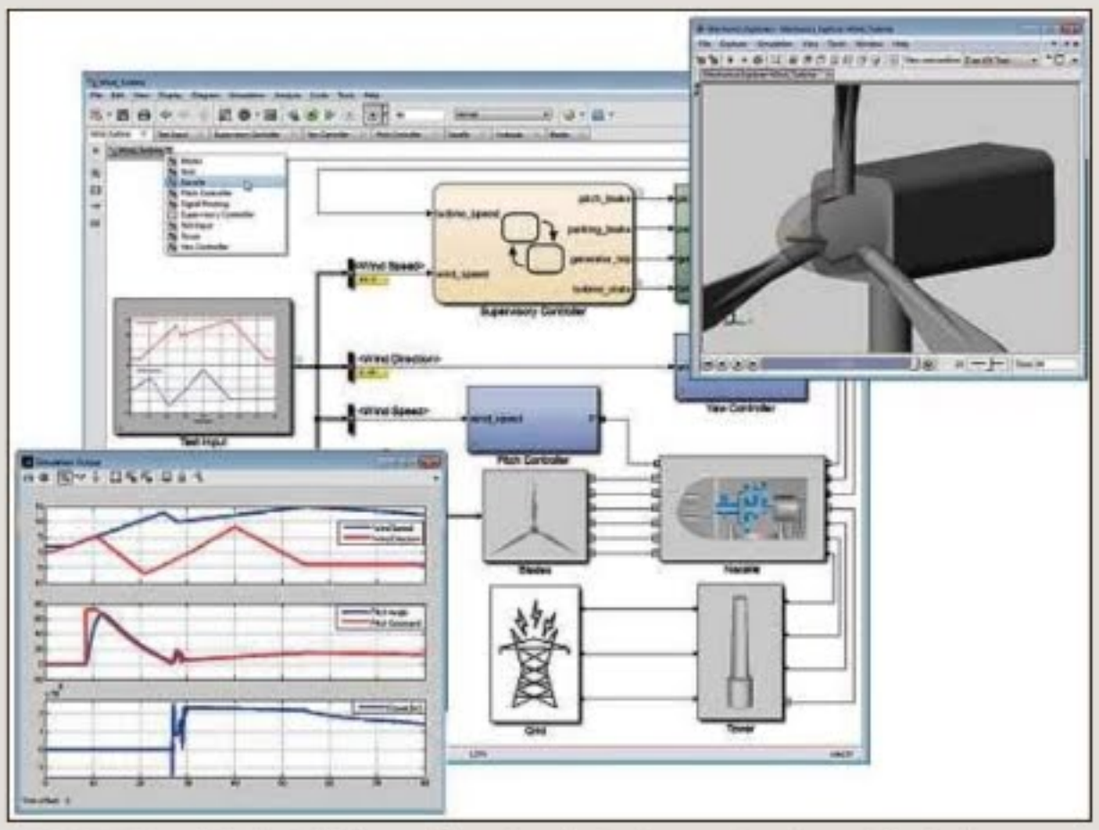
So far, we've seen models that define how things vary with time. However, most real-world problems that we might want to simulate also vary in space. So, for example, a model of the atmosphere has lots of differential equations that relate, for example, to wind speeds, pressure and temperature, but we're not interested in just a single point in the atmosphere. Instead, we're interested in weather-related variables throughout the atmosphere.

ABOVE: Weather forecasting has become far more accurate in recent years, thanks to computer simulations



RIGHT: Formula Student allows students to design and compete in their own racing cars. Simulation is key to fine-tuning aspects of the design

ABOVE: With manufacturing plants costing billions, semiconductor firms need to prove a chip design by simulation before spending all that cash



ABOVE: Simulink is widely used for simulation in engineering, with design applications ranging from wind turbines to racing cars

Not only that, but we can't solve the equations for each point in the atmosphere individually because the weather at one point depends on what's happening in neighbouring points. When we bear in mind that some of the Met Office's models solve all those equations for a grid of 2,560 by 1,920 points at 70 vertical levels – a total of almost half a billion points – we eventually get to see the enormity of the computing challenge. No surprise, then, that the Met Office's computer system is the world's 27th fastest supercomputer, and its quarter of a million cores can execute seven quadrillion (thousand trillion) floating point operations per second.

RACING AHEAD

Despite the massive computing resources needed, simulation is a technology that reaps major benefits, as an example reveals.

The Formula Student racing series brings together about 100 teams from all over the world to design and build a single-seat racing car. Competing teams spend one year designing, building and testing their cars. Then, at the Silverstone circuit, they present their projects to the judges, as well as demonstrating their technical solutions on the racetrack by competing in various static and dynamic events. As with most engineering challenges, simulation is crucial.

While computer simulation is sometimes thought of as a means of seeing into the future – a sort of high-tech crystal ball, if you like, as it is in weather forecasting, for example – here it's used for 'what if?' exercises. In other words, instead of building a car and trying it out, the much more efficient approach of trying out several options by simulation before starting manufacturing is adopted.

MathWorks is a Formula Student sponsor, and many of the teams use the company's software products. Included here is MATLAB, which is a programming environment for technical computing including simulation, and the Simulink add-on, which allows models to be created by connecting blocks together onscreen. Dr Veer Alakshendra, MathWorks' Student Competition technical evangelist, explains that modelling and simulation is a way to create a virtual representation of a vehicle that includes software and hardware.

"Iterating between modelling and simulation can improve the quality of the vehicle design early, thereby reducing the number of errors found later in the design process," he explains.

"In a Formula Student car, one can model and simulate components like suspension, steering, tyres and powertrain,

A SIMPLE EXAMPLE

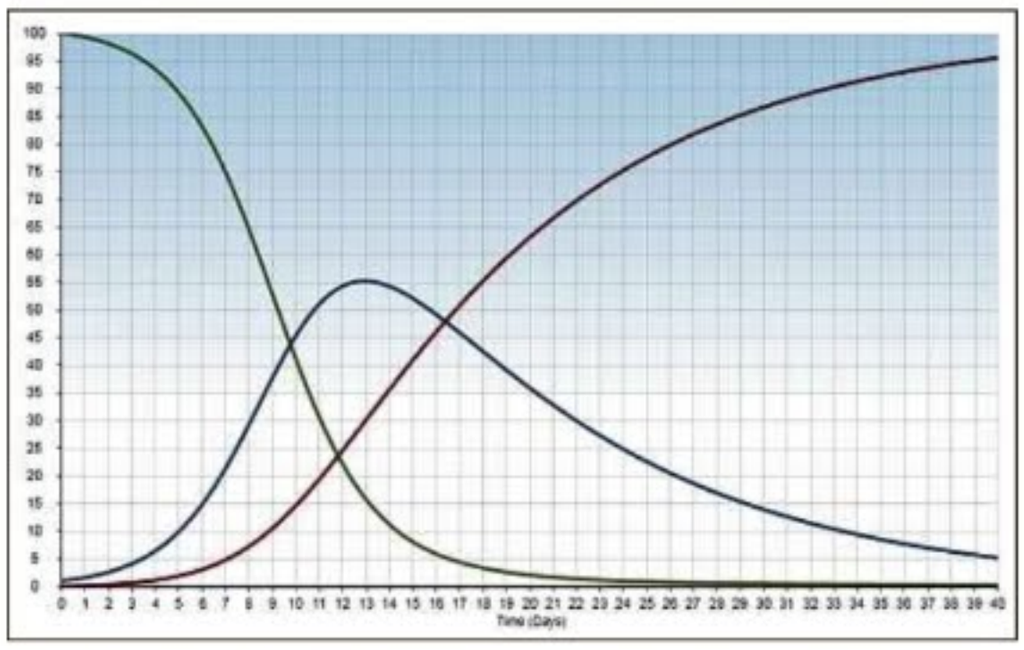
First, a word of warning: this is quite mathematical. Having said that, what we present here isn't at all difficult, and if you're prepared to put up with the odd differential equation here and there, it will give you a much better feel for how simulation works. We're going to look at a model of the spread of an infectious disease, which is a classic textbook example of simulation. The model comprises the following three equations:

$$dS/dt = -aSI$$
$$dI/dt = aSI - bR$$
$$dR/dt = bR$$

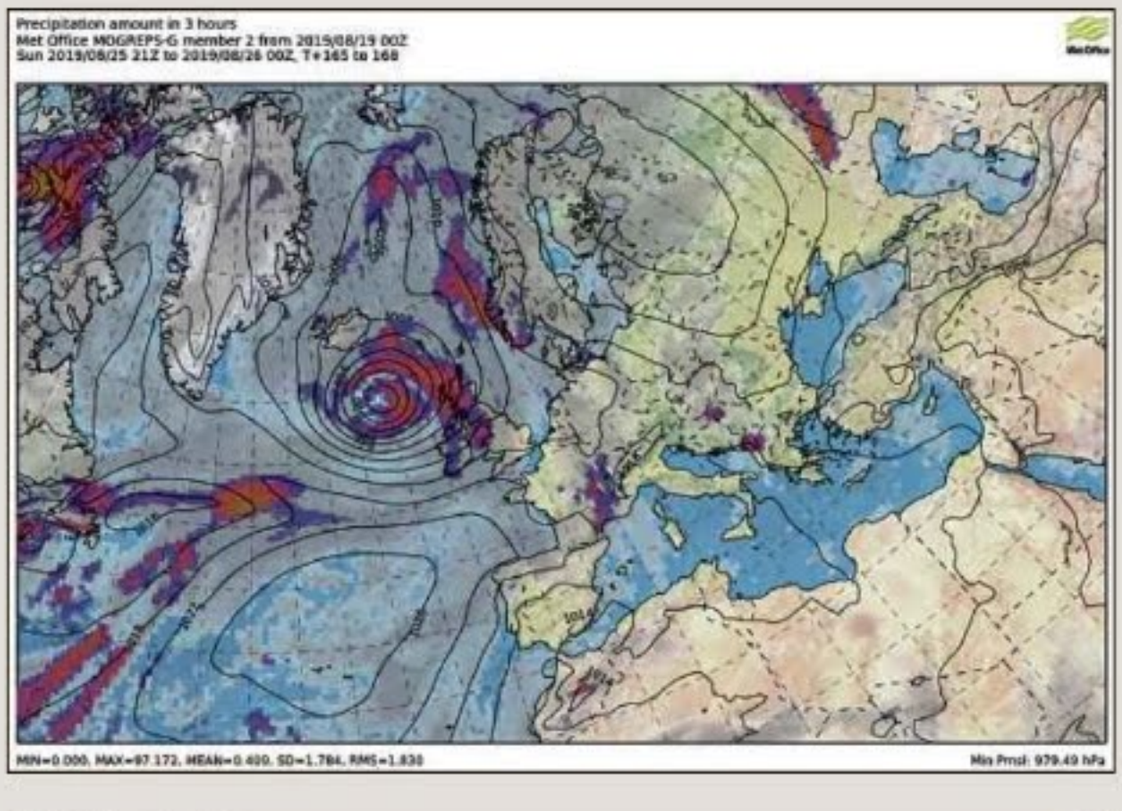
In these equations, S represents the number of healthy people who are susceptible, that is they have not succumbed to the disease; I is the number of people who are infected, and hence also infectious; and R is the number of people who have recovered and are therefore immune. a and b are two constants that represent the rate at which susceptible people are infected, and the rate at which infected people recover.

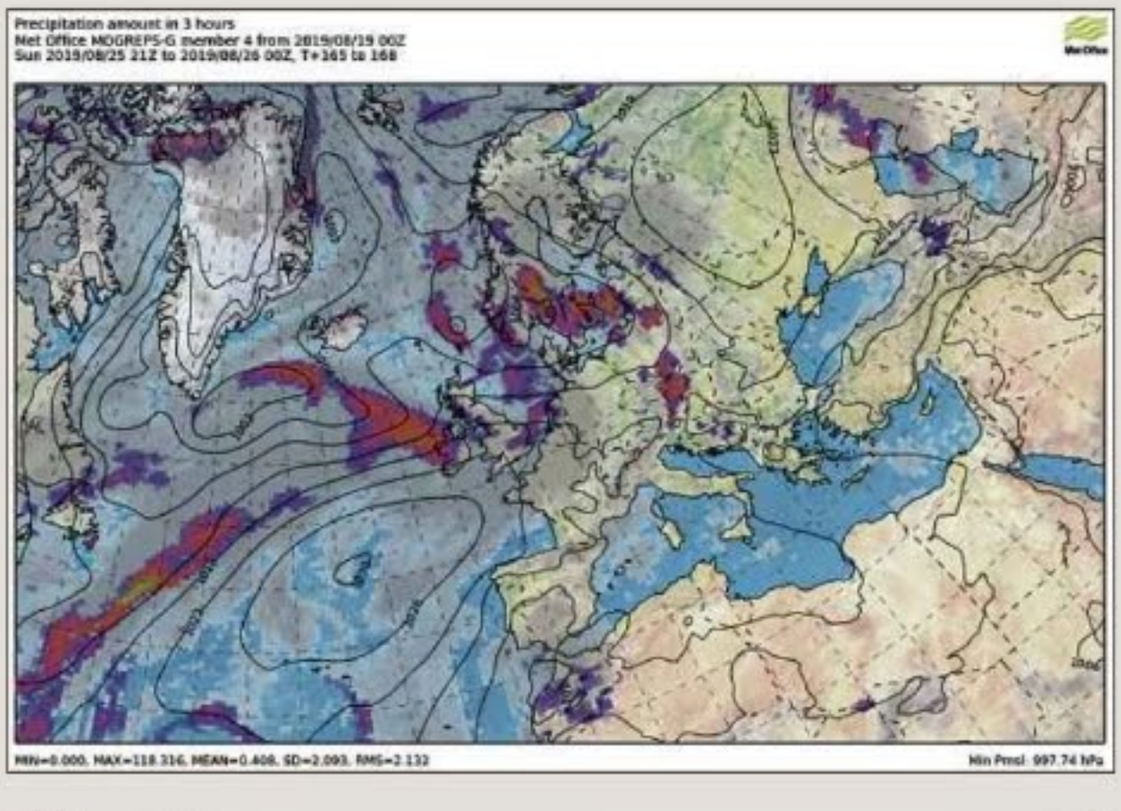
The equations should now make sense because they correspond to a common-sense view of how an epidemic progresses. So, for example, the first equation shows that the rate at which the number of susceptible people changes is a decrease (because of the negative sign) and is equal to the product of the number of susceptible and the number of infectious people, multiplied by the infection rate. The other equations should make perfect sense, too.

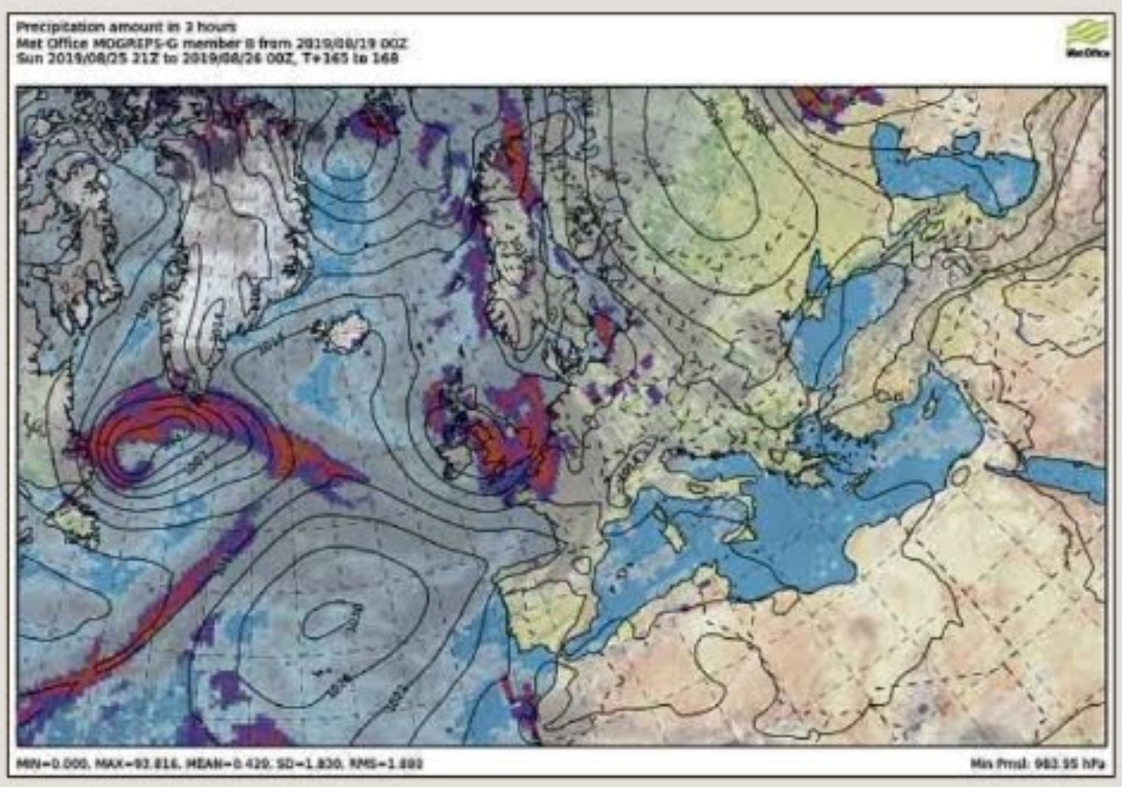
We're not going to look at exactly how these equations are solved in software, but it's not difficult, so if you want to know more, search for Euler Method, which is one of the simplest algorithms. What we will do, however, is show the results if we start with 99 healthy people, one infected person and no recovered people. A graph of these three populations against time appears below. And if you want to try this out yourself, without getting bogged down in the maths of solving differential equations, take a look at the 'DIY simulation' box on page 106.

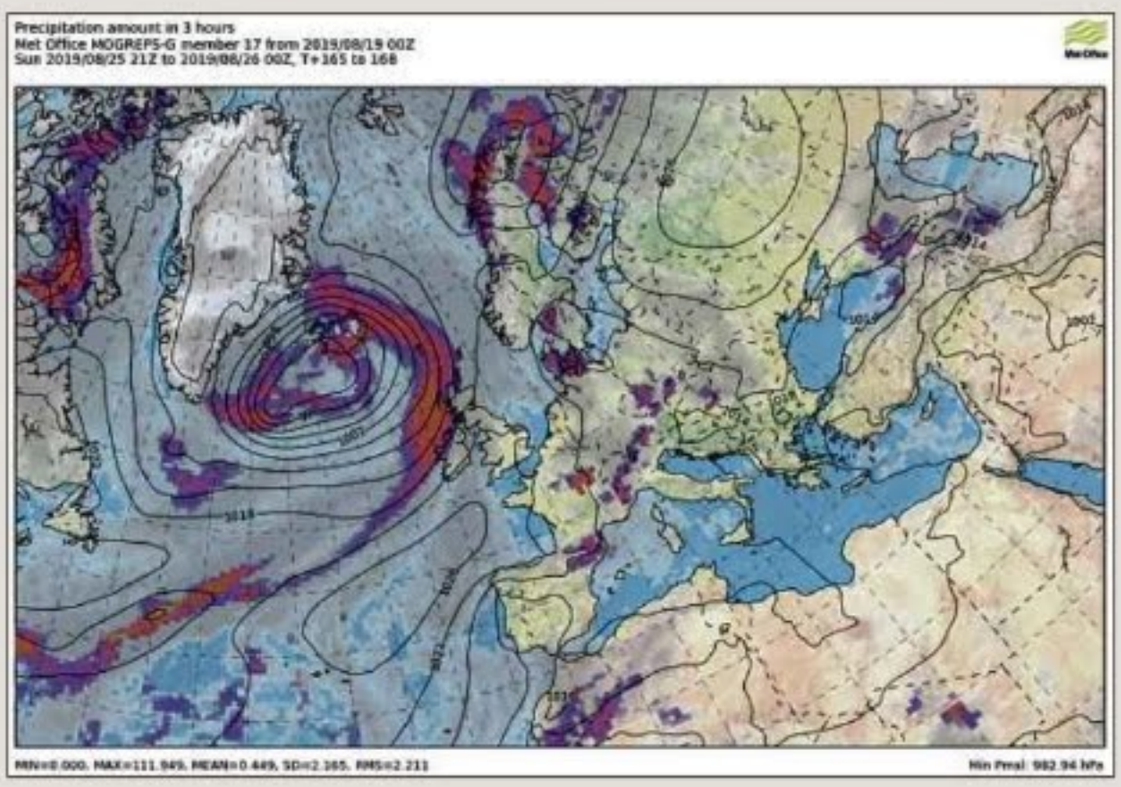


ABOVE: Solving three differential equations allows the spread of an infectious disease to be simulated. Green represents susceptible people, blue is those who are infected, and red is those who have recovered









ABOVE: Ensemble forecasting allows the Met Office to judge how susceptible the weather is to chaos at a particular time, and thereby assign a confidence level to a forecast

and integrate these parts to simulate a complete vehicle model," Alakshendra adds.

That might sound good in principle, but how do these specific benefits lead to a possible place on the podium? It seems that virtually all aspects of the race car can benefit from the simulation approach.

Alakshendra points out, "We have seen the teams using MATLAB and Simulink for various applications such as control system design, torque vectoring, lap-time simulation, optimisation, ECU programming, battery modelling and suspension tuning, which eventually improved their vehicle design."

We looked at Formula Student because it's a bit of fun, albeit with an important educational element, but there's no shortage of examples of simulations that have broader benefits. As with race cars, road cars are also simulated extensively during the design phase. The same is true of aircraft, and even the spacecraft that NASA is designing to take man back to the moon.

It's not just transport, either, with simulation being used effectively to give us so much of the technology we rely on. Coming closer to home, for example, it's pertinent to point out that the processor in your PC is a miracle of simulation. And in that sense, it's almost a chicken and egg situation – microprocessors are now indispensable in designing microprocessors.

STORMY WEATHER

It might seem obvious that if the mathematical model is correct, then carrying out a simulation by solving that model will give correct results. Surprisingly, this isn't guaranteed.

Meteorologists are fairly confident that the models of the atmosphere used for weather forecasting, which are based on well-understood science, are correct. While forecasts are undoubtedly a lot better than they were in the early days of numerical forecasting, however, it's still not unusual for a forecast to miss the mark.

This is no fault of the model, nor of the supercomputers used to generate the forecast, but it's a consequence of the weather being what scientists call a chaotic system. This is a system that displays, to use the jargon, super-sensitivity to initial conditions. In practical terms, this means that tiny errors in the measured starting conditions of temperature, pressure, wind speed and so forth will cause the forecast to eventually differ wildly from reality. And with 100% accuracy in the instruments used for measuring these starting conditions being an impossibility, there's a limit to how far into the future a forecast can be relied upon.

So do meteorologists just accept this as an inconvenient fact of life, or are there ways the impact of chaos theory can be alleviated? Dr David Walters, head of the Research to the Operations team at the Met Office, suggested that the problem isn't as severe as sometimes suggested.

"In the description of the weather as a chaotic system, people often quote Ed Lorenz – the father of chaos theory – who, among other similar statements, said that a butterfly flapping its wings in Brazil can produce a tornado in Texas. The good news is that while this is true, the influence of most of these small-scale perturbations on short time-scales is damped down, leaving a reasonable amount of predictability, at least over relatively short forecast periods," he tells us.

"The evolution of individual weather systems is fairly predictable over one to five days, and today, even a single numerical forecast will often capture their evolution accurately."

However, this isn't to say that chaos doesn't have an influence, as Walters then explained.

"The problem is that from this single forecast, it is impossible to determine when chaos will lead to a significant change in predictability and for different potential outcomes to move down

Photo: Simon Hammett, Met Office

very different paths. In particular, that forecast gives no indication whether it is sampling one of the rare cases where chaos leads to limited predictability, even the next day," Walters adds.

ENSEMBLE PERFORMANCE

One partial solution used by the Met Office involves so-called ensemble forecasts. Ensemble forecasts are multiple forecasts initialised at the same time, but with terms included to sample uncertainty in the initial conditions and the forecast evolution. This lets the team sample a range of possible outcomes.

"Not only does this help quantify the uncertainty in the future forecast, but it allows us to produce probabilistic forecasts and explore in detail the potential impacts of different alternative outcomes," Walters explains.

"At longer forecast ranges – say, six to 14 days – ensemble forecasts are even more important, as the chaotic nature of the atmosphere leads to a reduction in predictability, and each forecast must be viewed as only one of a potential range of outcomes. At a forecast range of about two weeks, there is a theoretical limit – again, the consequence of chaos theory – beyond which there is very little predictability in the structure of the atmosphere, and the forecasting process for individual weather systems breaks down."

ABOVE: Even the world's 27th fastest computer can't make the Met Office's forecasts fully immune from the effects of chaos theory

So ensembles allow a measure of confidence to be placed on a forecast, depending on the degree to which the weather is affected by chaos theory at a particular time, but is there any way to actually minimise the effect of chaos? Walters suggests there might be.

"Improved observations, and hence improved initial conditions, can help, as can improvements to our understanding of the atmosphere, and improvements to the algorithms used in the computer models," he says.

"But further improvements are allowed only by more powerful computers, such as representing finer scales and including additional complexity, such as the composition of the atmosphere, or modelling the evolution of the ocean state as well as the atmosphere."

This sort of continual improvement to the modelling process has led to the five-day forecast of individual storm systems today being as accurate as the two-day forecast was 30 years ago. All of these improvements are within the limit of chaotic predictability, however, and although further improvements will be made, chaos will continue to provide a limit to the range at which we can predict the evolution of the weather.

THE ANTIKYTHERA MECHANISM

When it was found on a wreck in the sea off the coast of the Greek island of Simi by sponge divers in 1900, it initially looked like nothing more than a piece of corroded bronze junk. However, there is more to the Antikythera Mechanism – as it's now called, named after the ship from which it was taken – than first appeared. The artefact remained largely ignored in the National Museum of Archaeology in Athens until 1951, when it came to the attention of a British science historian who, following X-ray and gamma ray images, came to the astonishing conclusion that it was a 2,000-year-old analogue computer.

Containing 37 gears, the purpose of this, the world's first known computer, was to solve the models that define the movement of the heavenly bodies. In other words, its function was to carry out astronomical simulations. In particular, it was able to predict the movements of the moon and the sun through the zodiac, to predict eclipses and even to model the so-called irregular orbit of the Moon, a phenomena that had only recently been discovered when this mechanism was built.

RIGHT: The sophistication of the Antikythera mechanism is quite remarkable for something that was built in the first century BC

Before dismissing the weather as a somewhat unusual case – chaotic because the atmosphere is such a complicated system – the stark truth is that even very simple systems can be hampered by chaos. Many of us learned about the physics of a pendulum at school, which might lead us to believe that predicting the behaviour of a double pendulum – basically a pendulum with a hinge at its centre – shouldn't be that much more difficult. Yet even this simple system is chaotic, so predicting its path after just a few swings is pretty much impossible.

HIGH FINANCE

Now we come to an area of computer simulation that vies with the weather for the title of least trusted: economic modelling. One of the biggest issues, certainly as far as those who model electronic circuits or racing cars are concerned, can be gleaned by taking a look at a typical equation.

The following equation forms part of the economic model that's jointly maintained by the Office of Budget Responsibility and the Treasury: *CBIUD = -169.01*dlog(MSGVA(-1)) +0.49*CBIUD(-1) + 0.23*CBIUD(-2) + 14.94.* We don't need to understand what all the variables are, but those strange numbers – 169.01, 0.49, 0.23 and 14.94 – stand out. With the exception of mathematical constants like Pi, models used in engineering tend not to contain odd numbers. That's because the relationships between the variables are exact or, as scientists would put it, they're based on first principles.

When we turn our attention to economics, however, we're dealing with a social science, which is quite different from a physical science such as physics. There are no first principles, so the equations are empirical, which means that they have been established by analysing historical trends.

The objections to empirical equations by some scientists might be ideological, but they're not without cause. Because a relationship has held true in the past, there's no guarantee that it will do so in the future. This is especially true if times are so unusual that historical data is in short supply, and if we bear in mind that compiling an economic model, let alone interpreting the output, invariably involves a subjective element, which leads to the possibility of political bias.

ABOVE: The public perception of bankers and politicians has led to distrust of economic modelling, but the nature of the model shares some of the blame

LEFT: It may be an important element of the Bank of England's policy making, but economic modelling has its issues

There's another aspect to economic modelling that's also quite unlike the majority of simulation exercises. If you publish a weather forecast, it won't change how the weather actually plays out. Similarly, if you simulate an electronic circuit and then try it out, the circuit will behave in exactly the same way as if you hadn't simulated it first.

With economic modelling, however, things are sometimes quite different. Recession is now a very real possibility, according to predictions made, partially on the basis of economic modelling. But consider the possible outcome of publishing that prediction. Fearing a drop in income or worse, people might choose to postpone that holiday of a lifetime or that new kitchen. Needless to say, if sufficient people decide to play it safe in this way, that will itself have a negative impact on the economy, and the end result could be a much worse recession than if that prediction hadn't been made.

Even if the output of the model had been totally wrong, if enough people believe it, then it would become a self-fulfilling prophecy. For all the benefits computer simulation has brought us, gazing into that digital crystal ball doesn't always have the results we wanted.

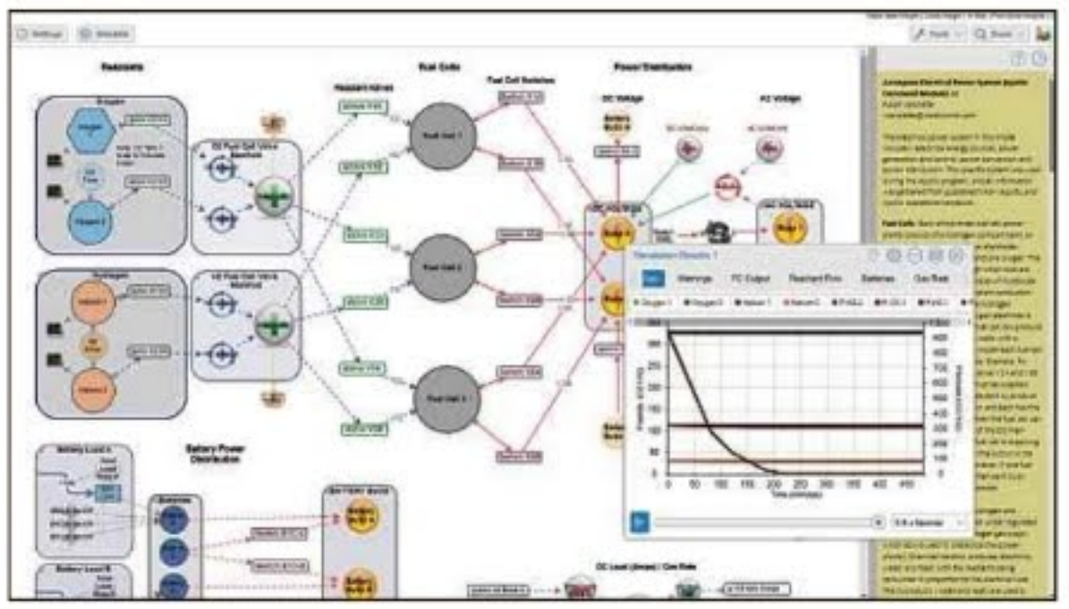
DIY SIMULATION

If you fancy a bit of hands-on experience of simulation, you don't need a supercomputer or a degree in computer science. Certainly it's not hard to knock up a bit of simple code, or you could even use Excel to solve a set of differential equations, but our suggestion is simpler still, and it won't cost you a penny.

Insight Maker is a powerful simulation tool that runs in your web browser. It supports two types of simulation, which it refers to as system dynamics and agent-based modelling. The first of these is the type of simulation we've been looking at in this article, which involves solving differential equations. Having got to grips with that, however, you might like to delve into the agent-based approach. So, head off to *insightmaker.com* and sign up for a free account.

To make things even easier, Insight Maker hides most of the maths from you. So, while you're effectively entering a series of differential equations, the onscreen process is much more user-friendly. For instance, in our example of the spread of an infectious disease (see 'A Simple Example', page 103), instead of entering the differential equations, you use a graphical interface.

Just place three boxes on the screen, representing healthy, infected and immune, draw arrows between them to represent the flow of people from healthy to infected and infected to immune, and enter a few values representing the initial numbers of people in each category and the flow rates between them. Now just run the simulation to see an immediate graph of the results against time. You'll probably get this example up and running very quickly, but if you want a bit more guidance, take a look at the example titled Disease Dynamics (SD).



ABOVE: You probably won't start with a model this complicated, but this example shows something of the potential of Insight Maker

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Perfect PRESENTS

Madeline Bennett picks out the top tech to give – or receive – this Christmas

For the vintage lover

For those who want a smart speaker with brains and beauty, the Hepburn Voice by VQ is the perfect gift. This vintage-inspired Amazon Alexa built-in smart speaker comes in a range of designer print options, from Cath Kidston to Joules. It's also a Bluetooth speaker and comes with a built-in rechargeable battery, so you can be stylish on the go, too.

www.amazon.co.uk ● £150

For the puzzle fan

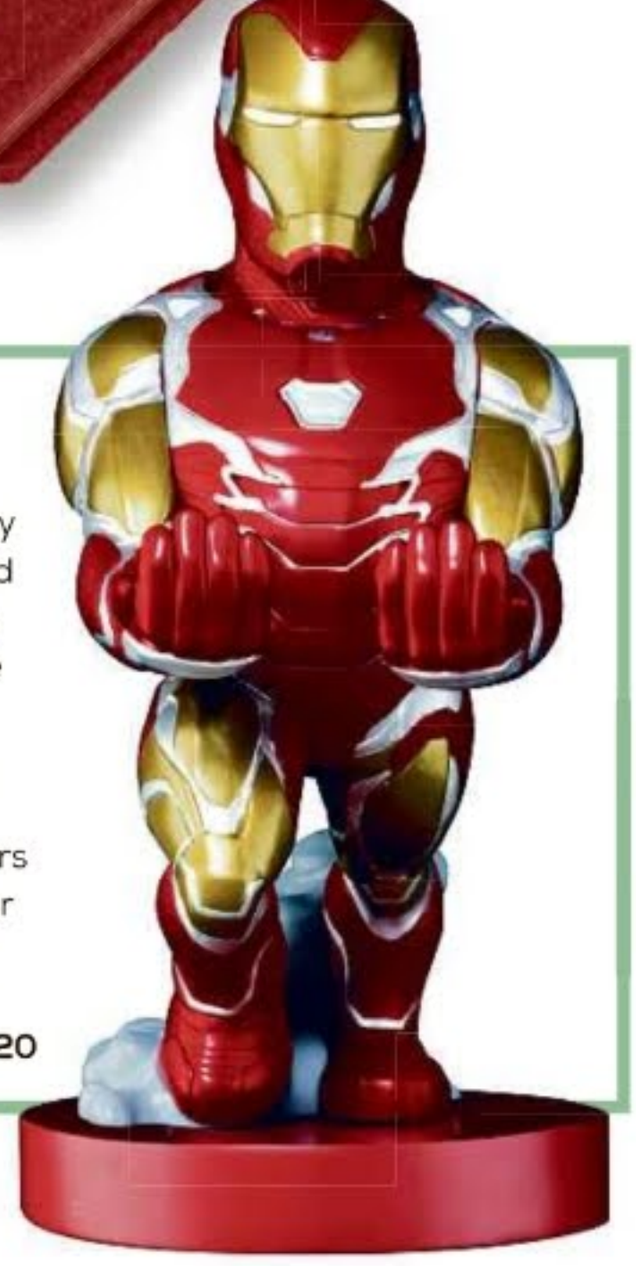
Untitled Goose Game is a truly British puzzle game, as you take control of the titular character to cause mayhem through a small rural village. It's a little short, but the fun challenges make this a game like no other and a must-play. Available to download for PC, Mac or Nintendo Switch.

goose.game ● PC/Mac: £16 ● Switch: £18

For the comic buff

Anyone into Marvel, Disney or gaming will be delighted to receive one of the cute Cable Guys from Exquisite Gaming under their tree. Serving as both a phone and gaming controller stand, dozens of characters are available, including our faves Sonic, Darth Vadar and Iron Man.

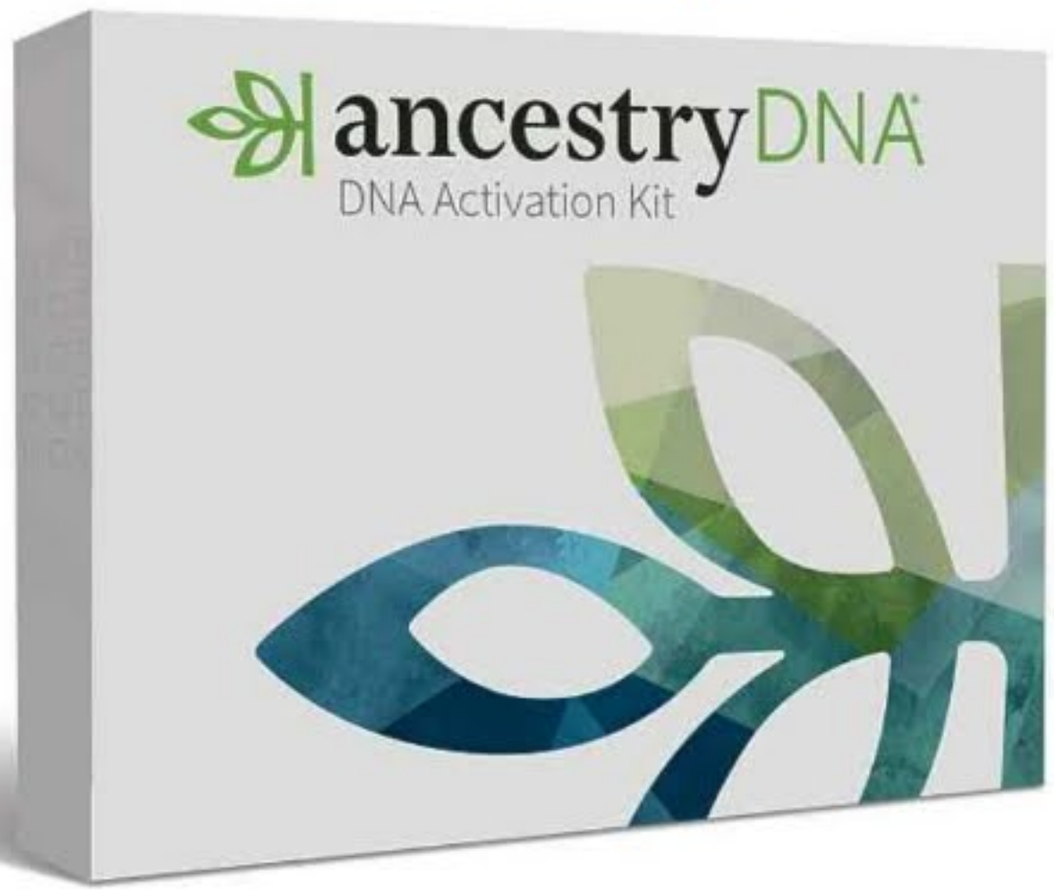
www.smythstoys.com ● £20



For the genealogist

The cutting-edge Ancestry DNA Kit is a great buy for tech-savvy gadget lovers who want to explore their back story. In just a few simple steps, you can understand your genetic origins and connect with relatives you never knew you had – more people for your Christmas card list.

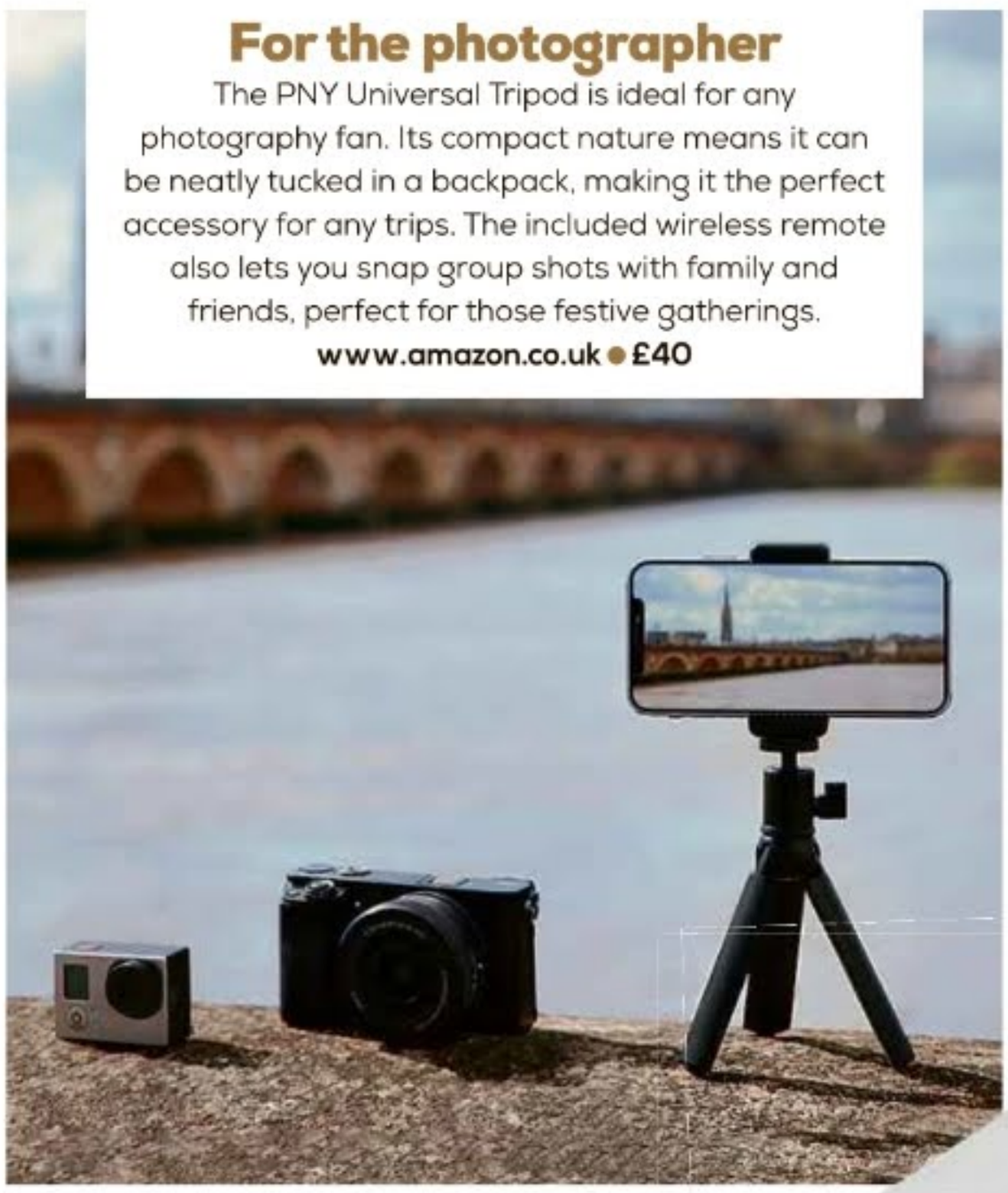
www.ancestry.co.uk/dna ● £79



For the design guru

The statement Samsung Serif TV is ideal for the design enthusiast. Complete with an iconic 'I' shaped design, your loved one can experience fantastic cinematic pictures made from over a billion colours and shades. When it isn't playing their desired film or TV show, they can enjoy the Serif as a work of art, displaying their chosen image.

www.samsung.com/uk/tvs/the-serif/highlights ● £1,099



For the photographer

The PNY Universal Tripod is ideal for any photography fan. Its compact nature means it can be neatly tucked in a backpack, making it the perfect accessory for any trips. The included wireless remote also lets you snap group shots with family and friends, perfect for those festive gatherings.

www.amazon.co.uk ● £40

For the gamer

Inspired by the iconic Sega Saturn gamepad, the PowerA Fusion Wired FightPad is available for the Nintendo Switch, PS4 and Xbox One. The six-button arcade-style layout gives you pinpoint control, while toggle switches for the D-pad and shoulder buttons let you customise your preferences in your favourite fighting or classic arcade games.

www.amazon.co.uk ● £55

For the retro fan

The Kodak Smile Classic is perfect for anyone craving a bit of nostalgia with their next camera, and it has the added bonus of a built-in photo printer. The Smile Classic prints out your pictures on 3.5x4.25in sticky-backed photo paper as soon as you've taken them, but it can also print pictures from your smartphone via Bluetooth.

www.amazon.co.uk ● £150

For the audiophile

The Ultimate Ears WonderBoom 2 ultra-portable speaker is the ideal gift for music lovers wanting sound everywhere. Its waterproof and dustproof casing and handy carry strap mean you can use it around the house, in the shower, outdoors and even in the pool. It comes in a range of fun colours, so it looks great, too.

www.ultimateears.com ● £90

For the content creator

Coming in 4TB or 5TB models, along with a free two-month subscription to Adobe Creative Cloud Photography, the Seagate Backup Plus Portable drive is perfect for storing all your content. The gleaming aluminium finish will add some sparkle to the festive seasons of all those beauty Instagrammers, photo-collecting parents and budding YouTubers out there.

www.amazon.co.uk ● £85

For the globe-trotter

Dubbed a 'smartspot for travellers', the Solis X combines 4G LTE Wi-Fi, a remote camera, a power bank and integrated smart assistant all in a pocket-sized circular package. Travellers get reliable connectivity in over 130 countries for up to 10 devices, whether they're down the street or across the world.

www.skyroam.com ● £180

For the smart home starter

The TP-Link Kasa Smart WiFi Plug HS100 is ideal for gadget lovers looking to get stuck into a smart home project over Christmas. It's simple to get up and running, and makes it easy to manage household electronic devices anywhere in the world with a tap of your smartphone.

www.argos.co.uk ● £25

For the new parent

The Arlo Baby is an all-in-one baby monitor, featuring 1080p HD video, a lullaby player, night light, rechargeable battery and air sensors. Covering all sensory bases, the smart camera keeps you connected to the most important little person in your life, even when you're not in the room with them.

www.amazon.co.uk ● £140

For the active kid

If you want to stop your kids whiling away the Christmas holidays watching films and playing video games, the Garmin vívofit jr. 2 should prove a worthwhile investment. Coming with a *Frozen 2* or *Star Wars* character band, kids can advance in an adventure with their heroes if they meet their daily activity goal. Better still, the bands are swim- and shower-safe, with battery life of up to a year.

www.garmin.com ● £80

For the budding coder

Robo Wunderkind offers coding blocks for kids of all ages. The modular kit teaches children the basics of coding and robotics, with just a few colour-coded blocks and two apps. Over 200 schools use it, so you know it's educational as well as fun. Reduced pricing is available from 25th November to 15th December.

robowunderkind.com ● £139

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subscribe.computershopper.co.uk ● £34

Play it again, SAM

The SAM Coupé was an 8-bit computer with 16-bit ambitions but, despite being able to emulate the ZX Spectrum, users steered clear, as **David Crookes** explains

Even now, 30 years after it was launched, enthusiasts bristle when a relatively little-known 8-bit machine is compared to that former giant of British computing, the ZX Spectrum.

Thanks to its ability to play games made for Sinclair's finest work, the SAM Coupé is often dubbed a super clone or, just as offensively, a Super Spectrum. Those who love the machine insist such names are a great disservice.

"It's unfortunate that the moniker of 'Super Spectrum' still lives on to this day," laments Colin Piggot, editor of *SAM Revival* fanzine, and a keen developer of software and hardware for the machine.

Yet its maker, Miles Gordon Technology (MGT), did little to discourage such talk ahead of its launch, with adverts targeting Speccy users that promoted a level of compatibility aimed at getting them to upgrade.

In many ways, it was inevitable that MGT would end up treading this path. The two men behind the company – Alan Miles and Bruce Gordon – were former employees of Sinclair Research, having left in 1986 when Amstrad bought the rights to the Spectrum.

⬆ According to Alan Miles, SAM means Some Amazing Micro and Coupé refers to the sports-car look of the machine, but with feet instead of wheels

They'd also initially used MGT to produce Spectrum peripherals such as joystick interfaces, monitor leads and the DISCiPLE floppy disk drive, before turning their attention to developing a computer of their own.

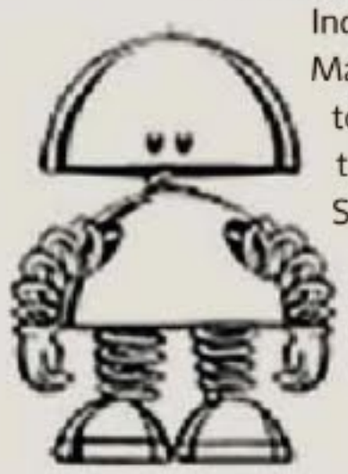
COUPÉ COPY

In order to ensure an immediate supply of software, they decided one of the SAM Coupé's four video modes should mimic the ZX Spectrum's display, allowing for the use of two colours in any of the 32x24 character cells and the ability to select 16 colours from a palette of 128.

The idea was that thousands of Spectrum games and applications could be used on the new computer, but while it was hoped that this would make for an irresistible upgrade path for anyone who had amassed a solid catalogue of Speccy titles, the decision hung heavy around SAM's neck.

"Despite the far superior specifications, magazines and the press focused on backwards compatibility with the ZX Spectrum in the run-up to the launch, relegating the true capabilities of the SAM Coupé as mere side notes," Piggot adds.

Indeed they did. *Crash* magazine in March 1988 – a publication dedicated to the Speccy – had an article about the machine headlined 'Beyond the Spectrum – a superclone takes shape'. *Sinclair User* called it a



⬅ *Shopper*'s very own Mel Croucher devised the computer's mascot, SAM, and it was drawn by our cartoonist Robin Evans

'megaspectrum' in a February 1989 preview. However, labelling would soon prove to be the least of the company's worries.

BEAUTY LIES WITHIN

It was clear early on that the SAM Coupé was developing into something special.

"It used the Z80 CPU at its core, but the SAM was clocked faster at 6MHz," Piggot explains of the use of the Z80B processor as opposed to the Speccy's Z80A.

"The SAM also sported up to 512K of internal memory, had disk drives for storage, four graphics modes and 128 colours in true bitmap displays without attribute clash. The specifications were nearing that of the mainstream 16-bit micros."

At the time, the computer was being positioned in the home and educational markets as one that could take on the Commodore Amiga and the Atari ST, but at a lower price. The machine boasted RS232 capabilities, a SCART socket, ports for a lightpen, mouse and Atari-compatible joystick, and – just as with the Atari ST – a MIDI interface, which was great for musicians. It also used the Philips SAA1099P six-channel, eight-octave sound chip so it could output in fully independent stereo.

Most of the functions were incorporated into a 10,000-gate custom chip, the Application Specific Integrated Circuit (ASIC), which was tasked with memory paging and colour-palette allocation. It processed the output of the Motorola MC1377P video chip allowing for that Speccy-mimicking Mode 1. There was also Mode 2 with 32x192 screen cells; Mode 3 with 80-column text display, 512x192 pixels and four colours from 128; and Mode 4, which allowed 16 colours from a palette of 128 with a 256x192-pixel resolution.

Users could take advantage of these, not least in unleashing their artistic flair via a bundled art package called Flash, developed by Swedish programmer Bo Jangeborg, whose work had already lit up the Spectrum scene with games such as the 3D adventures Fairlight and Fairlight II.

Jangeborg had also written a graphic tool called The Artist for the Speccy, but mouse-controllable Flash put the application in a similar sphere to those on the Atari ST and helped to showcase the great graphics the SAM Coupé was capable of.

Even so, the computer was an odd-looking beast. For anyone wishing to type (and the computer came with SAM Basic written by Dr Andrew Wright, who had previously developed an improved version of Spectrum Basic called BetaBasic), there was a full-travel 72-key keyboard, which used inexpensive membrane key switches (nevertheless ideal for typing the 61,439 permitted lines of code and developing programs of up to 217K in size). It was set back and raised with the front portion acting as a rest for the wrists. It also had little plastic legs either side of the white casing.

Not that the unconventional appearance seemed to be terribly off-putting to buyers.

Piggot says, "From all the SAM users I've met over the years, it's not something that has even cropped up in conversation as a bad point of the computer – it just adds to the SAM's quirky uniqueness. If you use the keyboard for a long time, it's not tiring or uncomfortable."

DESPITE THE FAR SUPERIOR SPECIFICATIONS, MAGAZINES AND THE PRESS FOCUSED ON BACKWARDS COMPATIBILITY WITH THE ZX SPECTRUM

NOT SO COMPATIBLE

What did put people off was an initial lack of availability. There had been a small story at the top of page three of the 23 September 1989 issue of the long-defunct *New Computer Express*, which said MGT had finally launched the computer at a cost of £150. It felt like a bargain, but was more than the £100 originally envisioned. It was also three years since development had begun, and *Your Sinclair* magazine said it had been a "gestation period longer than that of an African elephant".

In truth, potential users would have to wait even longer, since sales of the machine were further delayed. The problem was originally

➡ For the machine to emulate ZX Spectrum games up to 48K, users had to use an app in combination with a Speccy ROM – either the original or a cloned version

blamed on the company's move from Cambridge to Swansea, but it also transpired there was an issue with the supplier of the ASIC chip, so the computer didn't become available until December 1989. Even then, orders were limited to mail order, and it appeared to make a mockery of plans to sell 250,000 models by 1991.

It certainly left very little time for consumers to pick one up in time for Christmas and, in the end, just 200 were sold in that festive period. Buyers also had to shell out a little more, since the computer retailed at £170. This was for the basic model and, while it was possible to add one or two disk drives, an extra 256K of memory, RS232 and parallel interfaces, a mouse and more, the situation effectively poured cold water on the claims that the SAM Coupé was the less expensive option when compared to rivals for anyone wanting to spec it up.

Still, MGT ploughed on. The company planned to go slow and create 2,000 machines each week before reaching a manufacturing capacity of 20,000. It was assisted by assemblers A&A Electronics in Glamorgan, PCB makers Kamicircuits in Wiltshire, Plastic Injection Mouldings in Hereford and metalworkers Altar Engineering in Cardiff, but the problems continued to mount.

Slight delays to the drives, which were made by Citizen, added to the headaches suffered by MGT, made worse by the company needing to send out a ROM chip upgrade to 8,000

➡ Manufacturer Miles Gordon Technology soon ran into problems and had to find a way of ensuring the SAM Coupé didn't die an early death

⬆ There were many expansion ports at the rear of the computer including Midi in/out, which made it handy for musicians

customers in order to fix a DOS booting bug. Add to that an issue with the much-promoted Spectrum compatibility (as few as 50% of Spectrum games would actually work on the SAM Coupé) and the shine was beginning to wear off.

"The SAM used a mix of hardware and software to achieve the ZX Spectrum backward compatibility, with a graphics mode ideal to the ZX Spectrum and all necessary signals for the likes of keyboard and other ZX ULA functions appearing on the same I/O ports," explains Piggot of the problems with compatibility.

"The limiting factor at launch was that Amstrad owned the ZX Spectrum ROM code, so this could not be included in the emulator. MGT had to write a compatible ZX Spectrum ROM for the emulator from scratch, so this did result in less than spectacular compatibility, leading to the press criticising the functionality without making the reason why clear."

It didn't help that there was also a price rise to £180 (or £250 with a disk drive). On 11th June 1990, MGT went into administration with debts amounting to £1.7m.

SAM IS REBORN

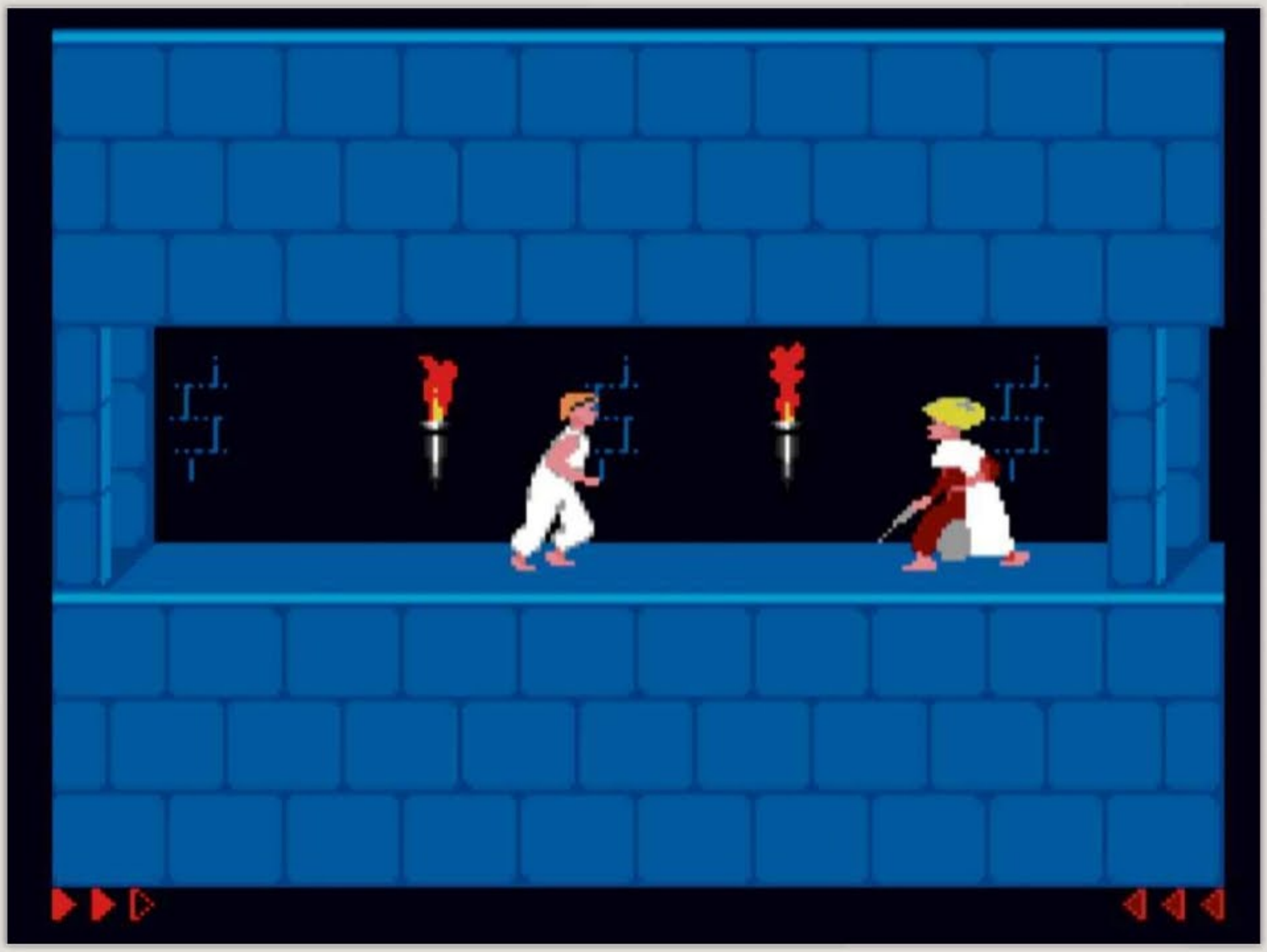
MGT looked for a buyer and, ironically, Alan Sugar, boss of Amstrad, was apparently sounded out but passed on the opportunity since his firm was on the verge of launching enhanced 8-bit computers of its own: the 464 Plus and 6128 Plus (and GX4000 console).

Instead, Sugar and Gordon created a new company, SAM Computers, pledging to support the SAM Coupé and honour their obligations to 8,000 owners. What's more, there was a promise of technical support and the issue of Spectrum compatibility was being resolved.

"Instructions for transferring the ROM code via tape from the ZX Spectrum to the SAM were given to get around the copyright situation, and both public domain and commercial emulators, which included the ZX ROM code, appeared very quickly," Piggot says.

"Both of these options then allowed the SAM to be virtually 100 percent compatible with 48K software."

At the same time, SAM Computers vowed that it would fix the problem of a distinct lack of software. This had been tried



⬆ Prince of Persia is arguably the best game for the SAM Coupé, and its graphics were not far off the capabilities of 16-bit computers

before just prior to MGT going under, as the company dangled a prize pot of £20,000 in front of anyone who could create some decent games and applications. MGT also looked into publishing software itself, snapping up Spectrum classics such as Lord of Midnight that could be enhanced with better graphics to showcase what the SAM Coupé could do.

Such a strategy, if repeated, Sugar and Gordon surmised, would get around the problem of third-party software houses waiting to see how well the SAM Coupé did before committing themselves. The situation had been causing prospective purchasers to be cautious.

The owners had already formed a close relationship with Enigma Variations, which pledged to support the new company. They appeared together at the All Formats Computer Fair in London in August 1990, showcasing Defenders of the Earth, a game that had made good use of the SAM Coupé's sound and graphics capabilities. Meanwhile, distributor Hollington Myers said it would continue to place the computer with retailers. Things were looking up.

In September 1990, Amstrad axed the Spectrum Plus 3, which, in theory at least, should have given the SAM Coupé a leg up given the elimination of a competitor. That same month, Sugar and Gordon's new company relaunched its computer, making the disk drive a standard feature and lopping £50 off the price so that the new SAM Coupé – rechristened the Super Spectrum (in a move that wouldn't help haters of the name) – would cost £199.

GENESIS TO REVELATION

Stocks of the machine were purchased from MGT's receivers and there was no doubting the effort being put in to try and make a success of the computer. In May 1991, there was news of the company's new software house, Revelation, which planned to launch games such as Quizball by Dave Tonks and educational titles including Highway Code by David Philpot.

Talks were under way with Ocean Software, Domark, Mastertronic and Palace about converting existing games. Approaches were made to top coding talent in the growing public domain scene, and new hardware, among them a light pen, was in the works.

It yielded some wonderful results. Coder Chris White converted Prince of Persia, which instantly became the best game for the computer (awarded 96% in *Crash* magazine). The deals were a shot in the arm for the format, and yet sales were still achingly slow,

➡ *SAM Revival* magazine has had a cover disc or two since issue nine. Issue 26 is currently being written

← The art package Flash! came with the SAM Coupé and could be used with a mouse

despite a passionate user base desperate to keep the computer alive. Overall, more than 350 games, apps and hardware products would be developed.

THE SAM REVIVAL

To allow Sugar to concentrate on the marketing and software side, and give Gordon the space to look after manufacturing and technical issues, SAM Computers was split into two. SAM Computers – or SAMCo as it was known – dealt with the former, and SAM Technology the latter.

On 28th July 1992, however, SAMCo was wound up, and once again the SAM Coupé's future was up in the air. Its stock ended up being bought by West Coast Computers four months later, and the name of the computer was altered to SAM Élite.

It now came with 512K of memory as standard, as well as a floppy drive, a parallel printer interface, a modified ROM, a change from blue to black feet and an external power supply unit. They were made available for a few more years.

As with many retro machines, enthusiasts then largely took over. In fact, Piggot only bought his first SAM Coupé in 1993 using his student grant. He recalls most of the support for the computer being small businesses started specifically to cater for the SAM and lone individuals who were the backbone of the scene as 'bedroom coders'.

"Within three weeks of having my SAM, I had my first game published via a disk magazine, with several utilities appearing in the following months and one utility published via a dedicated SAM publishing house," he says.

NEWS

CLASSIC AMIGA PINBALL GAME PINGS ON TO CPC

Originally created by Digital Illusions for the Commodore Amiga in 1992, the simulation game Pinball Dreams has finally made its way to the Amstrad CPC. In doing so, it has nudged away naysayers who claimed the computer wasn't capable of smooth-scrolling games, with a faithful version that includes four tables – Ignition, Steel Wheel, Beat Box and Nightmare – and amazing 8-bit sound.

The game has been a labour of love by the acclaimed Batman Group, which rose to prominence with a jaw-dropping demo called Batman Forever that tested and pushed the Amstrad's abilities.

"People were saying the techniques applied in Batman Forever couldn't be applied in games," group member Alejandro del Campo Gomez tells us. Pinball Dreams proves otherwise.

"It's a very demanding game, graphically, musically and technically due to physics and the smooth-scroll. Since the game had to run at 50 frames per second, we thought it was a good way to show that the Amstrad can run games that other 8-bit computers cannot," he adds.

Gomez says it uses a scrolling technique that takes advantage of architecture capabilities that were not officially documented.

"We believe that not documenting the machine well was one of Amstrad's biggest mistakes, but it has left a much richer and more surprising story than that of other platforms," he continues.

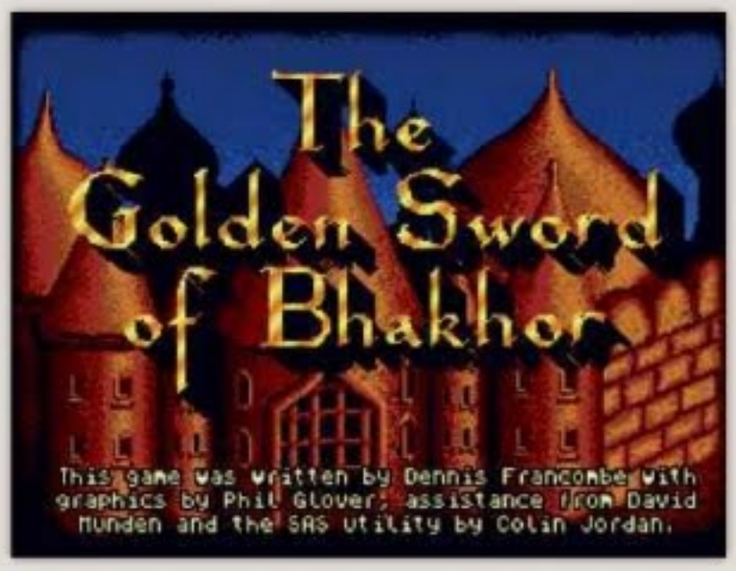
"It's true that anyone could look inside, see its components and, hopefully, find the datasheets, but it lacked the overall image of how chips could be used with each other to achieve incredible techniques. It's possible that [Alan] Sugar's own team was unaware of the possibilities of the hardware they had designed in its true dimension."

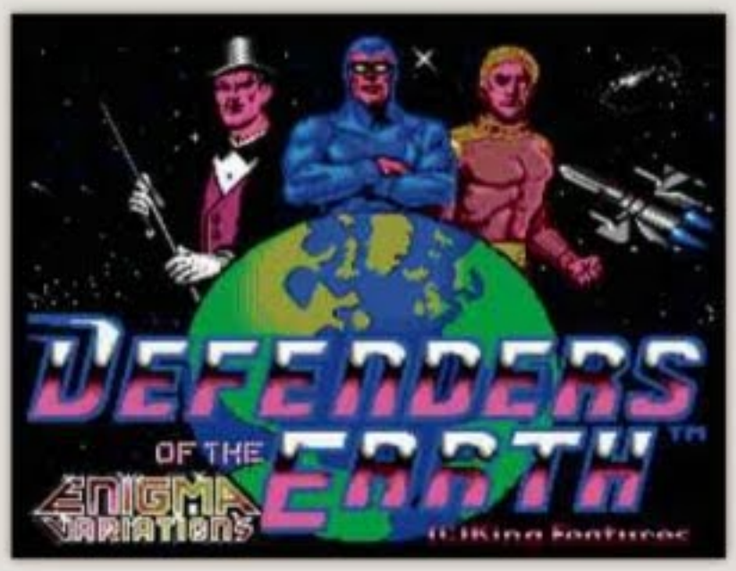
The game would have been released some time ago, but the group had been trying to secure an official licence from rights-holders Rebellion. Due to a breakdown in communication, it proved difficult, so the game has been released unofficially for free. It can be downloaded from *t.co/nAQuShB8A1* and it's best enjoyed on an original machine.

ATARI VCS TEAMS UP WITH ANTSTREAM

Although the current attempt to bring Atari back into the console market is not quite setting the world alight, the forthcoming Atari VCS will at least grant gamers access to a huge roster of retro titles.

The company has struck a deal with the game-streaming service Antstream, allowing players to enjoy hundreds of titles made for other systems





If you'd like to find software for the SAM, which can be used with a SAM emulator, then you should head to *www.worldofsam.org*

"It was in early 1995 that I decided to go it alone with the release of my first piece of SAM hardware – the Quazar Surround sound card to give the SAM true digital audio, up to a quality surpassing that of the Amiga."

Thanks to Piggot's sterling efforts, the SAM Coupé is now set to get a new lease of life. Not only is he currently putting together issue 26 of his magazine, he's working on a new version of the SAM Coupé, codenamed Pandemonium, having got hold of several hundred ASIC chips. He is also working on an eZ80 co-processor for the computer called Symbiote. You can discover more about these projects at *samcoupe.com*.

"Even though there had been next to no support from the mainstream software houses for the SAM since its launch, it lived on and was available commercially for 10 years until West Coast ceased trading in 1999," Piggot says.

"In the following years, I really ramped up my own endeavours for the SAM Coupé. I want to keep the system alive." CS

as well as the entire retro Atari back catalogue, including games such as Asteroids, Centipede and Missile Command.

You'll have to pay for the privilege, however. Subscriptions cost £9.99 per month or £96 if you pay up front. The idea is that 50 classic Atari games will be available when the system launches and that new games will be added on a regular basis.

SEGA MEGA DRIVE MINI HAS BEEN RELEASED

It's taken ages to arrive, but Sega's tinier version of its iconic Mega Drive is now available to buy, and it's already going down well with gamers. As the first console to have been produced by Sega since the demise of the Dreamcast, it comes with two three-button controllers (not the six-button version, alas, although it's available separately) and an impressive 42 pre-loaded games.

Sega has put a great deal of effort into the machine, bringing on board the renowned developer M2 and the composer Yuzo Koshiro to ensure the overall experience is polished and the games run without a hitch.

Certainly, as a slice of nostalgia, it takes some beating. The packaging is a replica of the box you'd have seen back in the 1990s, and the detailing of the console itself mirrors that of the original. You can even open the cartridge slot and move the volume switch (although you can't use either) and you can flip between a widescreen and 4:3 ratio.

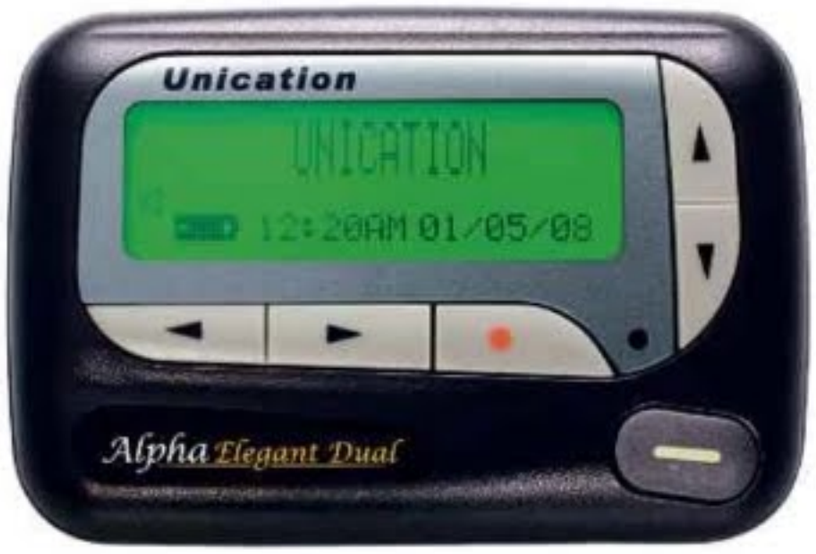
At a cost of just £70 (the equivalent of less than £1.67 per game), it takes some beating, and it shows that Sega can still cut it decades on. If only it would now have a crack at producing another next-gen console…

JAPAN'S PAGERS FALL SILENT

Pagers were popular in the 1980s and 1990s, but their days appear to be numbered. Japan's last pager provider, Tokyo Telemessage, has closed its service because it was down to just 1,500 subscribers, with most people having long since switched to messaging services on mobile phones.

Here in the UK, some are still clinging to these little devices, most notably in the NHS, where 130,000 pagers continue to be used (and where faxes are still regularly sent) thanks to patchy mobile and Wi-Fi coverage.

They are due to be phased out by 2021, however, (with fax machines likely to follow soon after) since they cost the NHS about £6.6m a year. Capita's PageOne is the only national pager network left in the UK.



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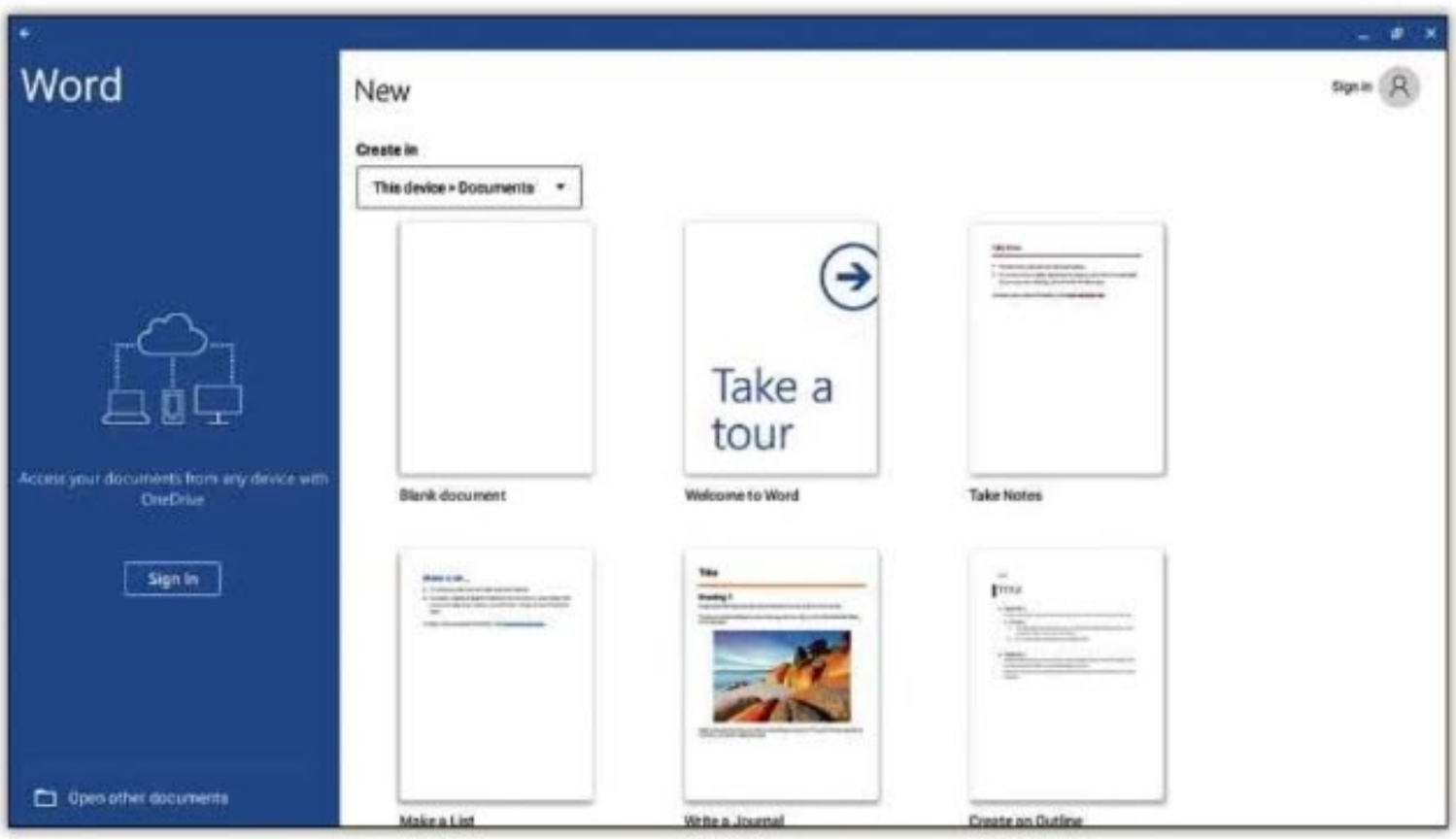
A novel approach

I'm a truck-mounted crane operator, and as such I often find myself twiddling my thumbs as I wait for supply boats, trains, lorries and joiners. To tide myself over, I read books (lots of books!), which have the handiness of being easily put aside when I'm required to do some actual work. As a bit of a puritan, I have so far refused to 'upgrade' from paper to an ebook reader.

Lately I've had an increasing urge to try writing my own novel, but my typing ability is best described as 'glacial', so I would prefer to write with a stylus. I can also see the advantage in having something that can carry an electronic library around with me.

I'm after a recommendation for a small tablet device that I can write on with a stylus and have my scrawl converted into text. I'd like to use the result in Microsoft Word, chiefly because I'm familiar with it. I'd also like to be able to read ebooks, but I don't need to watch films, surf the internet or play games. Also, I'm not after something flash and expensive: building sites are dangerous places, and accidents and thefts happen. Can you help?

Tim McGrath



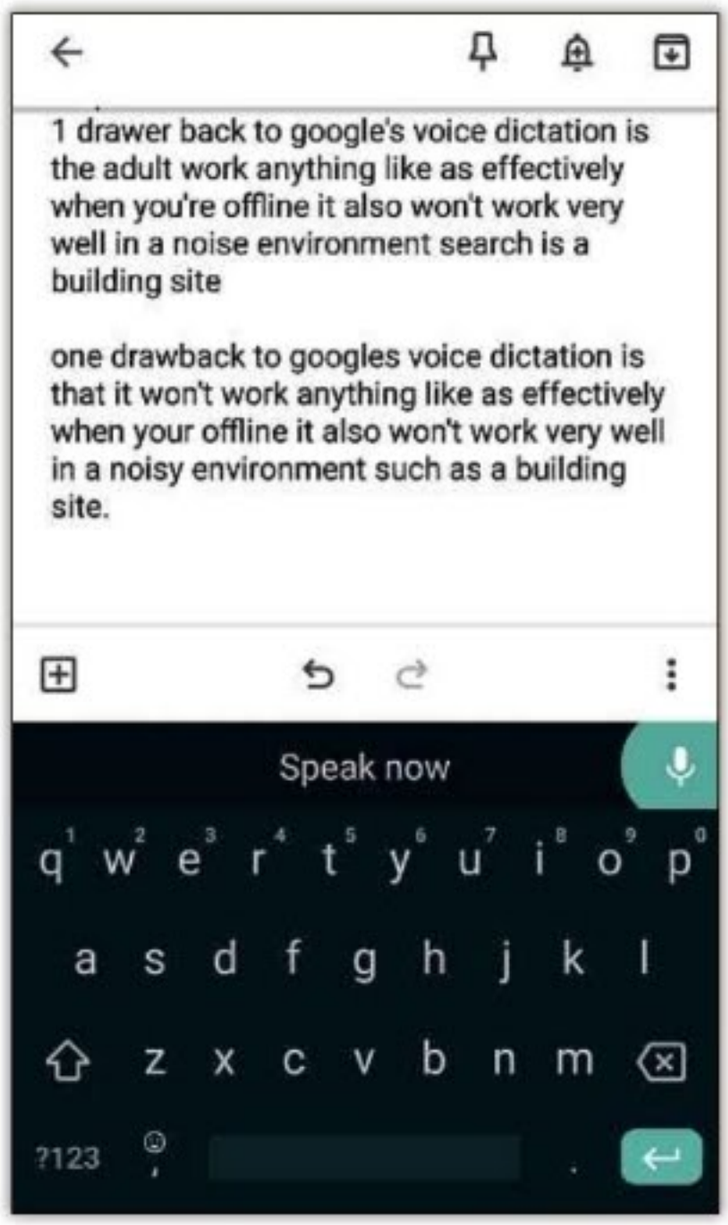
⬆ There's a Microsoft Word app for Android that lets you save documents in the .docx format

There are a few ways you could achieve what you need, but the best-value approach would be to use an Android tablet. Our reviews editor, James Archer, recommends you start with the 2019 Samsung Galaxy Tab A, which you can buy on Amazon for less than £200. You'll also need to buy the tablet version of Samsung's S-pen, and spend another £9 on the MyScript Nebo note-taking app. Finally, it makes sense to buy a protective case: these start at around £10, so your total outlay should be under £250. Note that Nebo has some strict compatibility requirements, so other combinations of tablet and pen may not work.

Once you're set up, the Nebo app will capture and recognise handwritten notes you make with the stylus. You can store the text in various ways, including saving your notes directly in Word's .docx format, or simply copying the text into a Word document; there's a free Word app for Android.

We should mention that voice dictation has recently become a reliable alternative to typing, and it may prove quicker and easier than using a stylus. You can use Google Voice Typing on most Android devices, although you may need to install and select the Google Keyboard first. However, while voice recognition should cope reasonably well with moderate background noise on site, it's much less accurate if you're without a data connection. It's also less private if you'd rather not be overheard.

Finally, there are lots of ebook readers for Android. It's hard to argue against the Kindle app, which manages and displays ebooks bought from Amazon. Using any reader will mean the tablet's screen stays on, so battery life could become an issue. You can use the tablet's supplied USB cable to charge from any USB port, or buy a cigarette lighter-to-USB adaptor for a few pounds; look for one with a 2.4A rating (or 4.8A if there are two ports).



➡ **Google Voice Typing is very effective, but only with an internet connection**

Network adaptor in a spin

About 18 months ago, I bought an Acer Spin 1 convertible tablet, which is currently running Windows 10 version 1903. I mostly use it to explore the web, which it does well, but it has no wired network port. There are times, such as during Windows updates, when it would be useful to connect it directly to my router, so I bought a Syncwire SW-AD061 USB Ethernet adaptor. However, when I connect this to the tablet I get a 'USB not recognised' message. The adaptor works without a problem on my two other Windows PCs. Can you suggest a cure?

Glyn Foster

⬆ Installing the Realtek driver may help

There's no reason we're aware of why your Syncwire adaptor wouldn't be compatible with an Acer Spin 1, so we assume that the error is down to a configuration or driver issue. Unfortunately, without more information, it's hard to narrow down a definitive cause. We'd start by trying to address any corrupt or missing drivers by reinstalling both the Syncwire adaptor and the tablet's USB drivers.

Open the Start menu, type **Device Manager** and run Device Manager from the results. Look under the Network adapters heading and delete any devices with an exclamation mark next to them. Now expand the Universal Serial Bus Controllers heading and delete every device from within it, then unplug the Syncwire adaptor and restart the tablet rather than shutting it down.

After the tablet reboots, it should reinstall the necessary drivers for its USB controllers. Wait for this process to finish and reboot again if prompted, then reconnect the Syncwire adaptor. The tablet should recognise it and install appropriate drivers, but if not you may be able to help by downloading drivers for the Realtek RTL8153 chip that it's based on.

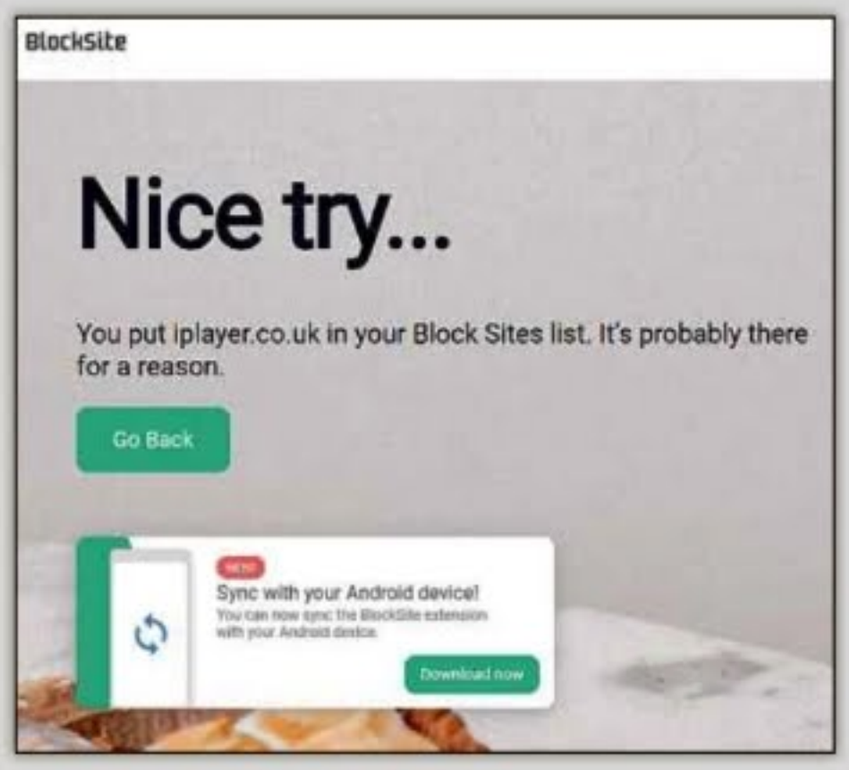
First, reopen Device Manager and again uninstall any devices with an exclamation mark under the Network adapters heading, before disconnecting the Syncwire adaptor. Now visit *tinyurl.com/383helpfile* and download the Realtek RTL8153 driver package. Extract the contents of the Zip file to a folder on the tablet, then run Setup.exe and allow the installation to complete. Finally, reboot the tablet and plug in the Syncwire adaptor again.

Omnishambles

I recently went to open iPlayer in Chrome. I typed 'iPlayer' and absentmindedly hit Enter, and before I knew it ended up at some awful spammy site that wanted me to install a dubious Chrome extension. Retracing my steps, I realised I'd accidentally accepted the search suggestion of 'iplayer.co.uk', which is clearly being squatted by miscreants.

No problem, except that now Chrome has remembered that result, and it always appears above the correct iPlayer address (*bbc.co.uk/iplayer*) in the Omnibox. You can highlight and delete the suggestion, but it always reappears. Is there a way in which I can strike it off forever?

Jenny Franklin



⬆ Want to avoid visiting the wrong websites in Chrome? Try the Block Site extension

You can remove it permanently by starting to type iPlayer, using the arrows to select the 'iplayer.co.uk' suggestion, then hitting Shift-Del. This should stop the annoyance, but if you find yourself repeating your original mistake, you might try blocking the URL. There are many ways to achieve this, but the simplest is to install the Block Site extension from the Chrome store. You can add any URLs you don't want, and if you accidently visit them you'll see a notification to remind you that they're blocked.

Simplified, or dumb?

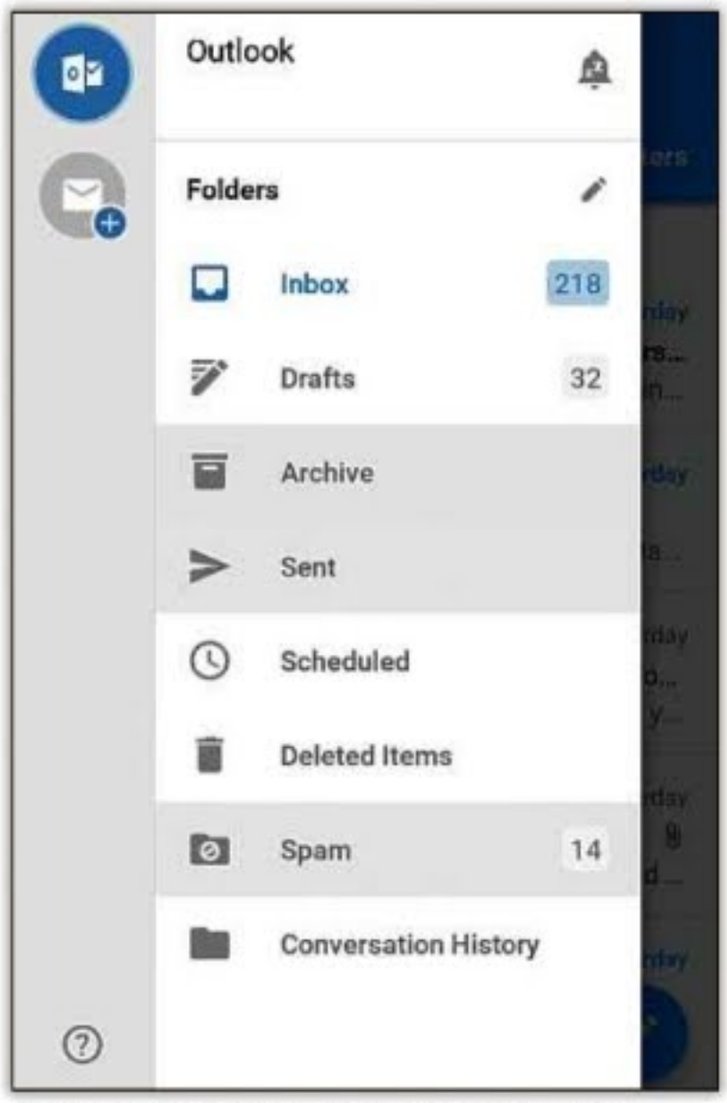
My wife recently received an email purporting to come from Tesco, asking her to update her account details. It looked genuine at first, but on closer inspection there were a couple of typos and some un-businesslike language, so we deleted it. I told her that next time she received a dubious email, she should view the email's header.

We use Outlook for our email on a PC, Android tablets and Android phones. I can still find the 'View message source' option on my Windows PC, but not on the other devices. Am I missing the option, or is it not possible to see the message source in the Android Outlook app?

Martin Simpson

Viewing an email's header information can provide a good additional check on its authenticity. Unfortunately, however, many mobile apps tend to be simplified to make them easier to use, resulting in the loss of useful features. It appears that Microsoft hasn't included the message source option in Outlook for Android, and it's also missing from the mobile version of the Outlook web interface.

You can usually get around mobile web limitations on Android by opening the Chrome menu and selecting Desktop site, but in this case that just appears to cause an endless loop between two redirecting URLs. Consequently, the only thing we can suggest is that if you or your wife receive a suspicious-looking mail, wait until you're able to use the Outlook client or web interface on a computer, and view the message header from there.



⬆ A simplified interface. But is it too simple?

Off in all directions

I live in a fairly modern, three-story house. Although we have Cat5 network cabling to the living room and bedrooms, we rely on our wireless network for our phones and laptops. In our current setup, our Sky router has its Wi-Fi radio disabled and just plugs into a central Gigabit switch to supply internet access to the network. There's a wireless router in the top bedroom, which provides 2.4GHz and 5GHz coverage for the house.

Except it doesn't quite reach everywhere. Through trial and error, I've found that having the wireless router on the top floor works better than putting it with the other network hardware on the ground floor, but either way we end up with a couple of small dead spots where our devices tend to drop off the network. The ideal solution would obviously be to put the router on the first floor, but nobody wants it flashing away in their bedroom.

The router has three external aerials that can be rotated and tilted through 90 degrees. Is there an optimal configuration that might help us get reliable coverage everywhere? I've tried putting them at right angles to each other, but that seemed to make things worse.

Andy Fletcher

← No more than 45 degrees between the first and third antennas, and think of the doughnuts

In our experience, moving a router's antennas around makes little odds when the signal is already good, but in dead spots it can make the difference between a signal that's borderline unusable and one that's stable enough to live with. The trick is to understand that an antenna radiates its wireless signal in a kind of thick disc shape, almost as though the antenna is poking through the hole in the centre of a Wi-Fi doughnut.

Understand this, and you can get a better idea of where to angle the antennas. Usually, it's best to keep all three aligned in one dimension, for example by bending all over by 90 degrees then just rotating them in relation to the router. Try to envisage the 'doughnuts', and angle the antennas so that their signals will cover the entire house.

Generally, you shouldn't have an angle of more than 45 degrees between the two outside antennas, and it usually works best to position the middle one roughly between them (see the image above).

A scan plan

A few months ago my daughter finally talked me out of continuing to use my ancient Acer netbook, which still runs Windows XP. She bought me a Chromebook, which I've used with some success, although I'm still struggling to work out how to do everything I'm used to doing on Windows.

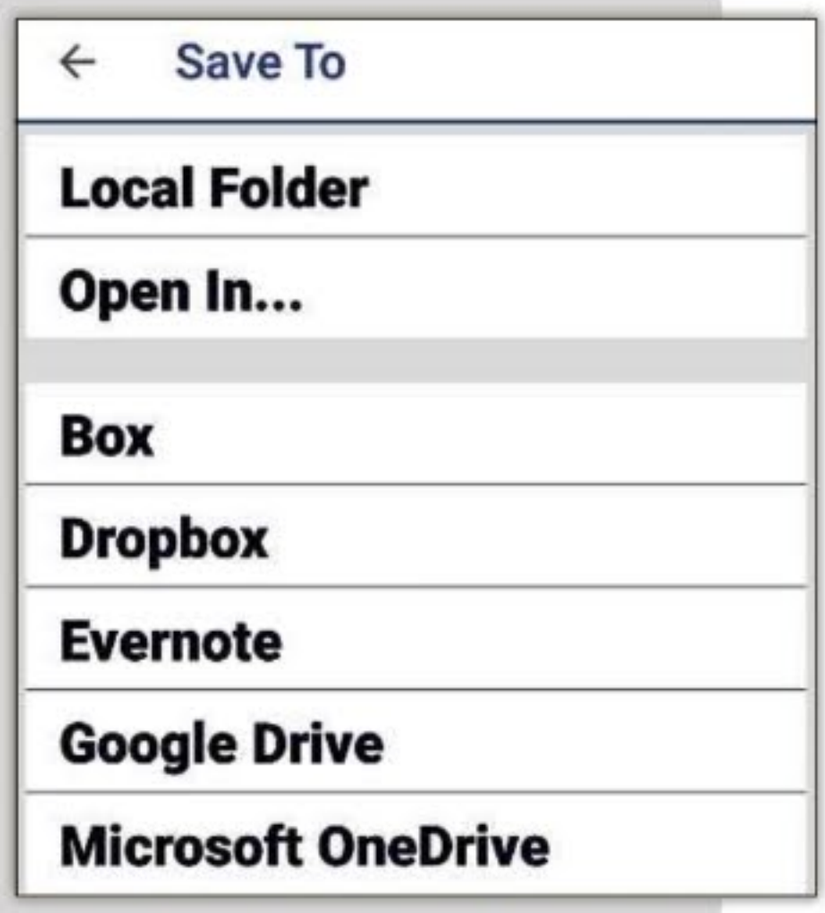
As a case in point, my old HP printer recently gave up the ghost, and I decided to replace it with an Epson EcoTank ET-2710. Unfortunately, only once it arrived did I realise that it doesn't have a display, so I couldn't manually join it to my wireless network. Eventually I discovered I could dust off my Windows XP PC, run Epson's setup program, have it connect via USB and magically configure the printer for my network.

With this done, I managed to access the printer from my Chromebook, and it works well. Unfortunately, however, I can't work out how to scan. Any pointers?

David McNamara

Unfortunately, there's no native scanner support in Chrome OS, but there may be some ways around it. Many multifunction peripherals (MFPs) now offer direct access to Google Drive, for example, making it possible to scan directly to your drive and access the documents from the Chromebook. Others support scans to a USB drive, which you could then simply plug into the Chromebook. Some HP MFPs allow you to initiate and save a scan from their web administration interface. Unfortunately, none of these options will work with your ET-2710.

If your Chromebook supports Android apps, you might try installing Epson iPrint and seeing if it will discover your printer. However, when we tried this with a Chromebook and a couple of Epson MFPs, the app couldn't detect either of them and wouldn't work with them when we manually entered their IP addresses. The app usually works perfectly well on standard Android or iOS devices, however:



↑ If your Chromebook won't scan, the next best plan is to use Google Drive on your phone

if you have either available, you could use iPrint to scan documents from the phone, and either save them in a local folder or to your Google Drive. CS

Advanced **Projects**

Clive Webster has been tinkering with computers ever since Windows 98 forced him to manually install his drivers

clive@computershopper.co.uk

Make a touchscreen jukebox

Building a touchscreen unit to control your music has never been easier, whether you're using old hardware or making a bespoke console. **Clive Webster** shows you how

THE INTERNET IS full of retro-fitted, 1950s jukeboxes – old units rescued from diners and bars, stripped down and rebuilt with Raspberry Pis and Arduinos to make steampunk-style retro-future party pieces. But you don't need to be a vintage restoration expert to make your own touchscreen jukebox.

To make your own jukebox, you can either use old PC hardware or a Raspberry Pi: simply add a cheap touchscreen and a neat ready-made case and you're ready to host some great parties. There are three general options, so we'll go through each and let you choose which is best for you.

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DIGITAL MUSIC COLLECTIONS have stopped being personal, with multiroom audio setups and Bluetooth speakers now becoming the norm. But possibly the most liberating way to share your tunes is a touchscreen system that anyone can use. Or perhaps you still want to keep your music to yourself, but just don't want to fish your phone out of your pocket to change the track. Either way, a touchscreen jukebox is a handy gadget to have around, and pretty easy to make yourself.

We'll start with bespoke units, based around a Raspberry Pi. We used a Pi 3, mainly because we had one spare; if you need to buy your Pi, you may as well go for the new Pi 4 (*Shopper* 379), as it's the same price. While a cheaper, lower-power Pi Zero WH would be a tempting choice for a touchscreen system, it won't fit the cases for the Official Raspberry Pi 7in Touchscreen that we've used. The standard case has a neat enclosure at the back for your Pi, which other cases lack. It's probably better to protect the Pi from dust and knocks for this project, as it will be on display all the time. With a 2.5A power supply and 16GB microSD card, that's a total bill of £125 (see *thepihut.com*).

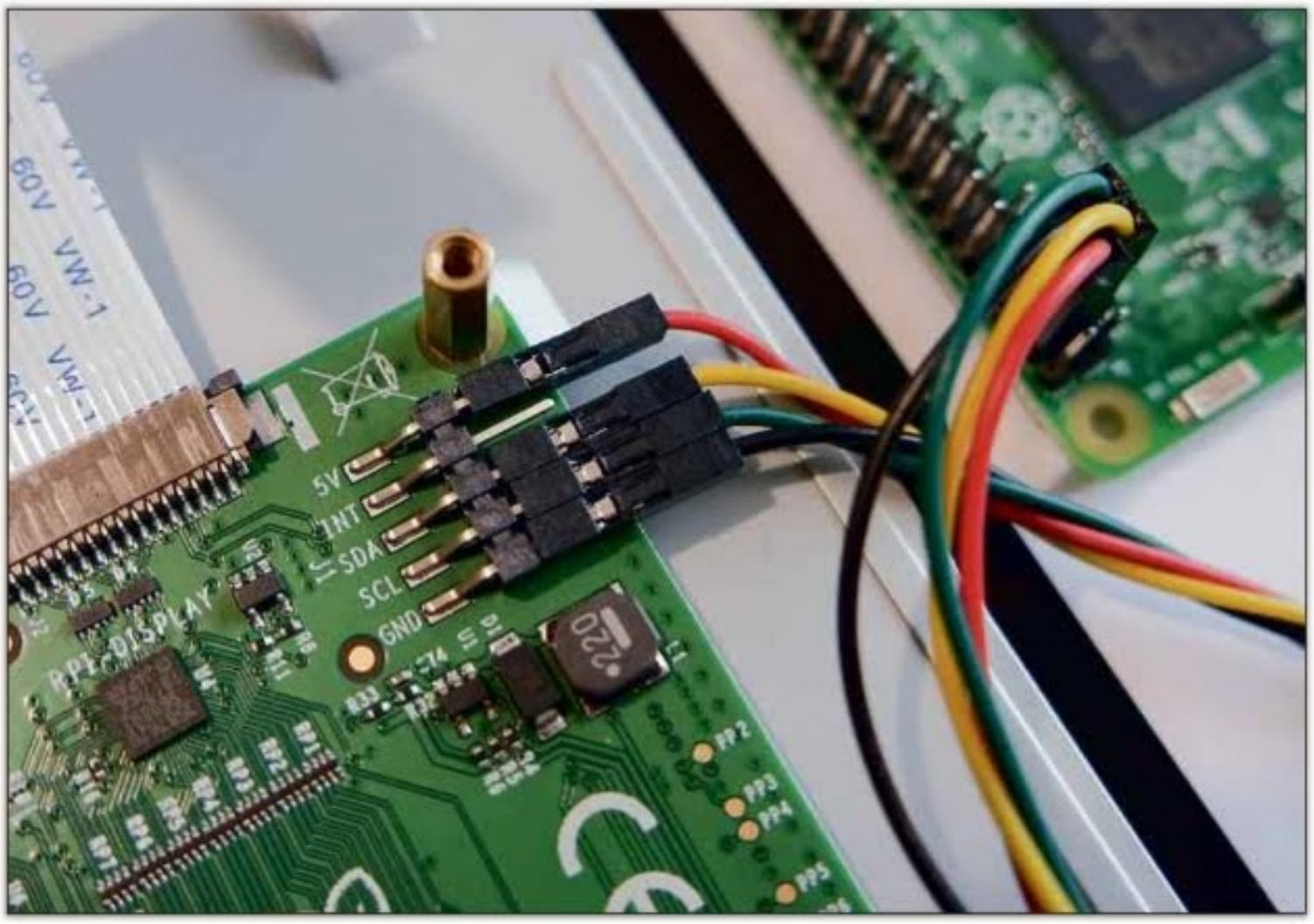
⬆ A case will give your jukebox a professional look, and help protect it from dust and knocks

READY AND CABLE

Building the unit is fairly straightforward. The touchscreen used to come as a kit, but it arrives ready-built now. You still need to attach it to the Pi, however. Use the four jumper cables to connect the GND, 5V, SCL and SDA pins of the screen's circuit board to the Pi. It's probably easiest to follow our colour coding, and hold the Pi with the 40 GPIOs on the right (with the USB and Ethernet ports facing you).

SCREEN PIN	CABLE COLOUR	PI PIN
5V	Red	Second pin down, on the right
INT	Leave unconnected	
SDA	Yellow	Second pin down, on the left
SCL	Green	Third pin down, on the left
GND	Black	Third pin down, on the right

Next, connect the ribbon cable to the screen's connector. Gently prize out the two clips, feed the cable in with the exposed side down, and then push the clips back in. Then loop the ribbon cable round and repeat the process with the Pi's ribbon cable connector. Sit the Pi on the four standoffs of the screen's control board and screw the Pi into place.



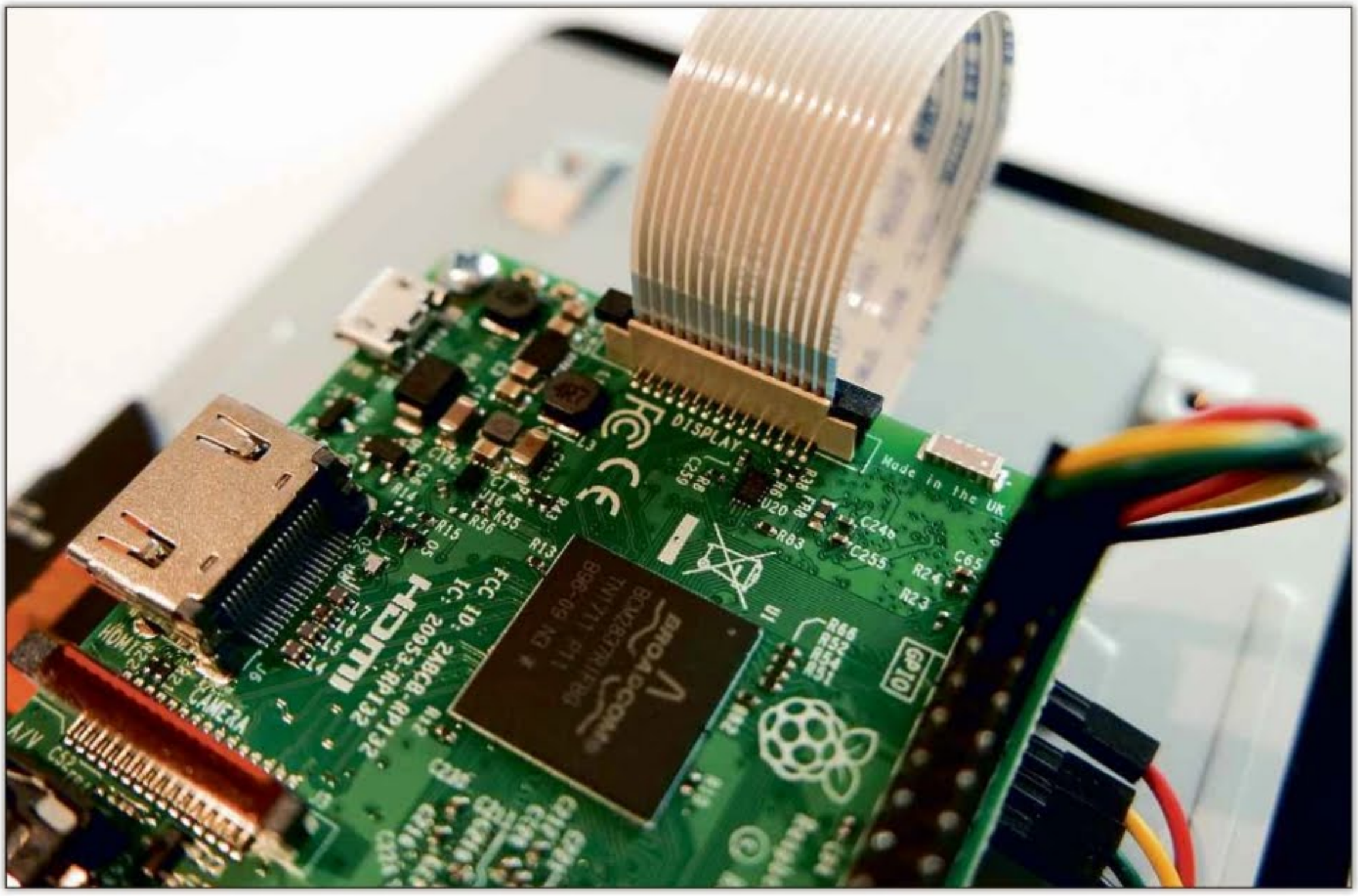
⬆ Use the four jumper wires to connect the screen's control board to the Pi

Next, download Raspbian, the standard operating system for a Raspberry Pi. We used the 'Buster with desktop' version as all we need is a basic desktop OS without the extra 800MB of software. Once downloaded, use a tool to 'flash' the image to the microSD card. We like Rufus for this job (*rufus.ie*), although others prefer Etcher (*www.balena.io/etcher*). You have to use these tools, as merely copying the OS image to the microSD card won't make the card bootable; that's the difference between flashing and copying.

Flashing the image to the card will create a small partition called Boot, which should automatically open in Explorer. Now open the View tab in Explorer and tick File name extensions. Right-click in the Boot partition and choose New, Text Document. When the file appears delete the whole filename (including the .txt) and replace it with ssh. Open this file and enter the following, replacing *SSID* and *PASSWORD* with your Wi-Fi network's name and password:

```
country=GB
ctrl_interface=DIR=/var/run/wpa_
 supplicant GROUP=netdev
update_config=1

network={
  ssid="SSID"
  psk="PASSWORD"
  key_mgmt=WPA-PSK
  }
```



⬆ Connect the Pi to the screen's control board using the ribbon cable. The printed side should be on the inside of the loop

Then click File, Save As and name the file wpa_supplicant.conf. Select All Files as the Save as type before clicking Save. This allows the Pi to connect to your Wi-Fi network automatically, and enables SSH so you can program it remotely.

Once done, remove the microSD card and plug it into the Pi. Then fit the Pi-and-screen combo into the case. This can be a bit fiddly, but a bit of perseverance will see the screen slide neatly into the case. To power up the Pi, connect your Micro USB cable into the power connector of the screen's control board. After 20 seconds or so, you should see the Raspbian desktop. And it will be upside down. That's not too much of a problem, but you'll need to connect to the Pi to put it right.

SETTING UP

First, you'll need to find the Pi's IP address; a neat trick is to use the ping command. Press the Windows key, type **comm** and hit Enter to open the Command Prompt. Then type **ping raspberrypi** and you'll see four replies, all of which list the same IP address (something like 192.168.1.XXX). Then use an SSH tool such as PuTTY (see *tinyurl.com/ssh-putty*); enter that IP address in the Host Name field and click Open. Click Yes to the warning and a text-input window will appear. Log in with the standard credentials – pi and raspberry – and you're ready to start sorting out the Pi.

Before doing anything, you should update the password. Enter **sudo passwd** and follow the prompts. Then update the software: enter **sudo apt-get update && sudo apt-get upgrade -y**. Next, we'll fix that upside screen. Enter **sudo nano /boot/config.txt** and find the framebuffer_width and framebuffer_height entries. Remove the hash at the front of both lines and change the values to 800 and 480 respectively. Then scroll to the bottom of the file and enter:

```
#Rotates display
display_rotate=2
```

To save your changes, press Ctrl-O, Enter, Ctrl-X. This fix will only rotate the image of the desktop, but not the

```
Command Prompt
Microsoft Windows [Version 10.0.18362.356]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\Clive>ping raspi
Ping request could not find host raspi. Please check the name and try again.

C:\Users\Clive>ping raspberrypi

Pinging raspberrypi.local [192.168.1.74] with 32 bytes of data:
Reply from 192.168.1.74: bytes=32 time=100ms TTL=64
Reply from 192.168.1.74: bytes=32 time=5ms TTL=64
Reply from 192.168.1.74: bytes=32 time=5ms TTL=64
Reply from 192.168.1.74: bytes=32 time=5ms TTL=64

Ping statistics for 192.168.1.74:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 5ms, Maximum = 100ms, Average = 28ms
```

⬅ Use the ping command to find your Pi's IP address quickly

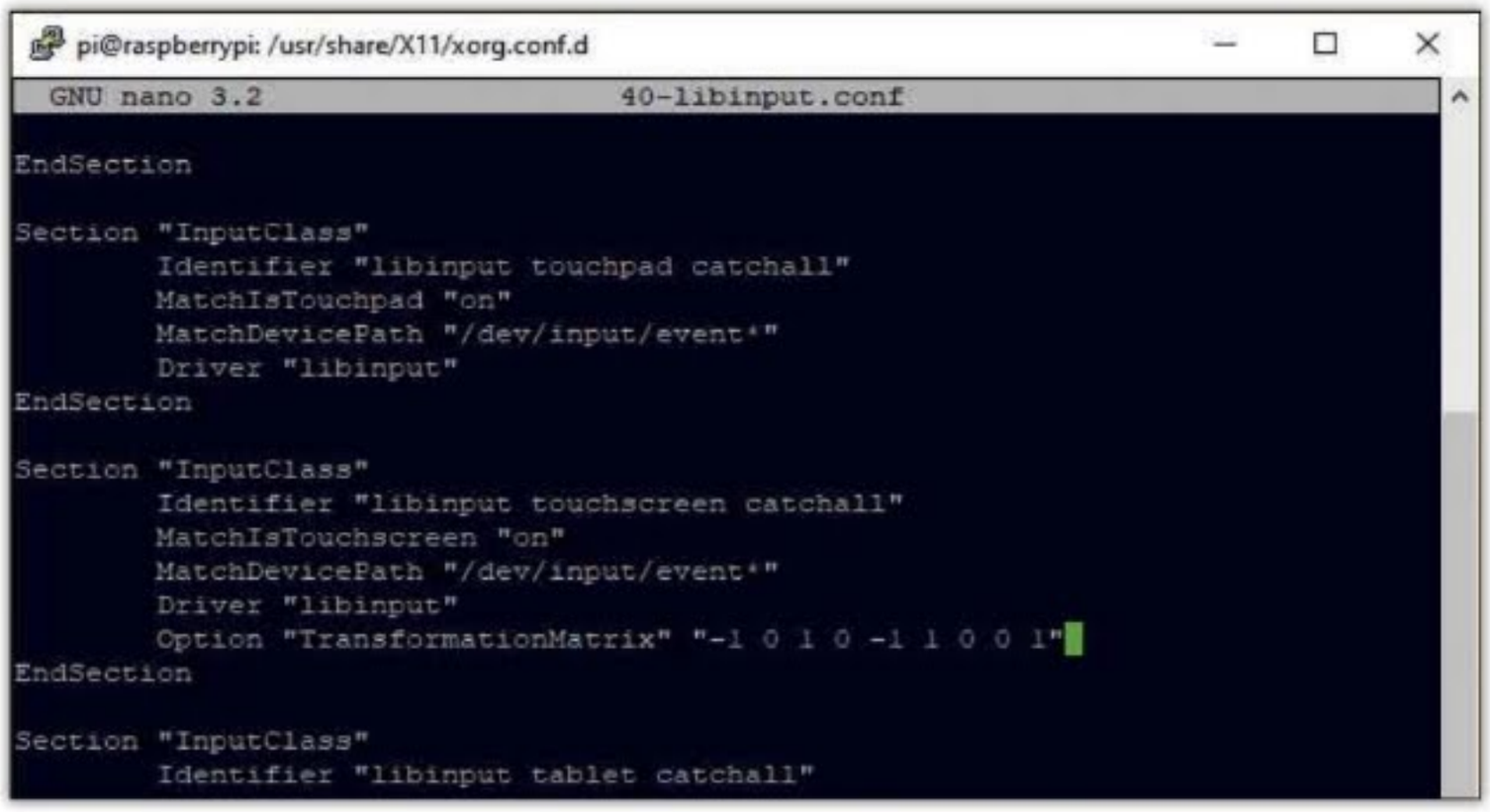
⬆ You can power up your touchscreen jukebox using the Micro USB port on the screen's control board

touchscreen controls. To fix that, enter **sudo nano /usr/share/X11/xorg.conf.d/40-libinput.conf**. Scroll through this file to find the entry with 'libinput touchscreen catchall'. Add the line **Option "TransformationMatrix" "-1 0 1 0 -1 1 0 0 1"** between Driver and EndSection. Press Ctrl-O, Enter, Ctrl-X to save that change. Now enter **sudo reboot** and the Pi should reboot with the desktop and touch controls the right way up.

Whether you're building a self-contained unit or a control panel for a wireless speaker, you'll need to configure how the Pi boots. Enter the following:

```
mkdir -p /home/pi/.config/lxsession/
 LXDE-pi/
cp /etc/xdg/lxsession/LXDE-pi/
 autostart /home/pi/.config/lxsession/
 LXDE-pi/autostart
```

This transfers the autostart file to the Pi user; as that's the user that logs in by default, that user needs its own autostart file.



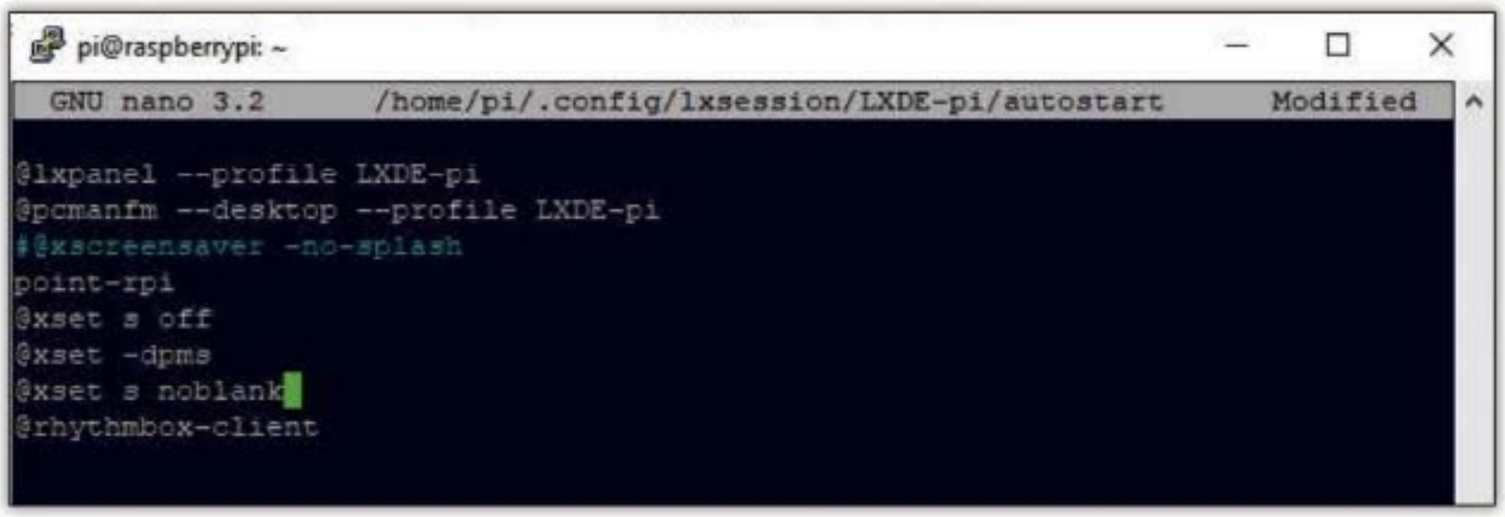
⬆You need to edit some config files to flip the desktop and touchscreen controls

OPTION 1: SELF-CONTAINED UNIT

For the self-contained option, we'll use music stored on the Pi and a music player. Simply plug some PC speakers into the mini-jack of the Pi and you've got a self-contained touchscreen jukebox. Let's transfer the music files first. The easiest tool to use is WinSCP (see *winscp.net*). Connect to your Pi using its IP address, agree to the warning, and you'll see two panes of folders: the left is your PC and the right is the Pi. You just select the files on your PC and copy them over to the Pi's Music folder.

While you're transferring your music collection, go back to your PuTTY SSH window and install the music player. Rhythmbox has a party mode that's a bit neater for our use. Type **sudo apt-get install -y rhythmbox unclutter**. The Unclutter app hides the mouse cursor when it's not in use, which makes the build a bit neater.

Once all the files are copied over and Rhythmbox has installed, you can edit that autostart file: **sudo nano home/pi/.config/lxsession/LXDE-pi/autostart**. Insert a hash before the line xscreensaver -no-splash (which 'comments it out', meaning the line will be ignored). Then add the lines



⬅ Use the LXDE-pi autostart file to suppress some options and auto-launch Rhythmbox

⬇ Rhythmbox's Party Mode gives you a full-screen music player that's touch-friendly

⬆ ZenPoint's DigitalCenter software turns your Windows PC into a jukebox

@xset s off, **@xset -dpms**, **@xset s noblank**, **@rhythmbox-client** at the end. Press Ctrl-O, Enter and Ctrl-X to save. Then enter **sudo reboot** and you should see the Pi reboot and automatically launch Rythmbox.

Unfortunately, there's no way to force the fullscreen Party Mode layout, so you'll have to do that manually. Open the Settings menu (the cog in the top-right), open the View menu and then tick Party Mode.

OPTION 2: A CONTROL PANEL

If you have some wireless speakers that can be controlled through a web browser, you can use a Pi-powered touchscreen to make a neat control console. Rather than install a music player, we instead need to use a web browser. Chromium (the open-source web browser upon which Google's Chrome is built) has a kiosk mode, so that's what we'll use.

SSH into the Pi and enter **sudo apt-get install -y chromium x11-xserver-utils unclutter**. This also installs the Unclutter app to hide the mouse cursor and make the final build a bit neater. Once Chromium has installed (in the latest version of Raspbian, it already is) you can edit the autostart file. Add a hash before the @lxpanel and @xscreensaver lines (to tell Raspbian to ignore those lines), and then add the following to the end of the file:

```
@xset s off
@xset -dpms
@xset s noblank
@sed -i 's/"exited_cleanly": false/
 "exited_cleanly": true/' ~/.config/
 chromium/Default/Preferences
@chromium-browser --noerrdialogs --
 kiosk http://<ip.address> -incognito
```

The penultimate line ensures that your console recovers neatly if it fails, while the switches (the commands following the double-dashes) for Chromium in the last line suppress warnings and again make the

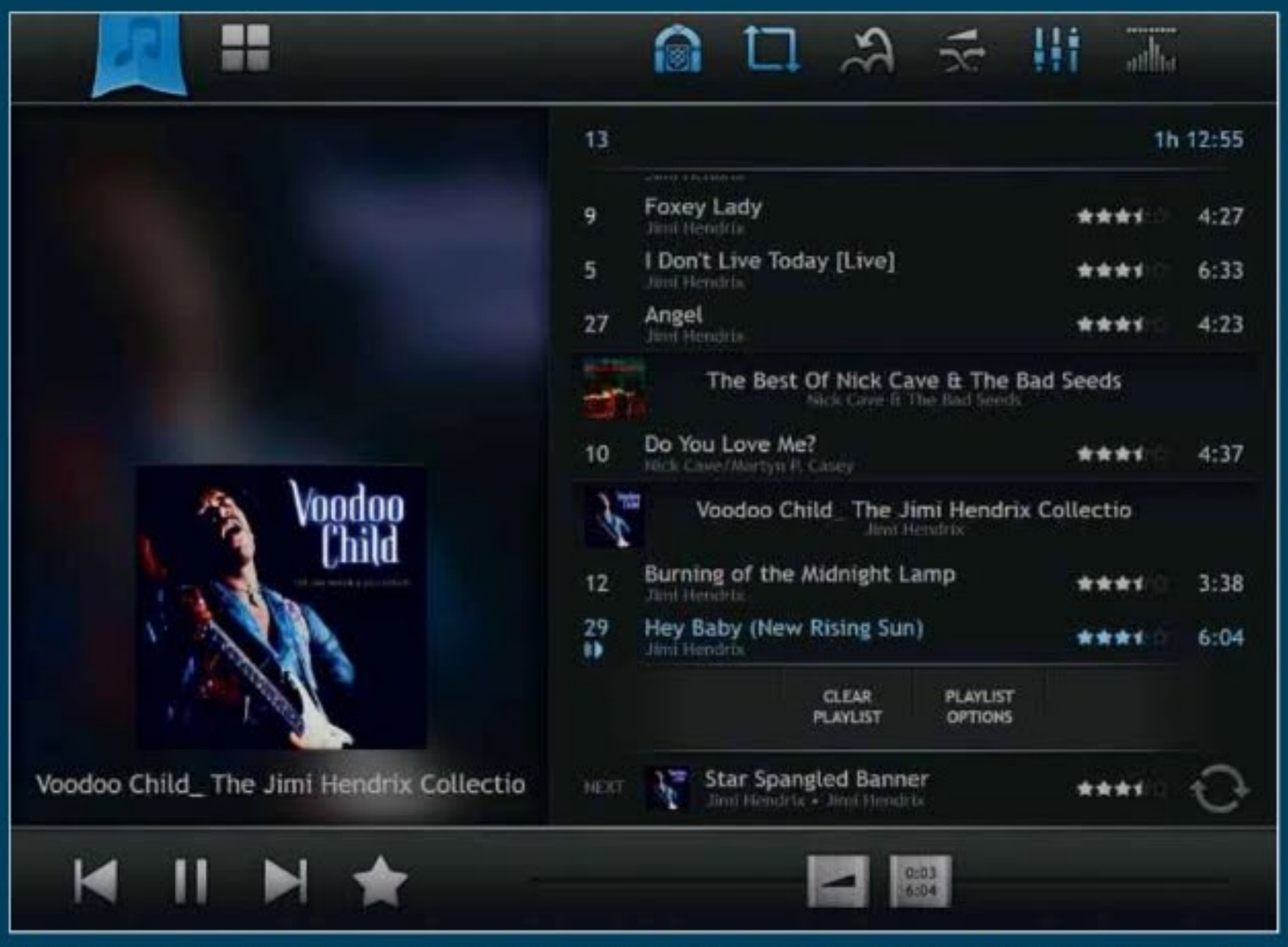
⬅ Volumio turns a Pi into a wireless Apple AirPlay speaker

Option 3: Reusing old Windows hardware

Repurposing some old Windows hardware – whether a desktop or a laptop – is relatively easy. Just get a touchscreen and install some software. There's no coding required, as there are plenty of bespoke jukebox applications scattered across the internet. However, only two are free, and we're not entirely convinced by one of those. While MediaMonkey (see *www.mediamonkey.com*) might be perfectly fine for general music playback (although we find it rather cluttered), its Party Mode lacks pizzazz and a truly finger-friendly interface.

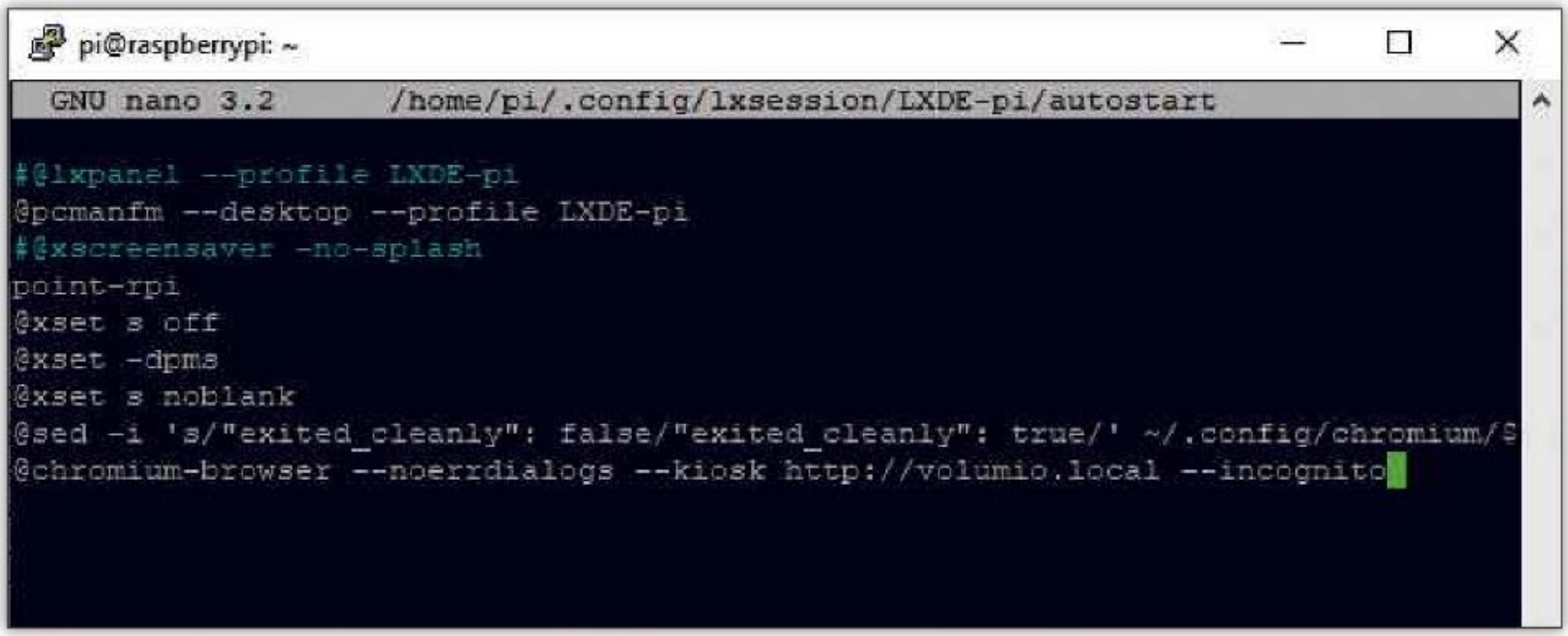
Which leaves us with the very simple Jukebox Arcade (see *www.extrastrength.com*), which is available through the Windows Store. The options are few, and the visual treatment could do with modernisation, but the controls are suitably chunky and the layout is very clear. The Auto-DJ feature is quite handy for a one-tap party mix, and tapping the diagonal-arrows button sends the app into fullscreen mode.

If you want something with a more modern aesthetic, Microsoft's Groove Music isn't too bad in fullscreen mode. However, it's too easy to turn off fullscreen mode, which spoils its effectiveness as a reliable jukebox alternative.



There are plenty of jukebox applications to choose from, but most aren't free – Albumplayer (pictured) costs over £30 a year

Given how impressive a touchscreen jukebox can be, it's not too surprising to find a mini-industry based around jukebox software. Among the more popular are Albumplayer (see *www.albumplayer.com*, €36.50/yr), ZenPoint DigitalCenter (see *www.zenpoint.org*, $39) and TouchJams (see *www.touchjams.com*, £40). These applications not only look impressive, but they incorporate all kinds of extras, from crossfades and music chart integrations to lyrics and karaoke support. All three of these players have free trial versions.



The Chromium web browser can launch in kiosk mode, which makes for a very neat control panel

system run smoothly. Hit Ctrl-O, Enter and Ctrl-X to save those changes and exit. If your speakers use the mDNS system (also called Bonjour or Zeroconf), then you can use its '.local' address rather than its IP address. This gives your control panel a bit more resilience, should your speaker be given a new IP address. For example, we used the Volumio software to turn a Pi into a wireless Apple AirPlay speaker (see *volumio.org*). The name you give your speaker will also be its mDNS name, so http://kitchen.local or http://office.local.

Once you've updated the autostart file, enter **sudo reboot**. All going well, the web interface of your speaker should appear in fullscreen mode, and with no ugly mouse pointer. CS

NEXT MONTH

TIGHTEN UP YOUR COMPUTER'S SECURITY

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Zygote

While waiting for his online pizza delivery to arrive, **Zygote** checks out the Rainbow Spa Erotic Massage Empire – purely in the interests of journalistic research, of course

.UK OFF

Colin McDermott was puzzled to receive a bill from 123-reg, which is the biggest internet domain name registrar in the UK. The bill for £11.99 had been issued to Mr McDermott for the 'renewal' of a .uk domain name that he had not wanted and never ordered.

Several other consumers then reported similar incidents, and Zygote believes that the root of the problem is simple to explain. It's a scam. Not only is it a scam, but it's a scam perpetrated by 123-reg itself.

The common .co.uk domain name category has been around since 1985, but the .uk domain is much more recent. It seems that customers who already own the former are being automatically billed for the latter without any explanation, and Zygote would like an explanation of the word 'renewal' that appears in these so-called invoices.

Zygote would also like an explanation from Nominet, the regulatory overseer of UK internet domains. It was Nominet that urged the creation of these new .uk domains two years ago, despite sensible and well-argued objections, and as well as 123-reg and the other registrars, it is Nominet that will benefit to the tune of millions of quid a year from suckers duped into paying for something they don't need and never asked for.

Readers may be interested to know that Nominet profits have risen from £28m to £43m since the .uk domains were introduced, and that the average salary of Nominet directors has risen by over 50% during the same period.

BOOK KEEPING

The EU's Intellectual Property Office has granted Facebook the European trademark to its own name, which Zygote considers to be perfectly proper. What Zygote considers to be stark-raving bonkers is Facebook's latest application to the Europeans to trademark the word 'book'.

Trademarks used to be restricted to brand or product names, but now anything goes, including holograms, colours, patterns, animations and sounds. In which case, Zygote is applying for a trademark on two fingers in the shape of a reversed V, rhythmically moving up and down.

Meanwhile, Facebook's Libra crypto-currency has been given the two fingers by the French. Their finance minister Bruno Le Maire says, "We cannot authorise Libra on European soil, the monetary sovereignty of European states is at stake."

He then went on to denounce Facebook's blockchain proposals as an open door to money laundering and terrorism. Which is much the same as any other currency as far as Zygote can see.

PIZZA THE ACTION

A hungry citizen of San Diego got frustrated waiting for their order to arrive from the local branch of Domino's Pizza. They used the Domino's app to embed a message saying they were being held hostage at their home in Sherman Heights, and needed their carbohydrate fix pronto.

Instead of a knock on the door from the pizza delivery courier, their door was kicked in by a squad of armed police in full tactical gear, who proceeded to rearrange the architecture.

According to Domino's Online Fun Facts service, customers have 15 digital ways to order. Make that 16.

DIS STRESS

In an attempt to uphold public decency, state censors in Kazakhstan tried to block access to a website run by the Rainbow Spa Erotic Massage Empire. They had reason to believe that Rainbow Spa had links to "an illegal prostitution ring", so they tried to pull the plug on two IP addresses associated with the website.

Unfortunately, when Zygote accessed Rainbow Spa online – for the purposes of research – it was up and running on a new server, and offering a full range of intimate services including "four-hand massage relieve of stress". Even more unfortunately, the result of this bungled attempt at censorship has also resulted in blocked access to 84,000 other websites and 9,500 domains.

INACTION REPLAY

Youthful videogame players who flock to the Belong Gaming Arena in central Bristol are delicate creatures, so the organisers at the location have done all they can to ensure the safety and wellbeing of the little darlings. Each of the play-pods, where the trigger-happy enthusiasts get plugged into their favourite entertainment, features an oversize Emergency Button within arm's reach.

The function of these alarms is not to call for help if suffering from a slipped disc, a seizure or even a bladder alert, but to summon up a freshly prepared snack via Deliveroo. What's more, the fodder is provided for free.

Well, free-ish. Players must be over 12 years old, not play longer than eight hours at a time, and pay up to £50 whether they eat their snack or not. Yummy.

SIN TAX ERROR

Parents were understandably upset when they accessed the Childcare Tax Service online portal run by Her Majesty's Revenue and Customs, only to be greeted by a security warning that "attackers might be trying to steal your passwords, messages or credit cards" due to the fact that the website was insecure. HMRC then took a wee while to issue a statement that included the words, "This technical issue has now been resolved and the service is working well".

And the cause of the problem? Some idiot had let the HTTPS secure certificate expire. Cost of the Revenue's tax credit spending in the current financial year is £26bn. The cost of a secure certificate is about £35. CS

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